School Related Factors Associated with Viral Non-Suppression Among Adolescents Living with HIV in Kenya

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Abstract

School Related Factors Associated with Viral Non-Suppression Among Adolescents Living with HIV in Kenya

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Objectives

To evaluate school-related factors associated with viral non-suppression among adolescents living with HIV (ALH) aged 14-19 years attending HIV care in Kenya

Design

Cross-sectional analysis using survey data and abstracted medical records across 20 HIV clinics in Kenya.

Methods

We surveyed ALH enrolled in care and abstracted viral load (VL) and clinical data from medical records. Poisson regression models with robust standard errors were used to determine correlates of viral non-suppression (defined as viral load >1000 copies/ml) among ALH overall, and in stratified analyses among boarding and day students.

Results

Among 812 ALH with available VL results, (80 [10%]) were virally non-suppressed and 39% had any detectable viral load (VL >40 c/ml)**.** Twenty-three percent of ALH were attending boarding school. Viral non-suppression was significantly associated with self-reported missed antiretroviral therapy (ART) doses in past month (PR 2.27[1.38,3.72] p=0.001) missed visits in

last 6 months (PR 2.19[1.34,3.57] p=0.002) and mild depression (PR 2.28[1.25,4.14] p=0.007). Viral non-suppression was significantly less frequent in those on dolutegravir (DTG) regimens (PR 0.43[0.23,0.82] p=0.01). Compared to ALH with monthly appointments, those with 3-monthly clinic appointments had a lower prevalence of viral non-suppression (PR 0.37 [95% CI: 0.23,0.62] p=0.001).

Among ALH in boarding school, needing to attend clinic when in school and a higher social support score were associated with a lower prevalence of viral non-suppression (PR: 0.38 [95% CI:0.15,0.96] p=0.04) and (PR: 0.96 [95% CI:0.19, 1.05], p=0.04), respectively.

Among those in day school, needing to attend clinic when in school, missing clinic appointments, being in a school that tracked ART adherence and mild to severe depressive symptoms were associated with a higher prevalence of viral non-suppression (PR:2.02 [95% CI:1.08,3.77], p=0.03, PR: 2.45 [95% CI:1.35, 4.34], p=0.003, PR: 2.52, 95% CI: 1.01,6.27, p=0.05 and PR: 2.26 95% CI:1.10, 4.63 p=0.03, respectively).

Conclusion

Support to ensure medication adherence, adherence to clinic appointments, and interventions to improve mental health among school-going ALH may improve clinical outcomes. Cofactors for viral non-suppression differed for boarding and day students, suggesting that interventions should be tailored for school context.

Keywords: Adolescents and young adults, viral non-suppression, school factors.

INTRODUCTION

Optimized antiretroviral therapy (ART) has increased life expectancy for adolescents living with HIV (ALH), transforming HIV from a life-threatening disease to a chronic manageable condition. ALH can now attend school and have better life expectancy than in the pre-ART era. However, HIV-associated mortality in adolescents, particularly in those aged 15-19 years old, is not decreasing significantly as in other age groups,[1] despite an overall decline from 2012[2] of deaths among ALH aged 10-19. Many of these deaths are thought to result from vertically infected adolescents who have HIV-related chronic illnesses[3–5]. However, ALH also have poor viral suppression, and lower retention in care than adults[6–9] with self-reported non-adherence as high as 45% in sub-Saharan Africa (SSA) [10]. In Kenya, more than a quarter of adolescents aged 10-19 years old who had been on treatment for more than 6 months had HIV viral loads greater than 1000 copies/ml in 2016[11]. When compared to adults and children, adolescents perform the worst in all care cascade indicators: testing, linkage to care and ART initiation, and viral suppression [7,12–16]

Adolescence is marked by transitions in educational stages, clinical care, as well as physical, psychosocial, and emotional changes, all of which may contribute to poor treatment outcomes [17,18]. A high proportion of ALH (60-98%) in SSA are enrolled in school[19,20]. Stigma in the school environment is an important cause of poor adherence and retention in care in ALH[21–23]. In many SSA countries, boarding schools provide secondary education for a large number of adolescents. Children typically attend local day primary schools and transition around age 14 to more distant secondary schools. In Kenya, over 2 million adolescents attend secondary schools, with roughly half of the 9000 public secondary schools serving as boarding schools or providing boarding facilities[24,25]. Several specific school-related policies and practices, particularly in boarding schools, such as requirements to keep medication with the school nurse and regular pill 'raids' to confiscate unauthorized drugs, pose a barrier to adherence[20–23,26–29].These barriers may result in forced disclosure of an adolescent's HIV status to obtain necessary support to adhere to HIV

medication and clinic visits. There is evidence of stigmatization and discrimination from the teachers and peers[19,26,23] when inappropriate or intentional HIV disclosure occurs within the school community. Due to fear of discrimination and stigma, ALH may conceal their HIV status from teachers and school staff limiting support for adherence[19,21,22]. A lack of or incorrect HIV knowledge among teachers,[26,27] rigid school policies regarding lateness, absenteeism, and excused absence [21,23,26], and an insufficient level of privacy and confidentiality[19,21,28] have been identified as barriers to adherence in the school environment.

Many community or clinic-based interventions have been developed to support adolescent ART care services [30–32] but few support ALH in schools, where many are enrolled [33,34] and spend a significant amount of time. In order for ALH to achieve the last 95 of the 95-95-95 global target by 2030 as set by UNAIDS, there is need to understand school-related barriers and facilitators to ALH treatment goals. To date, there are few studies examining the role of school-related factors on viral suppression. For this thesis, we aimed to determine prevalence and cofactors of viral non-suppression among ALH in boarding and day schools in Kenya.

METHODS

This cross-sectional analysis is nested within a larger study (TIMIZA), which aims to understand the role of schools in supporting HIV treatment outcomes among adolescents living with HIV (ALH) in Kenya. The parent study was approved by the Kenyatta National Hospital (KNH)/University of Nairobi (UoN) Ethics and Research Review Committee (ERC). Study sites included 20 HIV clinics in Homabay, Kajiado, and Nairobi County. Eligibility criteria were: ALH (age 14-19) attending care selected clinics and ever enrolled in school, and on antiretroviral treatment (ART) while in school. Participants in the parent study were recruited using a standard recruitment script during routine clinic visits. Written informed consent was collected from caregivers of adolescents aged 14-17 who came to clinic with caregiver, from ALH ≥18 years, or from ALH who came to clinic unaccompanied. A structured questionnaire was administered to obtain data on sociodemographic characteristics, school history, medication use while in school, barriers and facilitators to medication use and clinic attendance, and school policies related to medication use, in addition to information on family support and home environment.

Statistical analysis:

This analysis focused on viral non-suppression, specifically evaluating contextual, population level, and health behavior factors using Anderson's Behavioral model for Health services utilization (Fig.1).

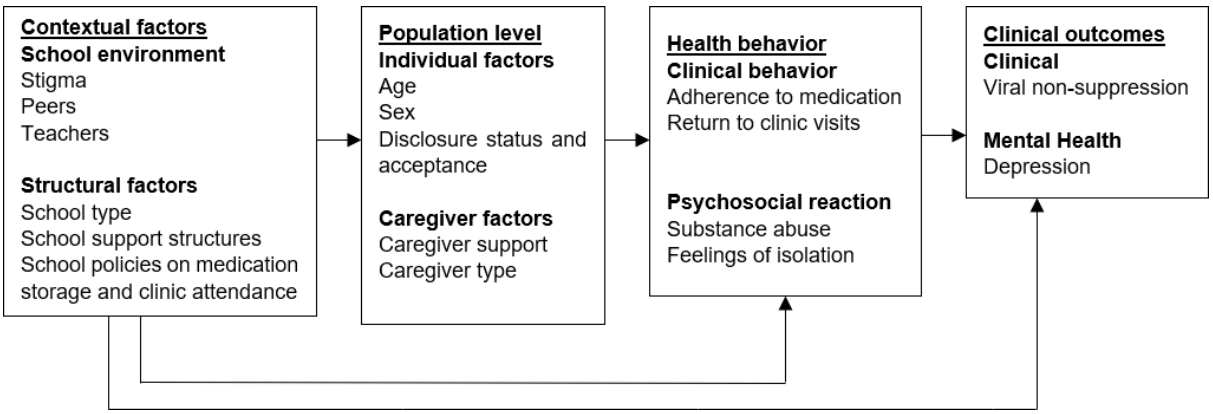

Figure 1: Conceptual model adapted from Andersen's Behavioral model for Health Service Utilization

We defined viral non-suppression as VL>1000 c/ml, a cut-off frequently used in the literature[35,36] and the threshold used clinically in prior Kenya Ministry of Health (MOH) guidelines at the time of the study[37].

Our analysis was primarily Univariate. We summarized baseline characteristics using medians and IQR for continuous variables and proportions for categorical variables. Using our framework, we focused on four main domains: sociodemographic, schooling characteristics, school type, and HIV/ART history. Sociodemographic variables of interest included age, gender (male/female), caregiver type (self/non-self) and parent status (both parents alive, one parent alive [single orphan] and both parents passed on [double orphan]). School characteristics of interest included school type (day or boarding and public or private), grade in school and changing schools in the past year. We evaluated school factors related to ART where our variables of interest included HIV status disclosure in school, school having counselor, peer support and ways to track ART adherence and clinic appointments. Clinical factors of interest included self-reported adherence to clinic appointments and ART, ART regimen, clinic visit schedule, attending clinic alone, age at HIV disclosure and HIV disclosure to others, attending adolescent clinic and making health decisions independently. We measured social support using the Multidimensional Scale of Perceived Social Support (MSPSS)[38]. For mental health, we used the PHQ-9 (Patient Health Questionnaire-9)[39,20] to screen for depression (depression was classified as mild [1-9], moderate [10-14] and severe depression [15-27]) as well as the Youth Brief Stigma scale to assess for stigma (classified as personal stigma [Q1-3 maximum score 15], disclosure concerns [Q4, 5 maximum score 10], negative self-image [Q6-9 maximum score 20) and public attitudes [Q10 maximum score 5); with a higher score indicating worse stigma[40].

We used Poisson regression models with robust standard errors to estimate prevalence ratios and 95% confidence intervals associated with the correlates of interest. We selected and entered each individual correlate into a univariate model. We did a sub-group analysis to look at the correlates of viral non-suppression among ALH in boarding school and those in day school. All analysis was unadjusted and was conducted using R[41] version 4.1.1.

RESULTS

Characteristics of the overall cohort of ALH

Among 880 adolescents living with HIV (ALH) enrolled, 812 (92%) had available VL results and were included in this analysis. Among these 812 ALH, median ALH age was 17 years (IQR: 15.2,18.2) and 446 (55%) were female. Almost all (797 [98%]) had a primary caregiver, with 76% of primary caregivers being a parent. Overall, 301 (38%) ALH were single orphans and 133 (16%) were double orphans. All ALH were aware of their HIV status; median age at HIV disclosure was 13 years (IQR: 10, 13). Ninety-one percent of ALH were enrolled in school at the time of the interview, more than half (412 [57%]) in primary school, almost a quarter (172 [23%]) in boarding school, and 581 (78%) in public schools. Slightly over half (426 [53%]) had disclosed their HIV status to someone in school. Few ALH (104 [14%]) reported their school had a counselor to support ART use or had peer support for ALH (90 [12%]). A total of 644 ALH (79%) attended the adolescent clinic for their HIV care, almost all unaccompanied (748 [92%]), and most (515 [69%]) had 3-monthly scheduled visits. The majority (537 [70%]) were on a TDF/3TC/DTG ART regimen. Almost a quarter of ALH (159 [20%]) self-reported missing a dose of their ART in the last month. Few ALH (53 [7%]) had mild or moderate depressive symptoms. Using HIV viral suppression cut-offs of <1000c/ml, <400 c/ml and undetectable (below the level of detection) to define viral suppression 732 (90%), 701 (86%), and, 501 (62%) were virally suppressed or undetectable, respectively (Table 1).

Comparison of ALH characteristics in day versus boarding school

Characteristics of ALH in day versus boarding school are compared in Table 1. ALH in boarding schools were significantly older (median 18 years versus 16 years, $p<0.0001$, in boarding vs. day school) and more likely to be double orphans than ALH in day schools (PR: 1.66[1.18,2.34], $p=0.004$). ALH in boarding schools were more likely to report that their school supports ART, tracks appointments and tracks ART adherence than ALH in day school (PR: 2.28[1.57,3.31],

p<0.0001), (PR: 2.66[1.55,4.58], p=0.0001) and (PR: 2.61[1.34,5.07], p=0.005), respectively. ALH in boarding schools had a higher prevalence of 3-monthly appointment, higher social support () scores and higher stigma scores, in the personal stigma and public attitudes domain than ALH in day schools (PR: 1.23 [95% CI:1.12, 1.36], p<0.0001), (PR:1.04 [95%1.01,1.08], p=0.02), (PR: 1.16[1.00,1.35], p=0.005) and (PR: 1.23 [95% CI:1.12, 1.35], p<0.0001), respectively.

Cofactors of viral load non-suppression

Cofactors of viral non-suppression (>1000 copies/ml) in the overall cohort are described in Table 2. ALH on TDF/3TC/DTG had a 0.43-fold lower (95% CI: 0.23,0.82, p=0.01) prevalence of viral non-suppression compared to those on TDF/3TC/ATZr. Compared to ALH who reported not missing a dose of their ART in the last month, those who missed a dose were 2.27-fold (95% CI: 1.38,3.72, p=0.001) more likely to be virally non-suppressed. Missing a scheduled visit in the past 6 months was associated with viral non-suppression (PR: 2.19 [95% CI:1.34, 3.57], p=0.002). ALH who screened positive for mild depression had a 2.28-fold higher prevalence (95% CI:1.25, 4.14 p=0.007) of viral non-suppression than those with minimal depression. ALH who were seen in clinic 3-monthly had a 0.37-fold lower (95% CI: 0.23,0.62, p=0.001) prevalence of non-suppression compared to those with monthly appointments.

ALH who reported being in schools that tracked HIV clinic appointments or ART adherence had a trend for higher viral non-suppression though this was not statistically significant (PR: 1.82[95% CI: 0.95,3.45], p=0.07 and PR: 1.93[95% CI: 0.95,3.93], p=0.07, respectively). Being in day versus boarding school or disclosure to someone in school were not associated with viral non-suppression.

Cofactors of viral load non-suppression among ALH in boarding school

Cofactors of viral non-suppression among ALH in boarding school are described in Table 3a. ALH who needed to attend clinic while in boarding school had a lower prevalence of viral non-suppression (PR: 0.38 [95% CI:0.15,0.96, p=0.04]). A higher social support () score was associated with a lower prevalence of viral non-suppression (PR: 0.96 per score point [95% CI:0.19, 1.05], p=0.04). ALH who reported that they had disclosed their HIV status to someone in school had a trend for less viral non-suppression though this was not statistically significant (PR: 0.45[95% CI: 0.19,1.05], p=0.06).

Cofactors of viral load non-suppression among ALH in day school

Cofactors of viral non-suppression among ALH in day school are described in Table 3b. ALH who needed to attend clinic while in school or who missed a scheduled clinic visit in the last 6 months had a higher prevalence of viral non-suppression (PR:2.02 [95% CI:1.08,3.77], p=0.03 and PR: 2.45 [95% CI:1.35, 4.34], p=0.003), respectively. Similarly, ALH who were in schools that tracked ART adherence had a 2.52-fold higher prevalence ratio for viral non-suppression (PR: 2.52, 95% CI: 1.01,6.27, p=0.05) compared to those that did not track adherence. ALH who screened positive for mild or moderate depressive symptoms had a 2.26-fold higher prevalence (PR: 2.26 95% CI:1.10, 4.63 p=0.03) of viral non-suppression than those with less than minimal depressive symptom scores.

ALH who were male, those who reported being in schools that had counselor support for ART or in schools that tracked HIV clinic appointments had a trend towards higher prevalence of viral non-suppression, though these were not statistically significant (PR: 1.62[95% CI: 0.97,2.71], p=0.07), (PR: 1.90[95% CI: 0.98,3.72], p=0.06) and (PR: 2.21[95% CI: 0.95,5.12], p=0.07) respectively.

DISCUSSION

In this large study of ALH in Kenya, the majority of ALH were enrolled in public schools; and a substantial proportion (23%) were in boarding schools. Over half of ALH cohort were single- or double-orphans. Almost half of ALH had not disclosed their HIV status in school. Overall, 10% were virally non-suppressed (>1000 c/ml) with 39% having detectable viremia.

Overall, viral non-suppression prevalence was similar in day and boarding schools. Viral non-suppression was associated with self-reported missed ART doses and missed clinic visits, positive screen for depression, and was less likely in ALH on DTG-based ART regimens. Our findings on self-reported adherence are consistent with other studies in SSA[12]. Self-reported adherence, though an imperfect surrogate marker, can potentially be used to identify ALH who require additional support. Importantly, we found that depressive symptoms were associated with viral non-suppression, indicating the importance of addressing mental health challenges in youth[42–44]. We found that ALH on DTG regimens were more likely to be virally suppressed, underscoring the importance of switching to DTG regimens programmatically. Importantly, ALH on PI regimens were likely on a second line regimen[45], highlighting the need to urgently address viral non-suppression to preserve future treatment options. Overall, less frequent clinic visits (3-monthly) were associated with less viral non-suppression. This may reflect some differentiated care practices, which incorporate longer visit intervals for individuals who are virally suppressed on ART [46–48].

ALH reported minimal ART support structures in school, including keeping track of clinic appointments, adherence support, peer and counselling support. There were some distinct factors associated with viral non-suppression in boarding and day schools. Needing to attend clinic while at school was associated with a lower prevalence of viral non-suppression in boarding school. This could be because YLH who needed to attend clinic while in boarding school had disclosed

their HIV status and were therefore more likely to get support for adherence while in school. Indeed, we found that HIV disclosure to someone among boarding school participants was associated with a lower prevalence of viral non-suppression. Previous studies have shown that ALH conceal their HIV status from teachers and school staff due to fear of discrimination and stigma, limiting support for adherence[19,21,22]. In boarding school, HIV disclosure to someone in school was linked to less viral non-suppression, which may reflect better support after disclosure. This differs from some studies which have noted worse outcomes following self-disclosure to peers in ALH[49]. We found an association between MSPSS score and lower prevalence of viral non-suppression, suggesting that social support is useful to promote adherence and viral suppression in boarding schools.

In day schools, missing a scheduled clinic visit and missed doses were associated with viral non-suppression. ALH may miss clinic visits due to rigid school policies regarding excused absence[21,23,26]. We found that most day schools did not track ART adherence or provide counseling. However, counterintuitively, adherence tracking and counseling at day school were associated with VL non-suppression. This may be because these services were implemented after identification of VL non-suppression in order to provide support.

Depressive symptoms were associated with viral non-suppression among ALH in day schools. Studies to better understand depression in day school and boarding school contexts, and to develop appropriate interventions to address depression in each of these contexts will be important.

To the best of our knowledge, our study was the first of its kind to quantitatively determine the correlates of specific school-related factors of viral non-suppression among ALH. The study enrolled a large number of ALH enrolled in schools, collected detailed data on school exposures

and in multiple counties with varying HIV prevalence. The limitations of the study were: missing viral load results as records were abstracted from clinical records, not enrolling in schools therefore missing out on individual clinic outcomes that are related to specific schools or specific school localities. The study was also a cross sectional analysis and therefore cannot be used to determine cause and effect.

In summary, we found that self-reported non-adherence, missed clinic appointments, and depressive symptoms were associated with viral non-suppression among ALH in Kenya. ALH on DTG regimens were less likely to have non-suppression. Students in boarding and day schools were distinct populations with distinct cofactors of viral non-suppression. Social support was associated with less viral non-suppression in boarding school, while missed ART doses, missed clinic visits and depressive symptoms were associated with viral non-suppression in day school. Our findings highlight the need to develop school-based interventions to complement HIV care in the clinic thereby providing a wholistic approach to HIV care among ALH.

Table 1. Baseline characteristics of the ALH cohort

Baseline Characteristics	**n (%) median (IQR)**							
Sociodemographic	**N=812**	**All**	**Boarding School n=172**		**Day School n=568**		**Prevalence ratio (PR) and 95% confidence interval**	**p-value**
Age	812	16.7(15.2,18.2)	172	17.5(16.6,18.7)	568	16.2(14.8,17.4)	1.08(1.06,1.09)	**<0.0001**
Female	812	446 (54.9%)	172	98 (57.0%)	568	299 (52.6%)	1.08(0.93.1.26)	0.31
Primary Caregiver	812		172		568			
Self		15 (1.8%)		1 (0.6%)		3 (0.5%)	1.1(0.11,10.6)	0.93
Non-Self	797		171		565			
Parent		615 (77.2%)		127 (74.3%)		448 (79.3%)	-	
Non-parent		182 (22.8%)		44 (25.7%)		117 (20.7%)	-	
Parent Status	808		172		564			
Both parents passed on		133 (16.4%)		40 (23.3%)		79 (14.0%)	1.66(1.18,2.34)	**0.004**
One parent alive		308 (38.1%)		70 (40.7%)		211 (37.5%)	1.09(0.88,1.35)	0.42
Both parents alive		367 (45.4%)		62 (36.0%)		274 (48.5%)	0.74(0.60,0.92)	**0.007**
Schooling characteristics								
Currently in School		740 (91.1%)		172(100%)		568(100%)	-	
Reasons not in school	72						-	
Completed/Waiting		20 (27.8%)		-		-	-	
Lack of school fees		21 (29.2%)		-		-	-	
Other		31 (43.0%)		-		-	-	
Current level in school	721		172		548			
Primary		412 (57.1%)		14 (8.1%)		398 (72.6%)	0.11(0.07,0.19)	**<0.0001**
Secondary		309 (42.9%)		158 (91.9%)		150 (27.4%)	3.36(2.91,3.88)	**<0.0001**
School type I	740							
Day		568 (76.8%)		-		-	-	
Boarding		172 (23.2%)		-		-	-	
School Type II	741		172		568			
Private		151 (20.4%)		38 (22.1%)		113 (19.9%)	1.13(0.81,1.56)	0.47

Public		581 (78.4%)		130 (75.6%)		450 (79.2%)	0.97(0.88,1.06)	0.49
Mission		9 (1.2%)		4 (2.3%)		5 (0.9%)	-	
Changed school in the past year	740	129 (17.4%)	172	22 (12.8%)	568	107 (18.8%)	0.68(0.44,1.04)	0.08
Type of School change	129		22		107			
Day to Boarding		9 (7.0%)		8 (36.4%)		1 (0.9%)	-	
Boarding to Day		17 (13.2%)		2 (9.1%)		15 (14.0%)	-	
Day to Day		93 (72.1%)		2 (9.1%)		91 (85.0%)	-	
Boarding to Boarding		10 (7.8%)		10 (45.5%)		-	-	
Reasons for changing school	127		22		107			
Parents wanted it		25 (19.4%)		7 (31.8%)		18 (16.8%)	-	
Poor Health		6 (4.7%)		-		6 (5.6%)	-	
Not wanting to be in that school		16 (12.4%)		3 (13.6%)		13 (12.1%)	-	
Other		43 (63.5%)		10 (54.6%)		70 (65.5%)	-	
School and ART								
Disclosed HIV status to someone in school	812	426 (52.5%)	147	147 (100%)	568	216 (38.4%)	-	
Ever missed ART when in school	812	252 (31.0%)	172	72 (41.9%)	563	138 (24.5%)	-	
Needs to attend clinic while in School	812	567 (69.8%)	172	91 (52.9%)	551	343 (62.3%)	-	
School has a counselor support for ART	746	104 (13.95)	166	39 (23.5%)	518	53 (10.2%)	2.28(1.57,3.31)	**<0.0001**
School has peer support for ALH	744	90 (12.1%)	165	20 (12.1%)	523	62 (11.9%)	1.02(0.64,1.64)	0.93
School tracks appointments	740	54 (7.3%)	165	22 (13.3%)	519	26 (5.0%)	2.66(1.55,4.58)	**0.0001**
School tracks ART adherence	737	39 (5.3%)	165	15 (9.1%)	516	18 (3.5%)	2.61(1.34,5.07)	**0.005**
HIV and ART history								
ART regimen	770		169		530			
TDF/3TC/DTG		537 (69.75)		123 (72.8%)		361 (68.1%)	-	
TDF/3TC/ATZr		77 (10.0%)		17 (10.1%)		53 (10.0%)	-	
ABC/3TC/DTG		18 (2.3%)		2 (1.2%)		16 (3.0%)	-	

Other		132 (17.1%)		26 (15.9%)		100 (18.9%)	-	
Self-reported Adherence (Past month)							-	
Never missed a dose	812	653 (80.4%)	172	145 (84.3%)	568	446 (78.5%)	-	
Missed at least one dose	812	159 (19.6%)	172	27 (15.7%)	568	122 (21.5%)	-	
Missed 2 days or more in a row	710	79 (11.1%)	162	16 (9.9%)	493	56 (11.4%)	-	
Age at HIV disclosure	812	12.9(10.0,13.0)	172	12.3(10.0,13.0)	568	12.6(10.0,13.0)	0.98(0.85,1.13)	0.79
Makes health decisions by themselves	811	191 (23.6%)	171	53 (31.0%)	568	101 (17.8%)	0.84(0.75,0.93)	0.002
Attends adolescent clinic	812	644 (79.3%)	172	149 (86.6%)	568	437 (76.9%)	1.13(1.05,1.22)	**<0.0001**
Attend clinic alone	812	748 (92.1%)	172	161 (93.6%)	568	519 (91.4%)	1.02(0.98,1.07)	0.31
Frequency of clinic appointments	751		163		520			
Monthly		94 (12.5%)		8 (4.9%)		75 (14.4%)	0.34(0.18,0.69)	**0.003**
2-Monthly		142 (18.9%)		24 (14.7%)		106 (20.4%)	0.72(0.48,1.09)	0.12
3-Monthly		515 (68.6%)		131 (80.4%)		339 (65.2%)	1.23(1.12,1.36)	**<0.0001**
Missed scheduled visits in the last 6 months	811	89 (11.0%)	172	18 (10.5%)	568	60 (10.6%)	0.99(0.60,1.63)	0.97
Disclosed HIV status to someone else	812	502 (61.8%)	172	103 (59.9%)	568	362 (63.7%)	0.94(0.82.1.08)	0.37
MSPSS score max score 84	812	54.8(49.0,60.0)	172	56.3(50.0,60.0)	568	54.1(48.0,59.0)	1.04(1.01,1.08)	0.02
PHQ9	807		171		565			
Minimal Depression (1-4)		754 (93.4%)		160 (93.6%)		530 (93.8%)	1.00(0.95,1.04)	0.91
Mild Depression (5-9)		48 (5.9%)		9 (5.3%)		33 (5.8%)	0.90(0.44,1.85)	0.78
Moderate to Severe Depression (10-27)		5 (0.6%)		2 (1.2%)		2 (0.4%)	3.30(0.47,23.4)	0.23
Youth Brief Stigma	812		172		568			
Personal Stigma(Q1-3) (max15) higher score, higher stigma		5.0(3.0,6.0)		5.4(3.0,6.0)		4.7(3.0.6.0)	1.16(1.00,1.35)	**0.005**

Disclosure concerns (Q4, 5) (max10) higher score, higher stigma		7.3(6.0,9.0)		7.4(6.0,9.0)		7.2(6.0,9.0)	1.03(0.99,1.07)	0.25
Negative self-image (Q6-9) (max20) higher score, higher stigma		7.5(4.0,9.0)		7.8(4.0,10.0)		7.2(4.0,9.0)	1.08(0.99,1.18)	0.07
Public attitudes (Q10) (max5) higher score, higher stigma		2.6(1.0,4.0)		3.0(1.0,4.0)		2.4(1.0,4.0)	1.23(1.12,1.35)	**<0.0001**
Any substance use (past 6 months)	812		172		568			
Alcohol		12 (1.5%)		3 (1.7%)		6 (1.1%)	-	
Other Drugs		9 (1.1%)		-		6 (1.1%)	-	
Viral load								
VL<1000c/ml	812	732 (90.1%)	172	152 (88.4%)	568	514 (90.5%)	-	
VL<400c/ml	812	701 (86.3%)	172	148 (86.0%)	568	487 (85.7%)	-	
VL undetectable	812	497 (61.2%)	172	112 (65.1%)	568	336 (59.2%)	-	

Table 2. Cofactors of viral non-suppression in the overall cohort

		Suppressed N= 732 (90%) n (%) median (IQR)	Not suppressed N= 80 (10%) n (%) median (IQR)	Prevalence ratio (PR) and 95% confidence interval	p-value
Baseline Characteristics					
Sociodemographic	812				
Age	812	17(15,18)	17(16,18)	1.04 (0.93,1.17)	0.49
Male		327 (44.7%)	39 (48.8%)	1.16(0.76,1.76)	0.49
Primary Caregiver	798				
Parent		556 (77.2%)	59 (75.6%)	Ref	
Non-parent (Relative)		164 (22.8%)	19 (24.4%)	1.08(0.66,1.77)	0.76
Parent Status	809				
Both parents alive		122 (16.7%)	11 (13.8 %)	1.53(0.81,2.90)	0.19
One parent alive		269 (36.9%)	39 (47.8%)	0.99(0.51, 1.92)	0.97
Both parents passed on		338 (46.4%)	30 (37.5%)	Ref	
Schooling characteristics					
School type	740				
Day		514(77.2%)	54 (73.0%)	Ref	
Boarding		152(22.8%)	20 (27.0%)	1.22(0.75,1.99)	0.42
Current level in school	736				
Primary		375 (56.6%)	37 (50.0%)	Ref	
Secondary		275 (41.5%)	34 (45.9%)	1.22(0.79,1.91)	0.37
Tertiary		12 (1.8%)	3 (4.1%)	2.22(0.77,6.44)	0.14
School Type	732				
Private		134 (20.4%)	17 (23.0%)	Ref	
Public		524 (79.6%)	57(77.0%)	0.87(0.52,1.46)	0.60
Changed School in the past year	740				
No		547 (82.1%)	64 (86.5%)	Ref	
Yes		119 (17.9%)	10 (13.5%)	0.74(0.39,1.41)	0.36
School and ART					
Disclosed HIV status to someone in school	458				
No		30 (7.4%)	2 (3.8%)	Ref	
Yes		376 (92.6%)	50 (96.2%)	1.88(0.48,7.42)	0.38
Ever Missed ART when in school	320				
No		213 (77.7%)	39 (84.8%)		
Yes		61 (22.3%)	7 (15.2%)	1.50(0.70,3.23)	0.29
Needs to attend clinic while in school	574				
No		7 (1.4%)	0		
Yes		504 (96.6%)	63 (100%)	--	1.00*
School has counselor support for ART	746				
No		582 (86.6%)	60 (81.1%)	Ref	
Yes		90 (13.4%)	14 (18.9%)	1.44(0.84,2.49)	0.19
School has peer support for ALH	744				
No		593 (88.2%)	61 (84.7%)	Ref	
Yes		79 (11.8%)	11 (15.3%)	1.31(0.72,2.40)	0.38
School tracks appointments	740				
No		623 (93.3%)	63 (87.5%)	Ref	

Yes		45 (6.7%)	9 (12.5%)	1.82(0.95,3.45)	**0.07**
School tracks ART adherence	737				
No		633 (95.2%)	65 (90.3%)	Ref	
Yes		32 (4.8%)	7 (9.7%)	1.93(0.95,3.93)	**0.07**
HIV and ART history					
ART regimen	614				
TDF/3TC/ATZr		66 (11.6%)	11 (25.0%)	Ref	
TDF/3TC/DTG		504 (88.4%)	33 (75.0%)	0.43(0.23,0.82)	**0.01**
Self-reported Adherence	757				
Missed a dose in the last month					
No		612 (89.6%)	57 (77.0%)	Ref	
Yes		71 (10.4%)	17 (23.0%)	2.27(1.38,3.72)	**0.001**
Makes health decisions by themselves	811				
No		168 (23.0%)	23 (28.7%)	Ref	
Yes		563 (77.0%)	57 (71.3%)	0.76(0.48,1.21)	0.25
Attends adolescent clinic	793				
No		91 (18.2%)	58 (19.8%)	Ref	
Yes		409 (81.8%)	235 (80.2%)	0.94(0.75,1.18)	0.7
Attends clinic alone	812				
No		60 (8.2%)	4 (5.0%)	Ref	
‘Yes		672 (91.8%)	76 (95.0%)	1.63(0.61, 4.31)	0.33
In a peer group	811				
No		149(29.2%)	76(25.3%)	Ref	
Yes		362(70.8%)	224(74.7%)	1.13(0.92,1.40)	0.25
Frequency of clinic appointments	751				
Monthly		75 (11.1%)	19 (25.7%)	Ref	
Bi-monthly		126 (18.6%)	16 (21.6%)	0.56(0.30,1.03)	0.06
Every 3 months		476 (70.3%)	39 (52.7%)	0.37(0.23,0.62)	**0.0001**
Missed scheduled visits in the last 6 months	811				
No		659 (90.2%)	63 (78.8%)	Ref	
Yes		72 (9.8%)	17 (21.2%)	2.19(1.34,3.57)	**0.002**
Disclosed HIV status to someone	812				
No		273 (37.3%)	37 (46.3%)	Ref	
Yes		459 (62.7%)	43 (53.7%)	0.72(0.47,1.09)	0.12
MPSS score max score 84	812	54.70(49,60)	55.44(48,60)	1.01(0.98,1.03)	0.59
PHQ9	807				
Minimal Depression (1-4)		685 (94.2%)	69(86.3%)	Ref	
Mild Depression (5-9)		38 (5.2%)	10(12.5%)	2.28(1.25,4.14)	**0.007**
Moderate to Severe Depression (10-27)		4 (0.6%)	1(1.2%)	2.19(0.37,12.87)	0.39
Youth Brief Stigma	812				
Personal Stigma(Q1-3) (max15) higher score, higher stigma		5.07(3.0,6.0)	4.84(3.0,6.0)	0.97(0.87,1.09)	0.67
Disclosure concerns (Q4, 5) (max10) higher score, higher stigma		7.32(6.0,9.0)	7.26(6.0,9.0)	0.98(0.87,1.10)	0.71
Negative self-image (Q6-9) (max20) higher score, higher stigma		7.40(4.0,9.0)	8.11(4.0,10.0)	1.05(0.99,1.10)	0.08
Public attitudes (Q10) (max5) higher score, higher stigma		2.57(1.0,4.0)	2.88(1.0,4.0)	1.11(0.98,1.26)	0.10

Table 3a. Correlates of viral non-suppression among ALH in boarding schools

		Suppressed N= 152 n (%) median (IQR)	Not suppressed N= 20 n (%) median (IQR)	Prevalence ratio (PR) and 95% confidence interval	p-value
Sociodemographic					
Age	172	18(17,19)	17(16,19)	0.90(0.66,1.23)	0.50
Gender	172				
Female		83(54.6%)	15(75.0%)	Ref.	
Male		69(45.4%)	5(25.0%)	0.44(0.17,1.18)	0.10
Primary Caregiver	172				
Parent		112(73.7%)	15(75.0%)	Ref	
Non-parent (Relative)		40(26.3%)	5(25.0%)	0.94(0.36,2.47)	0.90
Parent Status	172				
Both parents alive		36(23.7%)	4(20.0%)	Ref	
One parent alive		61(40.1%)	9(45.0%)	1.29(0.42,3.98)	0.66
Both parents passed on		55(36.2%)	7(35.0%)	1.13(0.35,3.68)	0.84
School History					
Current level in school	172				
Primary		13(8.6%)	1(5.0%)	Ref	
Secondary/Tertiary		139(91.4%)	19(95.0%)	1.68(0.24,11.96)	0.60
School type	172				
Private		32(21.6%)	6(30.0%)	Ref.	
Public		116(78.4%)	14(70.0%)	0.68(0.29,1.67)	0.40
Changed School in the past year	172				
No		131(86.2%)	19(95.0%)	Ref	
Yes		21(13.8%)	1(5.0%)	0.36(0.05,2.62)	0.31
School and ART					
Disclosed HIV status to someone in school	172				
Yes		130(85.5%)	17(85.0%)	Ref	
No		22(14.5%)	3(15.0%)	1.03(0.32,3.33)	0.95
Keeps ART when in school	116				
Yes		85(83.3%)	10(71.4%)	Ref	
No		17(16.7%)	4(28.6%)	1.81(0.61,5.34)	0.28
Ever Missed ART when in school	172				
Yes		63(41.4%)	9(45.0%)	Ref	
No		89(58.6%)	11(55.0%)	0.88(0.38,2.03)	0.76
Needs to attend clinic while in school	172				
No		67(44.1%)	14(70.0%)	Ref	
Yes		85(55.9%)	6(30.0%)	0.38(0.15,0.96)	**0.04**
School has counselor support for ART	166				
No		112(76.2%)	15(78.9%)	Ref	
Yes		35(23.8%)	4(21.1%)	0.87(0.30,2.50)	0.79
School has peer support for ALH	165				

No		127(87.0%)	18(94.7%)	Ref	
Yes		19(13.0%)	1(5.3%)	0.40(0.06,2.93)	0.37
School tracks appointments	165				
No		127(87.0%)	16(84.2%)	Ref	
Yes		19(13.0%)	3(15.8%)	1.22(0.38,3.90)	0.74
School tracks ART adherence	165				
No		133(91.1%)	17(89.5%)	Ref	
Yes		13(8.9%)	2(10.5%)	0.18(0.29,4.70)	0.82
HIV and ART history					
Makes health decisions by themselves	171				
No		45(29.8%)	8(40.0%)	Ref	
Yes		106(70.2%)	12(60.0%)	0.67(0.29,1.57)	0.36
Attends adolescent clinic	170				
No		19(12.6%)	2(10.5%)	Ref	
Yes		132(87.4%)	17(89.5%)	1.20(0.29,4.91)	0.80
Attend clinic alone	172				
No		11(7.2%)	0		
Yes		141(92.8%)	20(100%)	--	0.37*
In a peer group	172				
No		40(26.3%)	7(35.0%)	Ref	
Yes		112(73.7%)	13(65.0%)	0.70(0.29,1.66)	0.41
Missed scheduled visits in the last 6 months	172				
No		138(90.8%)	16(80.0%)	Ref	
Yes		14(9.2%)	4(20.0%)	2.14(0.79,5.78)	0.13
Disclosed HIV status to someone	172				
No		57(37.5%)	12(60.0%)	Ref	
Yes		95(62.5%)	8(40.0%)	0.45(0.19,1.05)	**0.06**
Medical History					
MPSS score max score 84	172	56.80(50.75,61.00)	52.55(47.00,58.50)	0.96(0.93,1.00)	**0.04**
PHQ9	171				
Minimal Depression (1-4)		142(94.0%)	18(90.0%)	Ref	
Mild/Moderate/Severe Depression (5-27)		9(6.0%)	2(10.0%)	1.62(0.42,6.20)	0.48
Youth Brief Stigma	172				
Personal Stigma(Q1-3) (max15) higher score, higher stigma		5.5(3.0,6.0)	5.0(3.0,6.0)	0.95(0.75,1.20)	0.67
Disclosure concerns (Q4, 5) (max10) higher score, higher stigma		7.5(6.0,9.0)	7.0(6.0,7.0)	0.87(0.72,1.05)	0.14
Negative self-image (Q6-9) (max20) higher score, higher stigma		7.8(4.0,10.0)	8.5(4.0,11.0)	1.04(0.94,1.15)	0.41
Public attitudes (Q10) (max5) higher score, higher stigma		3.0(1.0,4.0)	3.1(1.2,4.3)	1.05(0.82,1.35)	0.70

*Fischer's exact test p value

Table 3b: Correlates of viral non-suppression among ALH in day school

		Suppressed N= 514 n (%) median (IQR)	Not suppressed N= 54 n (%) median (IQR)	Prevalence ratio (PR) and 95% confidence interval	p-value
Sociodemographic					
Age	568	16(15,17)	17(15,18)	1.11(0.97,1.28)	0.14
Gender	568				
Female		277(53.9%)	22(40.7%)	Ref	
Male		237(46.1%)	32(59.3%)	1.62(0.97,2.71)	0.07
Primary Caregiver	565				
Parent		405(79.3%)	43(79.6%)	Ref	
Non-parent (Relative)		106(20.7%)	11(20.4%)	0.98(0.52,1.84)	0.95
Parent Status	565				
Both parents alive		73(14.3%)	6(11.1%)	Ref	
One parent alive		183(35.8%)	28(51.9%)	1.75(0.75,4.08)	0.20
Both parents passed on		255(49.9%)	20(37.0%)	0.96(0.40,2.31)	0.92
School History					
Current level in school	563				
Primary		362(71.1%)	36(66.7%)	Ref	
Secondary		135(26.5%)	15(27.88%)	1.12(0.62,1.97)	0.73
Tertiary		12(2.4%)	4(5.6%)	2.21(0.76,6.41)	0.14
School type	563				
Private		102(20.0%)	11(20.4%)	Ref	
Public		407(80.0%)	43(79.6%)	0.98(0.52,1.85)	0.95
Changed School in the past year	568				
No		416(80.9%)	45(83.3%)	Ref	
Yes		98(19.1%)	9(16.7%)	0.86(0.43,1.71)	0.67
School and ART					
Disclosed HIV status to someone in school	563				
No		316(62.1%)	31(57.4%)	Ref	
Yes		193(37.9%)	23(42.6%)	1.19(0.71,1.99)	0.50
*Ever Missed ART when in school	563				
No		396(77.8%)	29(53.7%)	Ref.	
Yes		113(22.2%)	25(46.3%)	2.67(1.61,4.38)	**<0.0001**
Needs to attend clinic while in school	551				
No		196(39.3%)	12(23.1%)	Ref	
Yes		303(60.7%)	40(76.9%)	2.02(1.08,3.77)	**0.03**
School has counselor support for ART	523				
No		428(90.5%)	41(82.0%)	Ref	
Yes		45(9.5%)	9(18.0%)	1.90(0.98,3.72)	**0.06**
School has peer support for ALH	523				
No		422(88.8%)	39(81.3%)	Ref	
Yes		53(11.2%)	9(18.7%)	1.72(0.87,3.38)	0.12
School tracks appointments	519				

No		450(95.5%)	43(89.6%)	Ref	
Yes		21(4.5%)	5(10.4%)	2.21(0.95,5.12)	0.07
School tracks ART adherence	516				
No		454(97.0%)	44(91.7%)	Ref	
Yes		14(3.0%)	4(8.3%)	2.52(1.01,6.27)	**0.05**
HIV and ART history					
Makes health decisions by themselves	568				
No		91(17.7%)	10(18.5%)	Ref	
Yes		423(82.3%)	44(81.5%)	0.95(0.50,1.83)	0.88
Attends adolescent clinic	564				
No		114(22.4%)	13(24.1%)	Ref	
Yes		396(77.6%)	41(75.9%)	0.92(0.51,166)	0.77
Attend clinic alone	568				
No		45(8.8%)	4(7%)	Ref	
Yes		469(91.2%)	50(92.6%)	1.18(0.44,3.14)	0.74
In a peer group	567				
No		128(24.9%)	10(18.5%)	Ref	
Yes		385(75.0%)	44(81.5%)	1.42(0.73,2.74))	0.30
Missed scheduled visits in the last 6 months	568				
No		466(90.7%)	42(77.8%)	Ref	
Yes		48(9.3%)	12(22.2%)	2.45(1.35,4.34)	**0.003**
Disclosed HIV status to someone	568				
No		181(35.2%)	25(46.3%)	Ref	
Yes		333(64.8%)	29(53.7%)	0.66(0.40,1.10)	0.11
Medical History					
MPSS score max score 84		53.87(48.00,59.00)	56.31(48.00,60.00)	1.02(0.99,1.05)	0.14
PHQ9	565				
Minimal Depression (1-4)		483(94.5%)	47(87.0%)	Ref	
Mild/Moderate/Severe Depression (5-27)		28(5.5%)	7(13.0%)	2.26(1.10,4.63)	**0.03**
Youth Brief Stigma	568				
Personal Stigma(Q1-3) (max15) higher score, higher stigma		4.7(3.0,6.0)	4.3(3.0,3.0)	0.94(0.78,1.13)	0.52
Disclosure concerns (Q4, 5) (max10) higher score, higher stigma		7.2(6.0,9.0)	7.3(6.0,9.0)	1.01(0.87,1.19)	0.86
Negative self-image (Q6-9) (max20) higher score, higher stigma		7.2(4.0,8.0)	8.0(4.0,10.0)	1.06(0.99,1.13)	0.10
Public attitudes (Q10) (max5) higher score, higher stigma		2.4(1.0,4.0)	2.8(1.0,4.0)	1.14(0.98,1.33)	0.09

*Fischer's exact test p value

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