Determinants of viral suppression to undetectable levels among a cohort of Kenyan adolescents and youths aged 15-24 years

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Abstract

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Introduction

The study evaluated factors that influence viral suppression among adolescents and youths living with HIV (AYLHIV) and described the historical context of their mental health, treatment behavior, and treatment outcome. It emphasized the significance of addressing mental health, stigma, social support, and Harmful alcohol use in enhancing treatment outcomes. Using standardized survey tools and retrospective data collection over one year, the research aimed to discern a one-year trend and assess the effectiveness of psychosocial interventions in promoting viral suppression.

Methods

We evaluated factors that influence viral suppression among AYLHIV and described the historical background of their mental health, treatment behavior, and treatment outcome using two complementary study designs nested within an ongoing HPV study. The study was performed in Thika, Kenya from October 2023 to March 2024. A cross-sectional study design was used to determine the burden and association of psychosocial factors on viral suppression in a cohort of AYLHIV, and a retrospective cohort study design was used to describe mental health status, treatment behaviors, the impact of interventions, and treatment outcomes over one year.

We administered validated survey questionnaires to 146 adolescents and youths on psychosocial factors related to viral suppression. AYLHIV) were asked to complete the PHQ-9 questionnaire, HIV Stigma Scale (HSS), Multidimensional Scale of Perceived Social Support (MSPSS), and Alcohol Use Disorders Identification Test (AUDIT) to determine the prevalence of depressive symptoms, perceived stigma, perceived social support, and harmful or hazardous alcohol drinking habits, respectively. We used the most current data on viral loads obtained within the three months of the survey's administration. Using both univariate and multivariate Poisson regression models, we evaluated the association between alcohol use, viral suppression, depression, stigma, and social support and calculated the relative ratio. For the retrospective cohort design, we extracted data from the 146 participants' routine medical records. We examined the Patient Health Questionairre-9 (PHQ-9) for depressive symptoms, any history of skipped medication within the previous two weeks, any completed interventions (e.g., adherence counseling, psychosocial counseling, and referrals depending on the severity of depressive symptoms), viral load measurements at baseline and month-12. To summarize the trends over the one year, we examined treatment outcomes such

as PHQ-9 scores, viral load results, and missed pills in the last two weeks at baseline, and compared with the same results at month 12.

Results

A total of 146 AYLHIV were enrolled. The median age was 22 years [Interquartile Range (IQR): 21-23 years), 139/146 (95.2%) were aged between 20 to 25 years, and more than half were female (75/146, 51.4%). Overall, 71.2% (95% CI: 63.9 - 78.5) achieved viral suppression at baseline and 119/146 (81.5%, 95%CI: 75.2 – 87.8) achieved at month 12. Overall, 14.4% (95% CI: 8.3 – 19.6) had mild/moderate depression symptoms, 58.0% (95% CI: 50.9 – 66.9) experienced high levels of HIV-perceived stigma, while only 1.4% (95% CI: 0.0 – 3.3) had low perceived social support. Additionally, 7.5% (95% CI: 3.2 - 11.8) had harmful or hazardous alcohol drinking habits. There was no statistically significant association between psychosocial factors and viral suppression on further analysis. At the start of the study, 13% of participants had depressive symptoms, 9.6% had missed taking their pills in the past two weeks, and 23.3% had received interventions. By the end of 12 months, the proportion of participants with depressive symptoms had decreased to 9.6%. However, the proportion of those who missed pills in the last two weeks had increased significantly to 27.4%. Additionally, the proportion of participants who received interventions had risen to 43.2%. Among the 146 AYLHIV, 34 received interventions at enrollment, while 63 received interventions at month 12. There was an increase in the proportion of AYLHIV who achieved viral suppression after receiving interventions from 55.6% at enrollment to 66.7% at month 12.

Conclusion

Our study provides valuable insights into the complex interplay between psychosocial factors and viral suppression among AYLHIV. Our findings highlight the prevalence of mental health issues, HIV stigma, social support, and alcohol dependence among AYLHIV. Notably, while a significant proportion reported high levels of social support, a considerable number experienced depressive symptoms and perceived HIV-related stigma.

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INTRODUCTION

Globally in 2021, approximately 1.7 million adolescents were living with HIV, with around 1.47 million residing in sub-Saharan Africa (SSA) (1). Young people aged 15-24 accounted for about 5 percent of all people living with HIV, with approximately 3.4 million globally in 2019 (1). In the same year, approximately 410,000 young people between 10 and 24 years were newly infected with HIV, with three-quarters of these new infections occurring among adolescents aged 10-19 years (1). HIV/AIDS ranks as the second most common cause of adolescent deaths globally and the leading cause of death among adolescents in SSA (2). Despite efforts, adolescents, particularly girls in high HIV epidemic areas, remain socially and economically vulnerable to HIV infection (3). In Kenya, AIDS-related deaths were estimated at 34,000 for adolescents and 46,000 for youths in 2017 (4). HIV/AIDS is the leading cause of death and morbidity among adolescents and youths in the country, with an estimated 51 percent of all new HIV infections occurring in this age group (5). Notably, HIV prevalence at around 15 years of age is similar for both genders but becomes almost four times higher among females by age 24. Adolescent girls and young women (AGYW) in SSA are disproportionately affected, being two to three times more likely to be infected with HIV than boys of the same age group (6). Approximately 59 percent of adolescents living with HIV globally were receiving antiretroviral therapy (ART) in 2021, with Kenya recording approximately 61 percent coverage (7). Adherence to ART during transitioning is likely to be influenced by the attainment of sexual reproductive developmental goals or milestones (8). Non-adherence and sub-optimal viral suppression outcomes during transitioning to adulthood are often characterized by instability, uncertainty, and stigma (8).

Despite advancements in HIV/AIDS treatment, a significant number of AYLHIV struggle with medication adherence, leading to suboptimal health outcomes (9). AYLHIV faces poor outcomes

in HIV care and treatment, with lower viral suppression levels compared to other age groups (10, 11). They often struggle with complex psychosocial factors and knowledge gaps about HIV prevention (12, 13). Determinants of adherence and viral suppression in SSA include stigma, substance abuse, socioeconomic challenges, and healthcare system constraints (14-21). There are also patient and family-related obstacles (17). The transition from childhood to adulthood poses challenges for adolescents living with HIV, affecting their adherence to ART and viral suppression (22). Mental health issues among AYLHIV are associated with poor viral load suppression, with limited resources for diagnosis and management in low- and middle-income countries like Kenya (23-27). Stigma and discrimination surrounding HIV/AIDS, limited access to mental health services, and a shortage of mental health professionals further exacerbate the problem in low- and middle-income countries like Kenya (26). Routine mental health screening is recommended by the National AIDS and STI Control Program (NASCOP) in Kenya (28).

Addressing the gaps and areas of concern related to psychosocial factors and medication adherence among AYLHIV is crucial. Understanding the specific factors influencing adherence in this population is essential to develop targeted interventions and support systems. By identifying the barriers to medication adherence and viral suppression, healthcare providers, policymakers, and support organizations can tailor strategies to address the unique needs and circumstances of this vulnerable population. We evaluated these factors influencing viral suppression among AYLHIV and described their mental health, treatment behavior, and outcomes in adolescents aged 15-24 who were under follow-up assessing their long-term response to the quadrivalent HPV vaccine.

METHODS

Study design

Two complementary study designs were used to address each specific aim. An analytical cross-sectional study design was used to determine the burden and association of psychosocial factors on viral suppression and a retrospective cohort study design to describe mental health status, treatment behaviors, impact of interventions, and treatment outcomes. Study procedures were integrated into an ongoing parent study. We administered validated survey questionnaires on psychosocial factors associated with viral suppression. We also abstracted the previous medical records on mental health trends, treatment outcomes, and viral load results. Viral load measurement was used as a measure of adherence to antiretroviral therapy.

Site and Population

The study was conducted at the Thika Partners in Health Research and Development (PHRD) research clinic in Kiambu County, central Kenya. According to 2023 data, the prevalence of HIV in Kiambu County was 2.13% (29). The study was nested within an ongoing longitudinal cohort study assessing the effectiveness and B-memory response to the 7 quadrivalent HPV vaccine, 9 years post-vaccination among HIV-infected boys and girls aged 15-24 years in Kenya.

Overview of the HPV study (the parent study)

The proposed work was nested within a longitudinal cohort study to assess the effectiveness of the quadrivalent HPV vaccine, 9 years post-vaccination among boys and girls living with HIV

aged 15-24 years in Kenya (NCT01446718), who were initially vaccinated at ages 9-14 years. Participants were followed for routine HIV standard of care together with administration of mental health screening (PHQ-9) every six months. Those with depressive symptoms received an intervention package of psychosocial counseling or referral depending on the severity. Adherence counseling was offered for those with detectable viral load and poor adherence. Viral load measurements were done at baseline and month 12. Viral suppression was defined as achieving a viral load of less than 200 RNA copies/ml

This study was nested on the HPV study so that we could be able to gain a more comprehensive understanding of the factors that influenced HIV care and management among this population, and also be able to identify modifiable factors that could be targeted through interventions to improve ART adherence and achieve long term viral suppression.

Data collection procedures

For the cross-sectional study (Aim one), we administered validated questionnaires to consenting participants to evaluate psychosocial factors. Depressive systems were assessed using the Patient Health Questionnaire (PHQ-9) (30). Participants were asked to rate how often they had experienced various depressive symptoms over the previous two weeks on a scale ranging from "not at all" to "nearly every day. HIV stigma was assessed using the HIV stigma scale (HSS), a 12-item Reinius scale with 4 domains developed by Maria Reinius, an abbreviation of the 40-item Berger's stigma scale (31). Participants were asked to rate how often they had experienced various forms of stigma on a 4-point scale, ranging from "never" to "often." The lowest score was "one" and the maximum score was "four" per item. The tool scale permitted us to assess the extent to

which AYLHIV experienced stigmatizing attitudes and behaviors from others, including healthcare providers, family, friends, and the general community. The Multidimensional Scale of Perceived Social Support (MSPSS) was used to assess AYLHIV's perceived level of social support in their lives (32). Participants were asked to rate the level of social support they received from family, friends, and significant other support, on a scale ranging from "very strongly disagree" to "very strongly agree. The burden of alcohol use was assessed using the Alcohol Use Disorders Identification Test (AUDIT), a 10-item screening tool developed by the World Health Organization (WHO) to identify individuals who may have alcohol use disorders (33). For aim two, we abstracted routine patient records from baseline and month 12 visits, which had been stored securely in the data office. Specifically, abstracted records included viral load measurements, assessment for depressive symptoms based on PHQ-9, adherence assessed through missed pills in the last two weeks, and any treatment interventions received including enhanced adherence and psychosocial support and counseling. We described and compared adherence reports and viral suppression at enrollment and one year post-enrollment in the parent study. The description entailed how mental health status and viral suppression levels had behaved over the one year. We looked at the interventions done such as adherence and psychosocial support and counseling during the follow-up period, and their impact on mental health, treatment behaviors, and viral suppression. All collected data were entered into Redcap and were checked for any errors or inconsistencies and cleaning was done if required.

Outcomes

For aim one, the primary outcome was viral suppression which was defined as a viral load of less than 200 RNA copies/ml. The covariates evaluated were depression, stigma, social support, and

harmful alcohol use. For stigma, total scores from the PHQ-9 tool ranged from 0 to 27, with higher scores indicating greater severity of depressive symptoms. A score of 5 or greater was considered to be a positive screen for depressive disorder (30).

HIV stigma was summarized using total scores from the HSS scale that consisted of 12 items covering four dimensions of HIV-related stigma: personalized stigma, disclosure concerns, negative self-image, and concerns with public attitudes (31). Higher scores on the scale indicated greater levels of stigma experienced by the individual. The resulting score was then used as an overall measure of the level of HIV-related stigma with a score of 1 to 12 indicating low levels of perceived HIV-related stigma, 13 to 24 indicating moderate levels of perceived HIV-related stigma, and 25 to 48 indicating high levels of perceived HIV-related stigma experienced by the participant. A positive screen for high perceived HIV-related stigma was a score of 25 and above.

Social support was determined based on 12 items on the MSPSS tool that covered four dimensions of perceived social support (32). Participants were asked to rate how they felt about various forms of social support on a 7-point scale, ranging from "Very strongly Disagree" to" "Very strongly agree". Total scores ranged from 12 to 84. A score of 12-29 indicated low perceived social support, 30-49 indicated moderate perceived social support and 50-84 indicated high perceived social support. In this study, a score of 29 or less indicated low perceived social support.

Scoring the AUDIT Scores for each question ranged from 0 to 4 (33), with the first response for each question (e.g. never) scoring 0, the second (e.g. less than monthly) scoring 1, the third (e.g. monthly) scoring 2, the fourth (e.g. weekly) scoring 3, and the last response (e.g. daily or almost daily) scoring 4. For questions 9 and 10, which only had three responses, the scoring was 0, 2, and 4 (from left to right). A score of 0-7 indicated low-risk alcohol drinking, a score of 8 or more was

associated with harmful or hazardous drinking, and a score of 13 or more in women, and 15 or more in men, was likely to indicate alcohol dependence.

More information was collected from participants on knowledge of viral load results on adherence, knowledge of HIV undetectable equal to untransmittable, and membership or participation in a support group. We collected the most recent viral load measurements that were close to the date of questionnaire administration or done within three months of survey administration. The recent viral load report was extracted from the participant's medical records.

Aim two was descriptive, the key outcomes of interest were mental health status, treatment behaviors, the impact of interventions, and treatment outcomes at baseline and 12 months. As for Aim One, an abstracted score of 5 or greater on the PHQ-9 was considered to be a positive screen for depressive symptoms, which further examined whether there was psychosocial support and counseling. The missing pills in the last two weeks measured the treatment behaviors. The treatment outcomes were measured through viral suppression levels and were defined according to WHO as any patient who achieved a viral load of less than 200 RNA copies per ml (34). Additionally, virological failure in this study was defined as treatment with ART failing to achieve viral suppression of viral load lower than 200 copies/ml.

Ethical Consideration

Before the study commencement, the study staff were trained on the protection of human subjects. Before enrollment, study participants were asked to give their informed consent, and were assured of confidentiality measures. The study assigned each participant a unique research identification number. Participants were contacted and recruited using personal identifiers. These data were

stored in link logs accessible only to the study team and were stored in a lockable cabinet in a secure place. All consent forms and study-related paperwork were maintained safely in a locked cabinet that was only open to the study staff. Password protection was used for digital databases

The study was approved by the Institutional Review Board (IRB) at the University of Washington, the Kenya Medical Research Institute's Scientific and Ethics Review Unit (KEMRI-SERU), and from National Commission for Science Technology and Innovation (NACOSTI).

Power/sample size

The sample size was fixed at 158 based on available participants enrolled in the parent study. We assumed that 10% of these respondents would not participate in the study and calculated the power using a sample size of 142 participants. We estimated that 20% would have a stigma, depression, and lack of social support while 80% of the participants would not have the exposures. We further estimated that 10% of those without any of the psychosocial factors would be poorly suppressed, while 38% of those with the exposure variables would be poorly suppressed (35-37). Power was estimated using the Stata program as follows: Power two proportions 0.1 0.38, test(chi2) n(142) nratio(4) nfractional continuity

Estimated power for a two-sample proportions test
Pearson's chi-squared test
H0: p2 = p1 versus Ha: p2! = p1
Study parameters:

Alpha = 0.0500
N = 142.0000
N1 = 28.4000

N2 = 113.6000

N2/N1 = 4.0000

Delta = 0.2800 (difference)

p1 = 0.1000

p2 = 0.3800

Estimated power:

Power = 0.8174

Statistical analysis

Socio-demographic characteristics and HIV knowledge were summarized using means, standard deviation, median, and interquartile range (IQR) for continuous variables and frequencies and proportions for the categorical variables. The point prevalence for mental health outcomes, HIV stigma, social support, and harmful alcohol dependence are presented with the corresponding Poisson 95% confidence intervals (CI). Viral suppression, defined as a viral load below 200 copies/ml at month 12, is also presented using the point prevalence. Noteworthy, AYLHIV were categorized as having low/moderate depressive symptoms if the PHQ-9 was ≥5, High levels of perceived HIV-related stigma if HSS was ≥25, Low perceived social support if MSPSS was ≤ 29, and harmful or hazardous drinking if AUDIT was ≤7. For aim one, modified Poisson model regression was used to evaluate the association between psychosocial factors (mental health, HIV stigma, social support, and harmful alcohol use) and viral suppression. First, a univariate modified Poisson model was fit, and all psychosocial variables were included in the multivariate regression model while adjusting for age, sex, relationship status, financial independence, and employment status. The association of psychosocial factors with viral suppression is reported as prevalence rate

ratios and corresponding 95% CI. Proportions and bar charts were used to display trends in overall viral suppression, as well as viral suppression among those who received psychosocial support or adherence interventions, both at the beginning of the study and after one year. A significant level of 5% was used across all data analyses. All data analyses were conducted using R version 4.3.1 statistical software.

RESULTS

Social demographic characteristics and HIV knowledge

A total of 146 AYLHIV were involved in this study. Table 1 summarizes the socio-demographic characteristics and their HIV knowledge. The median age was 22 years (IQR: 21-2 3 years), and 139/146 (95.2%) were 20 to 25 years. More than half were female (75/146, 51.4%), financially dependent (75/146, 51.4%), and single or separated (95/146, 65.1%). Most were in employment (56/146, 38.4%) and the majority of those employed earned less than Kshs. 10,000 per month (49, 33.6%). The majority reported having no income (47.9%) and had participated in the support group (103, 70.5%). More than three-quarters knew HIV Undetectable = Untransmittable (U=U) (129/146, 88.4%). Although a majority (132 [90.4%]) thought it is extremely important to maintain a low viral load through medication adherence, more than half (85 [58.3%]) reported that they did not understand how viral load relates to HIV treatment.

Prevalence of psychosocial factors

Table 2 presents the prevalence of psychosocial factors among AYLHIV. Overall, 14.4% (95% CI: 8.3 – 19.6) had mild/moderate to severe depressive symptoms. Based on the HIV stigma scale, 58.0% (95% CI: 50.9 – 66.9) experienced high levels of HIV-perceived stigma, while 1.4% (95% CI: 0.0 – 3.3) had low perceived social support. Additionally, 7.5% (95% CI: 3.2 - 11.8) had harmful or hazardous drinking habits. Overall, 119/146 (81.5%, 95%CI: 75.2 – 87.8) achieved viral suppression within three months of survey administration. Those who achieved viral suppression exhibited a lower proportion of mild or moderate depressive symptoms (11.8% vs. 25.9%), harmful or hazardous drinking (5.9% vs. 14.8%), and a higher proportion of high perceived social support (91.6% vs. 85.2%) compared to those who did not achieve viral suppression.

Association of psychosocial factors with viral suppression among AYLHIV.

Table 2 presents the results following univariate and multivariable log-binomial regression analyses for psychosocial factors associated with viral suppression. The depressive symptoms, HIV stigma, social support, and alcohol dependence were not significantly associated with viral suppression, respectively. In the multivariable model, after adjusting for age, sex, relationship status, financial independence, and employment status, the association between depression, HIV stigma, social support, and alcohol and viral suppression remained statistically insignificant.

Trends of mental health status, interventions, and suppression outcomes at enrolment (Month 0) and month 12.

Table 3 presents the proportion of AYLHIV who received mental health interventions and achieved viral suppression at enrollment (baseline) and after one year. At baseline, the proportion of participants with missed pills in the last two weeks was 9.6% and 23.3% of participants received interventions of psychosocial or adherence support counseling. Overall, the proportion of those with depressive symptoms decreased from 13% at baseline to 9.6% at Month 12. Similarly, we found that the proportion of participants with viral suppression increased from 71.2% at enrollment to 81.5% at Month 12. Furthermore, the proportion of those who received interventions such as psychosocial or ART adherence counseling increased from 23.3% at baseline to 43.2% at month 12. Among the 146 AYLHIV, 34 received interventions at enrollment, while 63 received interventions at month 12. The proportion of participants who achieved viral suppression after receiving interventions increased from 55.9% at baseline to 66.7% at month 12.

DISCUSSION

In this study among Kenyan AYLHIV, we found that low and moderate to severe depression was 14.4%. Our study revealed a low prevalence of low and moderate to severe depression. In studies conducted in Kenya, 48.8% of children and adolescents infected with HIV had psychiatric morbidity, with major depression being the most common condition (38). Youth living with HIV are four times more likely than their healthy peers to experience depression (37), and more than 25% of adolescents infected with HIV in Kenya had depression, with higher rates among females and older adolescents. The percentage of people who felt stigmatized because of their HIV status was 58.0% for high stigma and 97.7% for moderate to severe stigma. Studies conducted in Kenya on adolescents 13-19 years living with HIV revealed that stigma around the virus was widely felt, 54% of participants reported ongoing fears of stigmatization, with experiences in pre-adolescence

being a significant factor (38), 25.9% of participants experienced high levels of felt stigma related to being avoided by others (39). One point four percent of respondents reported low perceived social support. A study conducted in Ethiopia found a prevalence of low perceived social support to be 12.6% (40). In this study, 7.5% of AYLHIV reported drinking in an unsafe way. These findings are consistent with another study conducted in Kenya among young individuals living with HIV, which showed an incidence of hazardous alcohol consumption of 5.4% (41). We found that viral suppression was high in this study population (81.5%), which is below the 95-95-95 World Health Organization target. A previous investigation on the suppression of viruses in low- and middle-income countries following a year of antiretroviral medication revealed that 63% of patients had achieved suppression of less than 200 copies/ml (42).

Our findings provide insight into the intricate interactions that occur between treatment practices, psychosocial factors, and viral suppression in AYHIV. There is conflict about the relationship between multi-dimensional psychosocial factors and treatment outcomes. We did not find any statistically significant association between viral suppression and all the psychosocial factors explored in this study even after adjusting for age, sex, relationship status, financial independence, and employment status. Specifically, despite depression being a common occurrence in persons living with HIV, our study found no association of depressive symptoms with viral suppression. Several studies have evaluated an association between depressive symptoms and viral suppression among this group with mixed results. There was no association noted between depressive symptoms and viral suppression in, Uganda, Zimbabwe, South Africa, and the US (43, 44). The non-significance of our results could be a result of inadequate sample size which may have led to insufficient statistical power to answer our research question. There are several possible explanations for why many studies have found no association between psychosocial factors and

HIV viral suppression. First, the relationship between psychosocial factors and HIV viral suppression is complex and might be mediated by other variables, such as adherence to treatment, access to healthcare, and social support systems, all of which might not be adequately controlled for in some studies. Second, psychosocial factors might have varying levels of effects depending on the heterogeneity in study populations (e.g., demographics, HIV disease stages, access to ART). Third, with highly efficacious ART regimens, biological factors might overshadow psychosocial influences and it might be difficult to discern the influence of specific psychosocial factors on the level of successful viral suppression in study populations. Fourth, cross-sectional designs are common in these studies, which can make it difficult to establish causality. Fifth, the type and quality of psychosocial interventions vary widely across studies, and inconsistencies in intervention design could lead to mixed results. For example, continuous and varying levels of adherence counseling and psychosocial support intervention might mask the intrinsic influence of these factors on treatment outcomes. Lastly, cultural differences can also influence both psychosocial experiences and responses to HIV treatment, potentially leading to variations in study outcomes across different cultural contexts.

However, our findings and those of others (43, 44) are contrasted with other studies that found statistically significant associations between depression and viral suppression. For example, Kingori C. et al found that in Kenya, depression negatively influenced HIV-positive people's general health and may have an effect on viral suppression (45). The potential effect of these psychosocial factors is especially important for adolescents and youths, who may already be struggling to achieve suppression due to other multi-dimensional factors including age, gender, and antiretroviral therapy treatment duration (46). The developmental stage of adolescents can also have an impact on their psychosocial and emotional functioning, which may exacerbate the

effect of depression on the suppression of viral growth (47). Targeted treatments, however, may be able to lessen the negative effects of depression on viral suppression in adolescents and youths. This is because facilities with youth-friendly services and qualified staff have been linked to greater rates of viral suppression in this age group (48).

Similarly, we did not find a statistically significant association between stigma and viral suppression, but a considerable proportion of individuals (58%) experienced stigma due to HIV, underscoring the shared social barriers experienced by this community. This high level of stigma is consistent with findings from a different Kenyan study that looked at HIV-positive students and found that internalized stigma was highly prevalent (49, 50). People living with HIV/AIDS may experience social isolation, fear of discrimination, and feelings of humiliation as a result of stigma (51). These unpleasant experiences could discourage people from regularly following their drug regimens (50). Stigmatized adolescents and youths may be less inclined to ask for help or to speak honestly about their HIV status and unable to seek healthcare services, which could result in poor medication adherence and poorer rates of viral suppression (52). This is further aggravated by the fear of bias and discrimination, which is visible in a variety of situations, such as communities and schools (53-55). Interventions that strengthen social support, raise HIV acceptance in the community, and strengthen healthcare structural competency are necessary to overcome these obstacles (56).

This study found a high level of perceived social support. Many facets of client's lives, such as access to resources, adherence to ARVs, self-acceptance, and healthy living, can be positively impacted by social support (57, 58) and different kinds and sources of social support such as instrumental, emotional, and informational have been noted (57, 58). Good social support among youths living with HIV has been linked to improved general health in HIV-positive people (39),

and friend social support was linked to a 10% increase in the likelihood of suppressing viral load (59), inversely low perceived social support is linked to worse viral suppression (57, 60, 61). The beneficial effects of social support on the mental and behavioral outcomes of this population highlight how important it is. (62)

Harmful or hazardous alcohol consumption has a complex effect on the suppression of HIV in adolescents and youths. We found no significant association with viral suppression. However, interventions aimed at reducing alcohol consumption have been demonstrated to enhance HIV outcomes (63, 64), despite some studies finding no significant interaction between depressed symptoms and hazardous alcohol use on viral suppression (45). Risky alcohol consumption is often linked to lower levels of ART use, adherence, and viral suppression (63, 65). Nevertheless, these studies have not specifically examined the effect of risky alcohol consumption on viral suppression in youths living with HIV. To comprehend the particular difficulties and solutions for this demographic, more studies are required.

Furthermore, we found promising trends in treatment behaviors and outcomes over one year. The proportion of participants with depressive symptoms decreased, while the percentage of those achieving viral suppression increased significantly after receiving psychosocial or ART adherence counseling support. Enhancements in caregiver supervision and communication have also been associated with reduced sensations of anxiety and hopelessness (66). Notwithstanding these encouraging developments, a significant segment of the participants continued to report missing treatments during the previous two weeks, suggesting persistent difficulties with treatment compliance (67).

HIV treatment has advanced, but many AYLHIV still struggle to follow their regimens, which can lead to missing doses and ongoing issues (67, 37). Numerous reasons, including side effects, the

regimen's complexity, forgetfulness, and taking drug holidays contribute to nonadherence (68). To address these challenges, it is imperative to provide ongoing monitoring and support, which includes education, motivation, regimen simplification, and individualized treatments (68, 69).

Our study has noteworthy strengths. First, it offered insightful information about the psychological variables affecting viral suppression in AYLHIV. Second, the findings are more reliable and comparable when standardized instruments are used to evaluate alcoholism, social support, HIV stigma, and mental health. Thirdly, by examining patterns over one year, we gained a thorough understanding of the interplay between psychosocial factors and viral suppression over time. Fourth, the study focuses on youths and adolescents living with HIV, underscoring its relevance for informing focused interventions and support services meant to enhance health outcomes for this population. All things considered, these advantages support the study's findings' validity and importance in expanding our understanding of HIV treatment and management.

The study had several limitations that should be considered when interpreting the findings. Firstly, the results may not be fully generalizable due to the study's specific location in Thika, Kenya, which may not represent other geographic areas or populations with different healthcare settings or sociocultural contexts. Secondly, the sample size might have been limited, potentially impacting the statistical power and precision of the results. Thirdly, reliance on self-report measures for data collection, particularly regarding medication adherence and psychosocial factors, introduces the possibility of recall bias, as participants may struggle to accurately recall and report past experiences or behaviors. Additionally, there's a risk of social desirability bias, where participants may provide responses they perceive as socially desirable, leading to an overestimation of adherence or underreporting of sensitive issues like mental health challenges or social stigma. Moreover, the unavailability of the last 9 years of mental health data in medical records hindered

the ability to compare trends in interventions and treatment outcomes over the anticipated period. Finally, the cross-sectional study design limits the assessment of the temporal relationship between exposure, such as depression, stigma, and social support, and the outcome, viral suppression, necessitating cautious interpretation of causality

Conclusion

In conclusion, our study highlights the complex relationship between psychosocial factors and viral suppression among AYLHIV. We observed low levels of mental health issues, high perceived social support, and low levels of harmful alcohol use but high perceived HIV-related stigma. Despite these challenges, more than four-fifths achieved viral suppression at month 12, indicating some success. Interventions like counseling showed promise in improving outcomes, but a higher proportion reported missing pills at month 12, suggesting ongoing adherence challenges. Addressing mental health, community mobilization, and education to enhance the reduction of HIV-related stigma, and enhancing social support are crucial for optimizing treatment outcomes and achieving viral suppression in this vulnerable population. Regular substance use screening in HIV care settings is necessary. Future research should focus on tailored interventions for this vulnerable population, including larger longitudinal studies to assess the impact of psychosocial factors on viral suppression and qualitative studies to delve deeper into the complexities of treatment outcomes.

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TABLES AND FIGURES

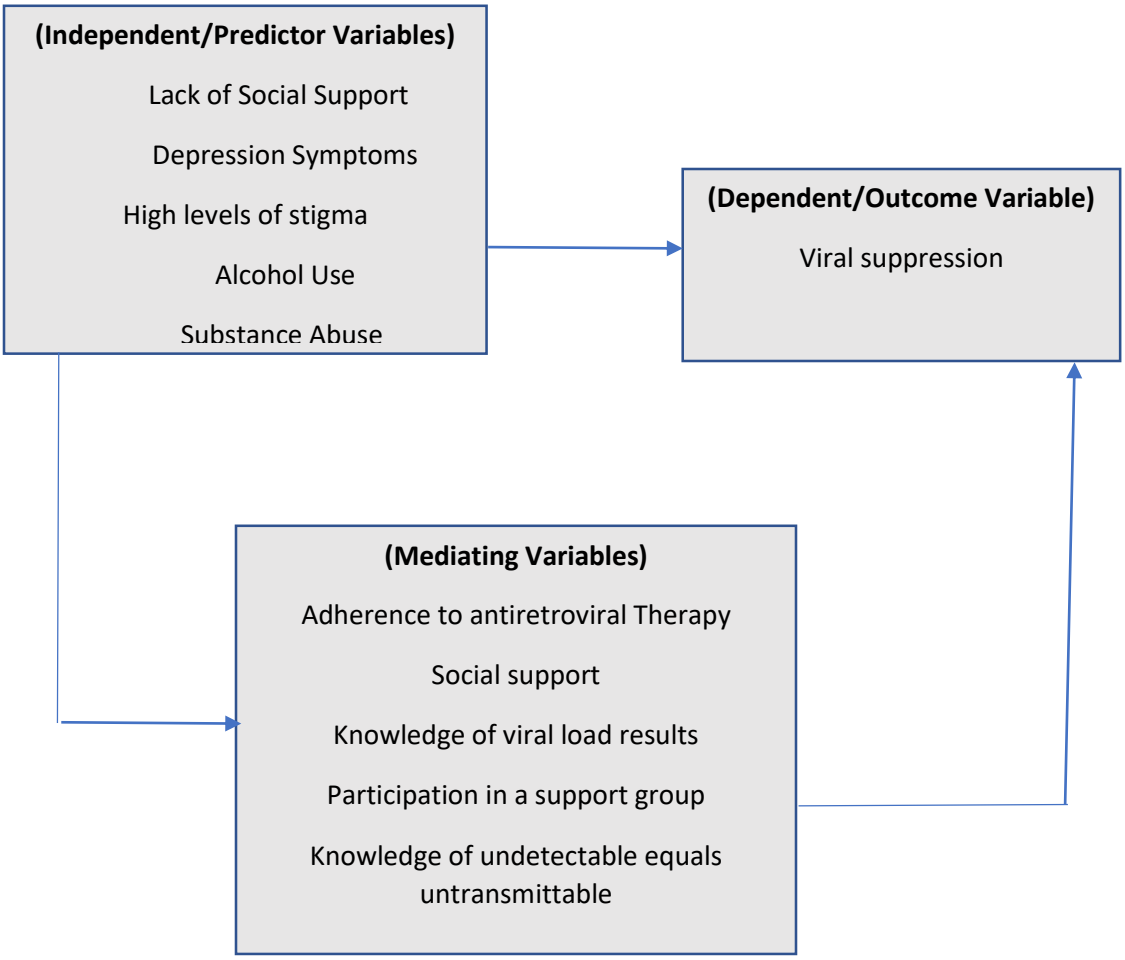

Figure 1. A conceptual framework to investigate and understand the factors that influence viral suppression among a cohort of adolescents and youths aged 15-24 years living with HIV

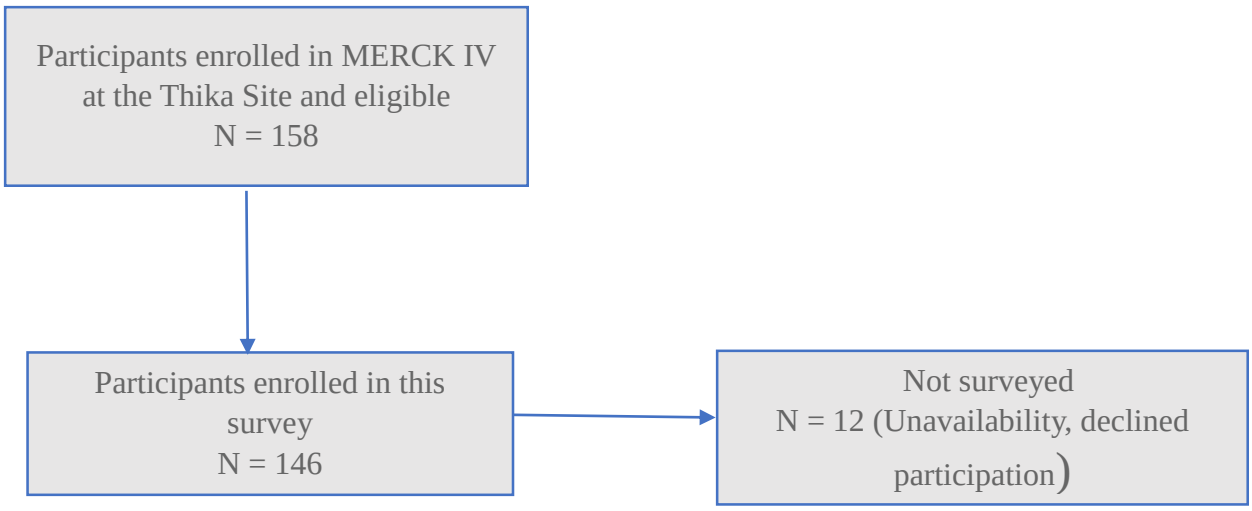

Figure 2. A sampling framework of participants

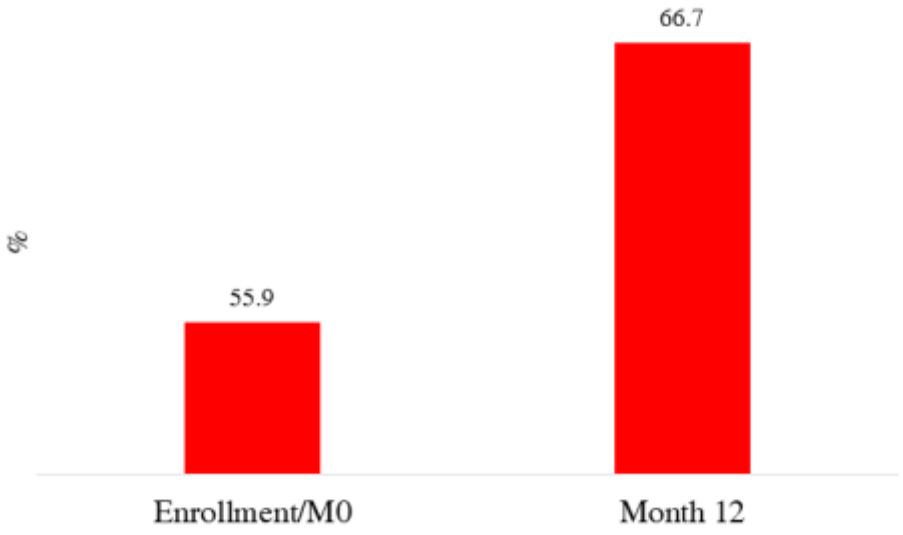

Figure 3. The proportion of viral suppression at baseline and month 12 among those who received intervention

Table 1. Participant characteristics (N=146)

		Overall (N=146)
Sex	Female	75 (51.4 %)
	Male	71 (48.6%)
Age in years	Mean (SD)	22.1 (1.62)
	Median [IQR]	22.0 [21.0,23.0]
	Min - Max	19 - 25
Age group		
	15 - 19	7 (4.8%)
	20 - 25	139 (95.2%)
Financially independent (*M=1)	No	75 (51.4%)
	Yes	70 (47.9%)
Employment status (*M=1)	Student	26 (17.8%)
	Employed	56 (38.4%)
	Unemployed	45 (30.8%)
	Other	18 (12.3%)
Level of income in Kshs (M=1)	No income	70 (47.9%)
	Less than 10000	49 (33.6%)
	Greater than 10000	26 (17.8%)
Relationship status (M=1)	Single/Separated	95 (65.1%)
	Married/Cohabiting/In a relationship	50 (34.2%)
Participation in the support group	No	43 (29.5%)
	Yes	103 (70.5%)
Understanding of viral load and how it relates to HIV treatment	I don't know much about it	16 (11.0%)
	I have some knowledge but would like to learn more	69 (47.3%)
	Yes, I have a good understanding	61 (41.8%)
How important do you think it is to maintain a low viral load through medication adherence?	Not very/somewhat important	14 (9.6%)
	Extremely important	132 (90.4%)
Heard of the term **U=U	No	17 (11.6%)
	Yes	129 (88.4%)

* missing data. ** Knowledge of HIV undetectable equal to untransmittable

Table 2. The psychosocial factors associated with viral suppression.

	All N=146	Not Suppressed N=27	Suppressed N=119	Univariable model		Multivariable model	
	n (%)	n (%)	n (%)	RR (95% CI)	p-value	aRR (95% CI)	p-value
Depression							
Depression unlikely	125 (85.6%)	20 (74.1%)	105 (88.2%)	1.00		1.00	
Mild/Moderate depression	21 (14.4%)	7 (25.9%)	14 (11.8%)	0.79 (0.58, 1.08)	0.147	0.81 (0.59, 1.11)	0.186
Perceived HIV-related stigma							
Low	2 (1.4%)	1 (3.7%)	1 (0.8%)	1.00		1.00	
Moderate	58 (39.7%)	10 (37.0%)	48 (40.3%)	1.65 (0.41, 6.65)	0.477	1.72 (0.42, 6.98)	0.446
High	86 (58.9%)	16 (59.3%)	70 (58.8%)	1.63 (0.41, 6.53)	0.492	1.86 (0.46, 7.49)	0.385
Social support							
High perceived social support	132 (90.4%)	23 (85.2%)	109 (91.6%)	1.00		1.00	
Moderate perceived social support	12 (8.2%)	3 (11.1%)	9 (7.6%)	0.91 (0.64, 1.27)	0.574	0.97 (0.74, 1.27)	0.813
Low perceived social support	2 (1.4%)	1 (3.7%)	1 (0.8%)	0.61 (0.15, 2.42)	0.479	0.57 (0.15, 2.19)	0.416
Alcohol dependence							
Low-risk drinking	135 (92.5%)	23 (85.2%)	112 (94.1%)	1.00		1.00	
Harmful or hazardous drinking	11 (7.5%)	4 (14.8%)	7 (5.9%)	0.77 (0.49, 1.21)	0.251	0.81 (0.51, 1.30)	0.378

Table 3. Trends in changes in mental health status, treatment behaviors, interventions, and suppression outcomes at baseline (Month 0) and month 12

	Enrollment/M0 (N=146)	M12 (N=146)
Depressive symptoms		
No	127 (87.0%)	132 (90.4%)
Yes	19 (13.0%)	14 (9.6%)
ART regimen		
First line	113 (77.4%)	112 (76.7%)
Second line	30 (20.5%)	29 (19.9%)
Unknown	3 (2.1%)	5 (3.4%)
Missed pills in the last two weeks		
No	132 (90.4%)	106 (72.6%)
Yes	14 (9.6%)	40 (27.4%)
Virally Suppressed		
No	42 (28.8%)	27 (17.8%)
Yes	104 (71.2%)	119 (81.5%)
Received intervention		
No	112 (76.7%)	83 (56.8%)
Yes	34 (23.3%)	63 (43.2%)

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