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Sexual practices among adolescents and young people in Eastern Cape, South Africa: the association with HIV status and mode of infection

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Sexual practices among adolescents and young people in Eastern Cape, South Africa: the association with HIV status and mode of infection

Abstract

There is a growing cohort of adolescents living with HIV in Sub-Saharan Africa whom sexual and reproductive health (SRH) practices need to be investigated. We aimed at analysing the association of HIV status and mode of infection on SRH practices among adolescents in Eastern Cape, South Africa. We used data from a three-wave cohort of adolescents of the Mzantsi Wakho (MW) study carried out in 2014-15 (first wave), 2016-17 (second wave) and 2017-18 (third wave). The Mzantsi Wakho study included adolescents living with HIV and stigma community controls (i.e., adolescents not living with HIV). We fitted random-effects logistic regression models for risky sexual practice outcomes, such as unsafe sex, transactional sex, older partnership, multiple partnership, with the aforementioned risky sexual practice outcomes. These models were fit for all adolescents and the sub-sample of adolescents living with HIV. Findings from our analyses first revealed lower odds of reporting any risky sex (and especially unsafe sex) among HIV-positive adolescents than HIV-negative adolescents. Then, we found higher odds of reporting any risky sex (unsafe sex, older and multiple partnership) among horizontally infected adolescents than vertically infected adolescents. Finally, girls were more at risk than boys for the effect of HIV on risky sexual practices. Actions aimed at reducing risky sexual practices should target horizontally infected adolescents, and girls more specifically.

1. Introduction

By 2030, sub-Saharan Africa will be home to over 2 million adolescents and young people living with HIV (AYLHIV) (Cluver et al., 2019). This cohort of AYLHIV has been growing due to improved survival among vertically-infected children and persistent high incidence among 15-24 years old in the region. Adolescence is a time of immense transformation and transitioning, physically, cognitively, emotionally, and socially. Currently, a common response to AYLHIV's sexual and romantic relationships is to discourage them, postpone sexual debut and childbearing, and avoid HIV-status disclosure to sexual partners (Mackworth-Young et al., 2019). As this cohort ages into adulthood, HIV treatment and health service provision must adapt to their changing needs and life stages to ensure positive treatment outcomes for AYLHIV and to support them in secondary HIV prevention. Understanding the sexual practices of AYLHIV is critical to identifying those at highest risk for onwards HIV transmission or unintended pregnancies, and is central to informing services and breaking the cycle of HIV transmission in sub-Saharan Africa.

Despite this large cohort of AYLHIV coming of age, there is still a gap in understanding their sexual and reproductive health behaviours using methods other than those employing classic cross-sectional observational data. A recent systematic review on AYLHIV's sexual and reproductive health behaviours in Sub-Saharan Africa found only four intervention studies on the topic. (See studies listed in the systematic review paper written by Toska, Pantelic et al., 2017). In particular, a handful of studies compare adolescents and young people living with HIV, but with no longitudinal analyses able to isolate longitudinal associations between HIV status and later engagement in sexual and reproductive practices (Epstein & Morris, 2011). Irrespective of the study design, several factors may shape sexual and reproductive health practices in adolescents, in addition to HIV status: socio-demographic factors such as age, gender, rural residence, among others (Gwokyalya et al., 2019; Mergui & Giami, 2011; Molla & Gelagay, 2017; Toska, Cluver et al., 2017).

Studies included in the systematic review by Toska, Pantelic et al. (2017)—updated and under preparation for submission by this team—documented that covariates that increase the odds of sexual risk-taking are: being female, living in rural areas, exposure to erotic content via television and movies, subjective norms of friends and caregivers about sex, gender-based violence, having biological children, poor health, physical or emotional abuse, emotional neglect, adverse childhood experience, horizontal mode of infection, and having an HIV-negative partner. We have also found that results from Vu et al.'s (2017) pre-post cohort study with intervention (based on health education and counselling provided by support groups to AYLHIV in Uganda) reported changes in risky sexual behaviours. The authors found significant increases at end time, compared with baseline, in condom use at last sex and as current use of modern contraception. Then, an randomized control trial on male circumcision in Uganda found that human papilloma virus genotype concordance declined significantly with age and male circumcision, and increased among couples with recent intercourse, only in HIV-negative couples. Moreover, many studies have shown that gender considerations play a central role in modelling adolescents' sexual reproductive behaviours (Hendriksen et al., 2007; Nankinga et al., 2015; Santelli et al., 2013; Test et al., 2012; Toska, Cluver, et al., 2017). A paper from Toska, Cluver, et al. (2017) showed that gender moderated the effect of adolescent-sensitive clinic care on reducing unprotected sex among adolescents living with HIV in South Africa.

Furthermore, although vertically-infected AYLHIV may experience delayed pubertal development due to early exposure to HIV, with improved ART access, their odds of engaging in sexual risk practices may increase (Beyeza-Kashesya et al., 2011; Toska, Pantelic et al., 2017). Moreover, over 90% of recent HIV infections among AYLHIV in sub-Saharan Africa are due to heterosexual transmission (Beyeza-Kashesya et al., 2011). The mode of HIV infection (either vertical or horizontal) may shape current and future sexual and reproductive practices, including risk-taking (Ferrand et al., 2009). No study, in sub-Saharan Africa, has investigated how HIV status (including the mode of HIV infection) is associated with risky sexual practices among adolescents using longitudinal data. Longitudinal analyses can establish patterns, help estimate the effect of time and age, and identify high-risk groups to inform the design of tailored differentiated care for AYLHIV. While considering these factors in analysing adolescents' sexual risk practices, this paper aims to document the effect of HIV status and mode of HIV infection on AYLHIV sexual risk practices. The motivation of the study is two-fold. First, it describes sexual risk practices of different groups of adolescents and young people based on HIV status and mode of HIV infection. Second, it provides insights for differentiated

service targeting and delivery, based on whether and how the behaviours are in fact different for these groups.

This paper investigates associations between (i) adolescent HIV status and (ii) mode of HIV infection, both recorded at study baseline, and the consequent sexual risk taking in a three-wave study of AYLHIV in South Africa – the Mzanti Wakho study.

2. Methods

This analysis uses three waves of the Mzantsi Wakho cohort study, collected between 2014 and 2018, to investigate both the association of HIV status at baseline and the mode of HIV infection (MOI) on consequent sexual risk practices. The Mzantsi Wakho study was conducted in the Eastern Cape province of South Africa, a disadvantaged area with poor infrastructure, high HIV prevalence (>30% in antenatal testing) and consistent high HIV incidence rates among 15-24 years old. South Africa has a generalized HIV epidemic (Burgert-Brucker et al., 2016), with a national HIV prevalence of 21.2%. The Eastern Cape has one of the highest burdens of HIV in South Africa (Hardee et al., 2014). The study is the largest-known longitudinal, community-traced, mixed methods cohort study of adolescents living with HIV to date.

2.1 Data collection procedures

The study followed more than 1600 adolescents living in the Eastern Cape, South Africa, over a period of four years. Interviews took place between March 2014 and March 2018. We identified all the 53 primary clinics, hospitals, and community health centres providing HIV treatment to adolescents in the study district, comprising rural, urban, and peri-urban communities.

The study investigates adolescents' lived experiences in high-HIV prevalence communities, specifically with regard to adherence to ART, and sexual and reproductive health. In each facility, all files (paper and computer) were reviewed to identify all individuals aged 10–19 years who had ever initiated HIV treatment. Adolescents were traced to 180 communities and interviewed at home or a location of their choice. This strategy enabled the research team to include adolescents lost to follow-up as well as those retained in care. At baseline, 90% of all those eligible were enrolled, with no significant differences between enrolled and unenrolled participants (Cluver et al., 2019). At follow-up interviews (second and third waves), all adolescents who had given consent to be re-approached were asked for consent for follow-up. Due to migration, participants lived in six provinces at follow-up: Eastern Cape, Free State, Gauteng, KwaZulu-Natal, North-West and Western Cape.

Ethical approval was given by the University of Cape Town (Cape Town, South Africa; CSSR 2013/4), Oxford University (Oxford, UK; CUREC2/12-21), Provincial Departments of Health and Education, and all participating health-care facilities. All adolescents and their primary caregivers gave written informed consent at both timepoints in their language of choice (Xhosa or English), which was also read aloud in cases of low literacy. There were no financial incentives, but the study's adolescent advisory group recommended a certificate, snack and small gift pack including soap, and immediate health and social service referrals with follow-up support.

2.2 Data analyses

2.2.1 Outcome variable

The main outcome for these analyses was *any sexual risk*, computed from participants reporting any of four sexual risk practices: past-year unsafe sex, older sexual partnership, transactional sex, multiple sexual partnership (Reta et al., 2019). (1) *Unsafe sex* was measured as having had unprotected sex at last sexual intercourse. (2) *Older sexual partnership* was measured as having had sex with a partner who was at least five years older than the adolescent in the last year. (3) *Transactional sex* was measured as being given a present for having sex or having had sex for a present in the last year. (4) *Multiple sexual partnership* was measured as having had at least two sexual partners in the last year. Any risky sexual behaviour is measured as having had one or more of the aforementioned risky sexual behaviours.

2.2.2 Explanatory and control variables

The main explanatory variable of the study is HIV status at baseline which was categorised as: HIV-negative and HIV-positive, followed by two mode of infection categories: sexual and vertical infection. Mode of HIV infection was determined using age of treatment initiation and adjusted using an algorithm that confirmed or reallocated participants to take into account 'slow progressors', delayed treatment rollout in the Eastern Cape province for this cohort, and additional individual-level factors such as parental HIV/AIDS, potential exposure through sexual abuse, etc.

Other covariates representing sociodemographic factors (such as gender, age, and rural residence) and literature-informed factors associated with the outcomes (such as food security and poverty) were included as covariates, based on literature identifying links between these factors and sexual risk exposure among adolescents in South Africa. *Poverty* was measured as lack of access to at least one of the eight highest socially perceived necessities for children in the nationally representative South African Social Attitudes Survey (enough food, money for school fees, to see a doctor when needed, school uniform, basic clothing, soap, school books, and shoes). *Food security* was measured as being able to afford enough food at home for at least one day in the past week, and school attendance was measured as currently attending school. Table 1 summarises the measurement used for each variable.

Table 1: Summary of variables and measurements used for the analysis

Variable	**Measurement**
Dependent variables (unsafe sex, older sexual partnership, transactional sex, multiple sexual partnership, and any risky sex)	Wave 1, 2, and 3
HIV status and HIV mode of infection	Baseline
Gender	Baseline
Age	Wave 1, 2, and 3
Rural residence	Wave 1, 2, and 3
Food security	Wave 1, 2, and 3
Poverty	Wave 1, 2, and 3

We conducted analyses in five steps. First, we examined potential attrition bias by analysing systematic differences between the participants who stayed in and those who dropped out of the study at any of the three waves. In other words, we compared baseline characteristics of participants who completed all three survey rounds with those of participants who did not. Chi-square test statistics were used to determine whether complete cases were comparable to cases not retained (those who dropped out of the study).

Second, we conducted descriptive analyses to characterize included participants. We presented the variation in proportion (with 95% confidence intervals values) of outcome measures (risky sexual practices) across wave and by HIV status (a three-category variable: HIV-negative, vertically-infected HIV-positive, and sexually-infected HIV-positive) and gender. The confidence interval values were obtained by subtracting from (at the lower boundary) and adding to (at the upper boundary) the proportion 1.96 times the standard errors of the proportion.

Third, we assessed the relationship between baseline HIV status and mode of HIV infection, and sexual risk outcomes. Given the correlated structure of the data and since the main explanatory variables (HIV status and mode of infection) is time-invariant, random-effects analysis techniques were applied (Hamaker & Muthén, 2019). Using random-effects estimation, we assumed that unobserved heterogeneity is uncorrelated with HIV status and HIV mode of infection.

We fitted four random-effects logistic regression models for the main outcome (any risky sex), then for each the four outcomes—first without adjusting for any variables. Then, estimates were adjusted for aforementioned control variables and study wave. The first model (model [1]) provides estimates (of the association between HIV and sexual risk practices) for all adolescents, the second (model [2]) for adolescent girls, the third (model [3]) for adolescent boys and the fourth (model [4]) for gender moderation effects. The gender moderation effects model presents estimates from the association between HIV status (positive vs. negative) and sexual risk practices while interacting HIV status and control variables with gender. This model identified whether gender moderates the relationship between HIV status and sexual risk practices, that is whether there was a gender discrimination in the relationship between HIV status and sexual risk practices.

Fourth, we reproduced these models for the sub-sample of adolescents living with HIV. These models aimed at investigating—for the sub-sample of AYLHIV—the relationship between the mode of infection (horizontal / sexual vs vertical) and sexual risk practices. They include a model for all AYLHIV (model [5]), adolescent girls living with HIV (model [6]), adolescent boys living with HIV (model [7]), and gender moderation effect (model [8]). We replicated the same models for each of four individual sexual risk outcomes. We applied Benjamini-Hochberg's (2018) False Discovery Rate corrections to account for multiple hypothesis testing of the association between HIV and four different sexual risk outcomes.

Finally, when gender moderation effects are significant for the association between HIV and risky sexual behaviours, we computed predicted probability (based on adjusted associations) of reporting sexual risk practices by gender, in order to identify the most vulnerable groups. All analyses were performed in Stata, version 16 (StataCorp, 2019).

3. Findings

3.1 Descriptive analysis

Table 2 presents cases of attrition based on the comparison of characteristics of participants who stay in and those who dropped out of the study. Over three-quarters (76%) of participants were living in urban areas. Most of the participants were female (about 58%) and aged 15–24 years (68%). Approximatively 67% of participants were living in poor households and 24% were facing food insecurity. About 70% of the sample were living with HIV (including 17% sexually/ recently-infected and 53% vertically-infected). Nearly 21% of participants were engaging in at least one of the following (past-year) risky sexual behaviours (unsafe sex: 9%, at least five years older sexual partnership: 6%, transactional sex: 4%, multiple sexual partnership: 14%).

Table 2: Comparison of complete cases (No. = 1338) with excluded cases (No. = 202)

	Complete cases		**LTFU**		**Total**		**p-value**	**Missing values (No.)**
	No.	**%**	**No.**	**%**	**No.**	**%**		
HIV status							<0.001	
HIV-negative	397	29.7	59	29.2	456	29.6		
Horizontally infected	206	15.4	55	27.2	261	16.9		
Vertically infected	735	54.9	88	43.6	823	53.4		
Gender							0.007	
Male	584	43.6	68	33.7	652	42.3		
Female	754	56.4	134	66.3	888	57.7		
Age group							0.897	
10–14 years	430	32.1	64	31.7	494	32.1		
15–24 years	908	67.9	138	68.3	1,046	67.9		
Place of residence							0.092	2
Urban	1,003	75	161	80.5	1,164	75.7		
Rural	334	25	39	19.5	373	24.3		
Poverty	892	66.7	141	69.8	1,033	67.1	0.377	
Food security	1,018	76.1	158	78.2	1,176	76.4	0.506	
Any risky sex	272	20.3	53	26.2	325	21.1	0.055	
Unsafe sex	105	7.8	27	13.4	132	8.6	0.009	
Older partnership	66	5.3	14	7.2	80	5.5	0.267	91
Transactional sex	50	3.9	13	6.6	63	4.3	0.082	63
Multiple partnership	178	13.3	31	15.7	209	13.6	0.353	5

Cell values may not add up to total values due to missing values.

Participants who did not complete all survey rounds (N = 202 excluded) were comparable to those who completed all three survey rounds (N = 1338 included) with regard to age, rural residence, residence in poor household, food security, older partnership, transactional sex, multiple partnership, and any risky sexual behaviours. Excluded participants were more likely to be female, to be sexually/ recently infected with HIV and to have had unsafe sex. Participants lost to follow-up were excluded for multivariate analyses.

Table 3 presents—for adolescents we included in this study—the proportions of the key study variables at the first, second and third wave of data collection. It shows increases in all past-year risky sexual behaviours from wave 1 to wave 3 (except for transactional sex where the prevalence decreased from 6-7% at wave 1 and wave 2 to 4% at wave 3), likely due to the different recall period at baseline. The proportion of participants who had unsafe sex slightly increased from 7% at wave 1 to 8% at wave 3. There are increases in the proportion of older sexual partnership (from 2% to 6% over the three waves) and multiple sexual partnership (from 9% to 14%). In total, participants who had any risky sexual behaviours during the last year increased from 14% at the first wave to 23% at the third wave.

Table 3: Prevalence of key study variables at the three study waves

	Wave 1		**Wave 2**		**Wave 3**	
	No.	**%**	**No.**	**%**	**No.**	**%**
HIV status						
HIV-negative	397	29.7	397	29.7	397	29.7
Horizontally infected	206	15.4	206	15.4	206	15.4
Vertically infected	735	54.9	735	54.9	735	54.9
Gender						
Male	584	43.6	584	43.6	584	43.6
Female	754	56.4	754	56.4	754	56.4
Age group						
10–14 years	813	60.8	604	45.1	430	32.1
15–24 years	525	39.2	734	54.9	908	67.9
Place of residence						
Urban	970	72.6	995	74.6	1,003	75
Rural	366	27.4	339	25.4	334	25
Poverty	898	67.1	1,059	79.1	892	66.7
Food security	1,034	77.3	963	72	1,018	76.1
Any risky sex	178	13.3	262	19.6	272	20.3
Unsafe sex	89	6.7	91	6.8	105	7.8
Older partnership	23	1.9	63	4.9	66	5.3
Transactional sex	73	5.7	92	7	50	3.9
Multiple partnership	110	8.6	174	13.3	178	13.3

Figures 1-4 were plotted from findings from Tables TS1-TS2 in the appendix. Figure 1 presents the rates of risky sexual behaviours by gender, and HIV status as well as mode of infection at each study wave for the full sample of 1338 adolescents. Figure 1 indicates that the percentage of participants engaged in any risky sexual behaviour is higher among females (19% at wave 1 and 26% at wave 3) than among males (8% at wave 1 and 20% at wave 3). Figures 2-4 included

in the Appendices show data on each individual high-risk behaviour included in the composite risk outcome. Vertically infected HIV participants had the lowest percentage of reporting any risky sexual behaviours. Table TS6 reports on the correlation across the four sexual risk practices used to compute the composite outcome measure—all four practices were significantly correlated, with Spearman's rho values ranging from 0.2042-0.3454.

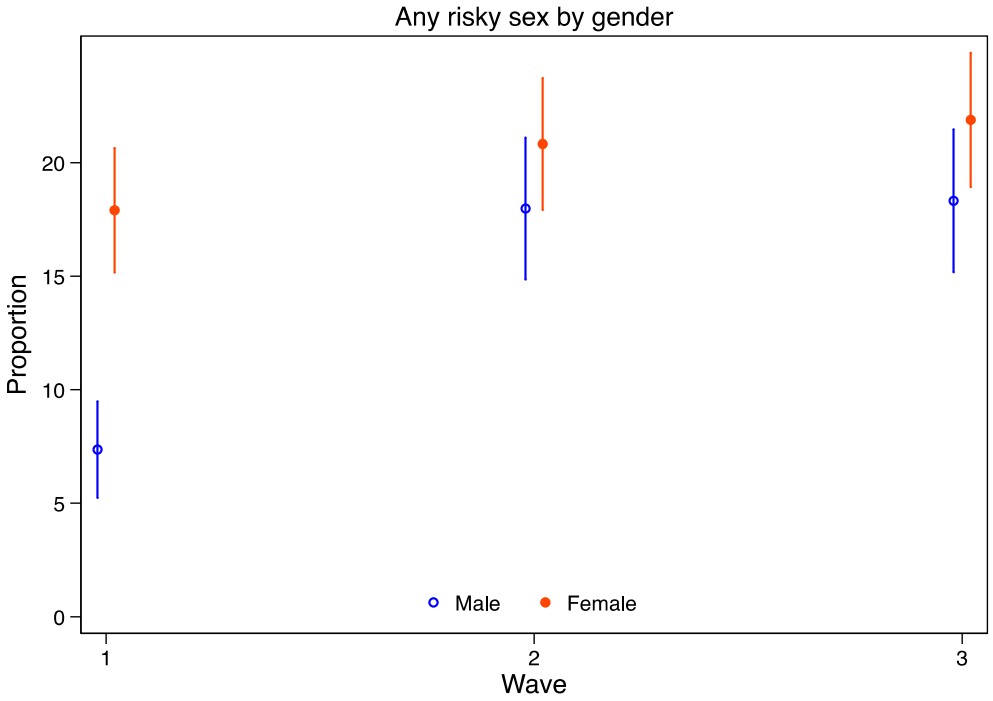

Figure 1: *Proportion (with 95% confidence intervals) of adolescents who reported any risky sexual behaviours by gender and across waves.*

3.2 Multivariate analysis

Table 4 shows the results of random effects models presenting adjusted odds ratios (see unadjusted odds ratios in the appendix TS4) of the association between HIV status (positive or negative) and the main outcome: any risky sexual practices in the past year. Eight different models are presented including four for the sample of all adolescents and four for the sub-sample of AYLHIV. The first set of models include the relationship between HIV status and any risky sex for [1] all adolescents, [2] adolescent girls, [3] adolescent boys, and [4] all adolescents' gender moderation effect. The second set of models include the relationship between mode of infection and any risky sex for [5] AYLHIV, [6] adolescent girls living with HIV, [7] adolescent boys living with HIV, and [8] AYLHIV's gender moderation effect. These models are adjusted for gender, age, place of residence, poverty, food security, and school attendance.

3.2.1 Composite outcome: any sexual risk

a. All adolescents

Findings show significant lower odds of having any risky sexual behaviours among AYLHIV (adjusted odds ratio [AOR]: 0.75, 95% CI: 0.57–0.97, *p*=0.028 than among HIV-negative adolescents (model [1]). The significant lower odds of engaging in any risky sex among AYLHIV as compared to HIV-negative adolescents hold for girls only (AOR: 0.69, 95% CI: 0.49–0.96, *p*=0.029) (model [2]), however gender did not significantly determine the relationship between HIV status and any sexual risk.

b. AYLHIV

Within the AYLHIV sub-sample, sexually-infected adolescents have higher odds of engaging in any risky sexual behaviours (AOR: 2.25, 95% CI: 1.54–3.29, $p < 0.001$) than vertically-infected adolescents (model [5]). In particular, sexually-infected adolescent girls have higher odds of engaging in any risky sexual behaviours (AOR: 2.93, 95% CI: 1.84–4.65, $p < 0.001$) than vertically-infected adolescent girls (model [6]). There is no significant association between mode of infection and any risky sex among adolescent boys living with HIV (model [7]), after including covariates, and gender did not significantly moderate the association between HIV mode of infection and any sexual risk.

Table 4: Random-effects estimates (adjusted odds ratios) of the relationship between HIV and any risky sex

Models testing effect of HIV status	**All adolescents [1]**	**Girls [2]**	**Boys [3]**	**Gender * HIV status [4]**
HIV-positive (vs. HIV-negative) [AOR (95%CI); p-value]	**0.75 (0.57–0.97);0.028**	**0.69 (0.49–0.96);0.029**	0.82 (0.53–1.27);0.377	0.85 (0.55–1.29);0.439
Observations	4007	2058	1749	4007
Individuals	1353	766	587	1353
Models testing effect of HIV mode of infection	**AYLHIV [5]**	**Adolescent girls living with HIV [6]**	**Adolescent boys living with HIV [7]**	**Gender * MOI [8]**
Horizontally-infected (vs. Vertically-infected) [AOR (95%CI); p-value]	**2.25 (1.54–3.29);<0.001**	**2.93 (1.84–4.65);<0.001**	1.59 (0.79–3.20);0.197	1.21 (0.70–2.10);0.501
Observations	2817	1556	1261	4007
Individuals	941	520	421	1353

*Adjusted models are controlled for gender, age, location, poverty, food security and baseline any risky sex.

The same models ([1] to [8]) were then fitted for specific risky sexual behaviours outcomes such as unsafe sex, older sexual partnership, transactional sex and multiple sexual partnership (see Table 5 to 8). These models were adjusted for gender, age, place of residence, poverty, food security, and school attendance. Estimates from unadjusted models are presented in Table TS3a-c in the appendices.

3.2.2 Results of individual sexual risk practices

Findings from adjusted regression reveal that HIV status is significantly associated with having unsafe sex among adolescents (Table 5, model [1]). Adolescents living with HIV have lower odds of engaging in unsafe sex (AOR: 0.64, 95% CI: 0.47–0.85, $p = 0.003$) than HIV-negative adolescents. Specifically, the odds of having unsafe sex are lower among girls living with HIV (AOR: 0.64, 95% CI: 0.45–0.89, $p = 0.009$) than among HIV-negative adolescent girls (model [2]). There is no significant association between HIV status and any of the other risky sexual behaviour outcomes except for multiple sexual partnership (Table 8, model [3] and model [4]).

Findings from model [5] to model [8] of Tables 5-8 show that the mode of HIV infection is significantly associated with unsafe sex, older sexual partnership (for AYLHIV and adolescent girls and boys living with HIV) and multiple sexual partnership (for AYLHIV and adolescent girls living with HIV). Compared to vertically-infected adolescents, sexually-infected adolescents have higher odds of engaging in unsafe sex (AOR: 2.89, 95% CI: 1.80–4.63, $p < 0.001$), older sexual partnership (AOR: 3.47, 95% CI: 1.83–6.56, $p < 0.001$), and multiple sexual partnership (AOR: 2.26, 95% CI: 1.41–3.63, $p < 0.001$). There were not differences by mode of HIV infection for transactional sex rates.

Compared to vertically-infected adolescent girls, sexually-infected adolescent girls have higher odds of engaging in unsafe sex (AOR: 3.89, 95% CI: 2.18–6.92, $p < 0.001$), older sexual partnership (AOR: 2.93, 95% CI: 1.35–6.35, $p = 0.007$), and multiple sexual partnership (AOR: 2.60, 95% CI: 1.40–4.85, $p = 0.003$).

Sexually-infected adolescent boys have higher odds of engaging in older sexual partnership (AOR: 4.75, 95% CI: 1.60–14.11, $p = 0.005$). Gender significantly moderates the association between HIV mode of infection and older sexual partnership (model [8] of table 6) (for sexually-infected adolescents, AOR: 3.78, 95% CI: 1.36–10.49, $p = 0.011$). We found that sexually-infected girls had higher risks of engaging in older sexual partnership (predicted probabilities: 11% for sexually-infected girls and 1% for vertically-infected girls) than boys (6% for sexually-infected boys and 1% for vertically-infected boys).

Table 5: Random-effects estimates (adjusted odds ratios) of the relationship between HIV and unsafe sex

HIV status	All adolescents [1]	Girls [2]	Boys [3]	Gender * HIV status [4]
HIV-positive (vs. HIV-negative) [AOR (95%CI); p-value]	**0.64 (0.47–0.85);0.003**	**0.64 (0.45–0.89);0.009**	0.64 (0.34–1.19);0.159	0.65 (0.35–1.24);0.192
Observations	4007	2058	1749	4007
Individuals	1353	766	587	1353
HIV mode of infection	**AYLHIV [5]**	**Adolescent girls living with HIV [6]**	**Adolescent boys living with HIV [7]**	**Gender * MOI [8]**
Horizontally-infected (vs. Vertically-infected) [AOR (95%CI); p-value]	**2.89 (1.80–4.63);<0.001**	**3.89 (2.18–6.92);<0.001**	1.48 (0.51–4.29);0.470	1.29 (0.45–3.70);0.631
Observations	2817	1556	1261	2817
Individuals	941	520	421	941

*Adjusted models are controlled for gender, age, location, poverty, food security and baseline unsafe sex.

Table 6: Random-effects estimates (adjusted odds ratios) of the relationship between HIV and older sexual partnership

HIV status	All adolescents [1]	Girls [2]	Boys [3]	Gender * HIV status [4]
HIV-positive (vs. HIV-negative) [AOR (95%CI); p-value]	0.87 (0.56–1.34);0.528	0.94 (0.56–1.58);0.816	0.79 (0.34–1.80);0.567	0.85 (0.39–1.85);0.687
Observations	3806	2166	1640	3806
Individuals	1352	765	587	1352
HIV mode of infection	**AYLHIV [5]**	**Adolescent girls living with HIV [6]**	**Adolescent boys living with HIV [7]**	**Gender * MOI [8]**
Horizontally-infected (vs. Vertically-infected) [AOR (95%CI); p-value]	**3.47 (1.83–6.56);<0.001**	**2.93 (1.35–6.35);0.007**	**4.75 (1.60–14.11);0.005**	**3.78 (1.36–10.49);0.011**
Observations	2669	1484	1185	2669
Individuals	940	519	421	940

*Adjusted models are controlled for gender, age, location, poverty, food security and baseline older partnership.

Table 7: Random-effects estimates (adjusted odds ratios) of the relationship between HIV and transactional sex

HIV status	All adolescents [1]	Girls [2]	Boys [3]	Gender * HIV status [4]
HIV-positive (vs. HIV-negative) [AOR (95%CI); p-value]	1.14 (0.80–1.62);0.464	1.32 (0.83–2.09);0.239	0.92 (0.49–1.73);0.798	1.01 (0.58–1.79);0.959
Observations	3903	2224	1679	3903
Individuals	1353	766	587	1353
HIV mode of infection	**AYLHIV [5]**	**Adolescent girls living with HIV [6]**	**Adolescent boys living with HIV [7]**	**Gender * MOI [8]**
Horizontally-infected (vs. Vertically-infected) [AOR (95%CI); p-value]	1.25 (0.77–2.03);0.371	1.49 (0.80–2.79);0.208	1.14 (0.40–3.22);0.811	0.80 (0.34–1.88);0.602
Observations	2721	1518	1203	2721
Individuals	941	520	421	941

*Adjusted models are controlled for gender, age, location, poverty, food security and baseline older transactional sex.

Table 8: Random-effects estimates (adjusted odds ratios) of the relationship between HIV and multiple sexual partnership

HIV status	All adolescents [1]	Girls [2]	Boys [3]	Gender * HIV status [4]
HIV-positive (vs. HIV-negative) [AOR (95%CI); p-value]	0.80 (0.59–1.09);0.155	0.87 (0.59–1.28);0.475	0.70 (0.43–1.15);0.158	0.73 (0.46–1.15);0.178
Observations	3966	2249	1717	3,966
Individuals	1353	766	587	1,353
HIV mode of infection	**AYLHIV [5]**	**Adolescent girls living with HIV [6]**	**Adolescent boys living with HIV [7]**	**Gender * MOI [8]**
Horizontally-infected (vs. Vertically-infected) [AOR (95%CI); p-value]	**2.26 (1.41–3.63);0.001**	**2.60 (1.40–4.85);0.003**	2.29 (0.99–5.30);0.053	1.81 (0.90–3.66);0.096
Observations	2767	1536	1231	2,767
Individuals	941	520	421	941

*Adjusted models are controlled for gender, age, location, poverty, food security and baseline multiple partnership.

4. Discussion

This working paper presents longitudinal analyses from a three-wave cohort of adolescent and young South Africans. The results of our analyses highlight the importance of HIV status and mode of HIV infection in understanding risky sexual practices among adolescents in resource-constrained settings. Interventions to reduce sexual risk practices must be tailored to respond to the unique needs of different adolescent sub-groups. AYLHIV were less likely to report sexual risk practices than HIV-negative adolescents even after adjusting for age, gender, food security, poverty, and baseline values. This finding pinpoints the need to focus on reducing risk exposure among HIV-negative adolescents in such a high HIV prevalence context.

We also found that HIV mode of infection tended to be a more significant determinant of engaging in sexual risk practices: recently infected adolescents were more likely to report any sexual risk, unprotected sex, sex with an older partner, and multiple sexual partners. Recently infected adolescent girls had higher risks of engaging in these sexual risk practices compared to vertically infected adolescent girls. Gender moderated the impact of mode of HIV infection on sex with an older partner: adolescent girls who were recently infected with HIV were more likely than adolescent boys to report sex with an older partner.

These findings—capitalising on knowledge of HIV-status at baseline of a three-wave dataset—allow us to disentangle the temporality of risk, and suggest that the sexual risk practices, resulting in the sexual HIV transmission among adolescent girls and young women in this context, persist following HIV infection. HIV risk reduction programming must acknowledge this risk continuum and not stop once adolescent girls and young women have been diagnosed positive. A recent systematic review found few interventions focusing on positive prevention and sexual risk reduction among AYLHIV (Toska, Pantelic et al., 2017). Our findings suggest the importance of linking secondary HIV prevention efforts with primary efforts in a continuum of care. Moreover, given rates of unintended pregnancies and early motherhood among adolescent girls and young women in South Africa, it is critical to link HIV care with Prevention of mother-to-child transmission and post-partum SRH services.

The study has several limitations. First, it analyses only self-reported data—though HIV status was validated with medical records where available. Second, despite the three data points, it cannot control for unmeasured confounders such as individual personality traits. Nonetheless, the analyses have several key strengths. The availability of three waves of data allows for temporal precedence of explanatory variables: HIV infection and mode of HIV infection occurred prior to all three study data points (and were recorded at baseline) and are confirmed by Tables TS5 and TS5a-d in the appendix. The 3-wave outcome measures provide increased statistical power to detect the effect of HIV status and mode of HIV infection. These analyses take into account the aging of this young cohort since baseline, and explore the additional impact of HIV infection beyond the expected change over time. The study recruited participants via community-tracing, ensuring lower bias compared to studies that focus on clinic-based recruitment. Although data were collected in a South African health district, the social and economic status of the study communities are similar to those in neighbouring countries in Southern Africa.

The study highlights several areas for future analyses, including which support factors may help reduce risk among all adolescents or among different groups, by HIV status or mode of infection.

It provides an important reminder to differentiate care provision and to invest HIV prevention efforts among those who were most recently infected, to ensure that they can initiate and maintain safe and healthy practices.

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Appendix

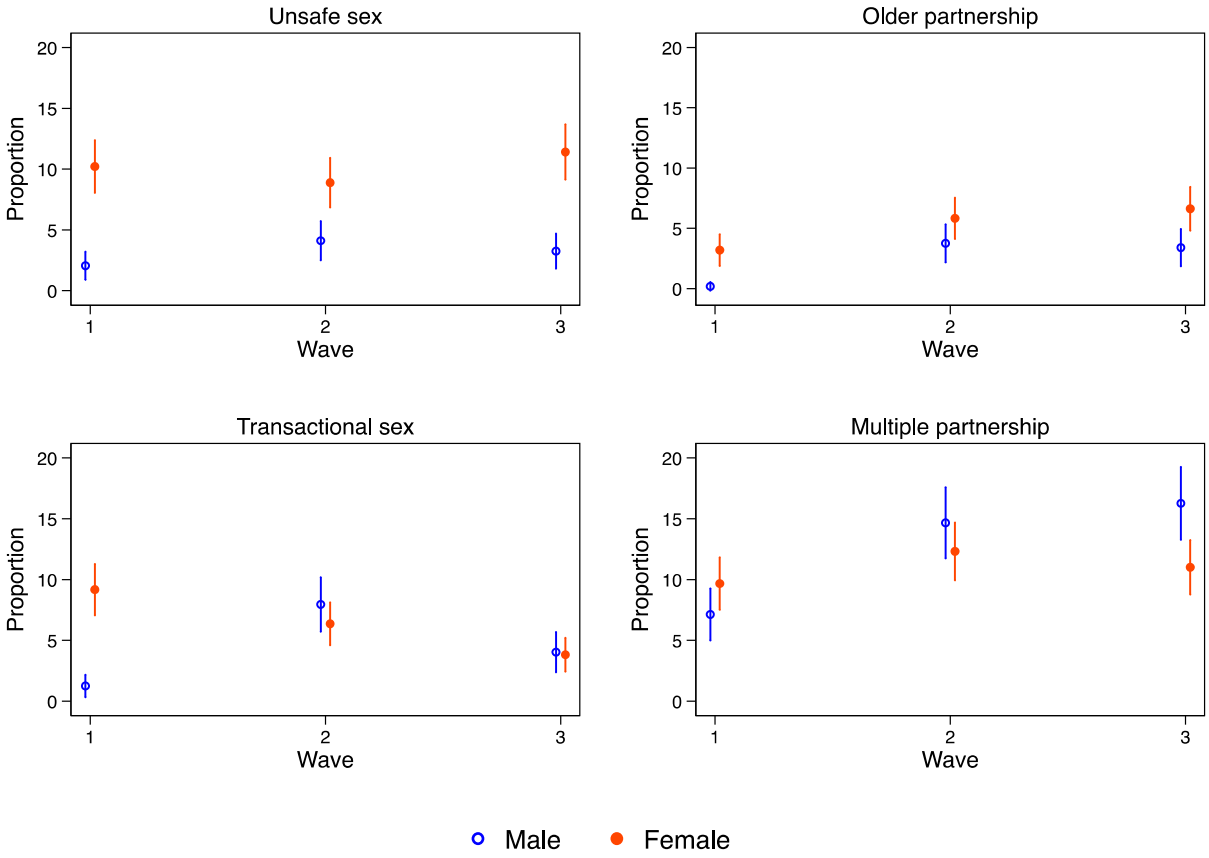

Figure 2: *Proportion (with 95% confidence intervals) of adolescents who reported risky sexual practices by gender and across waves (From Table TS1a-c).*

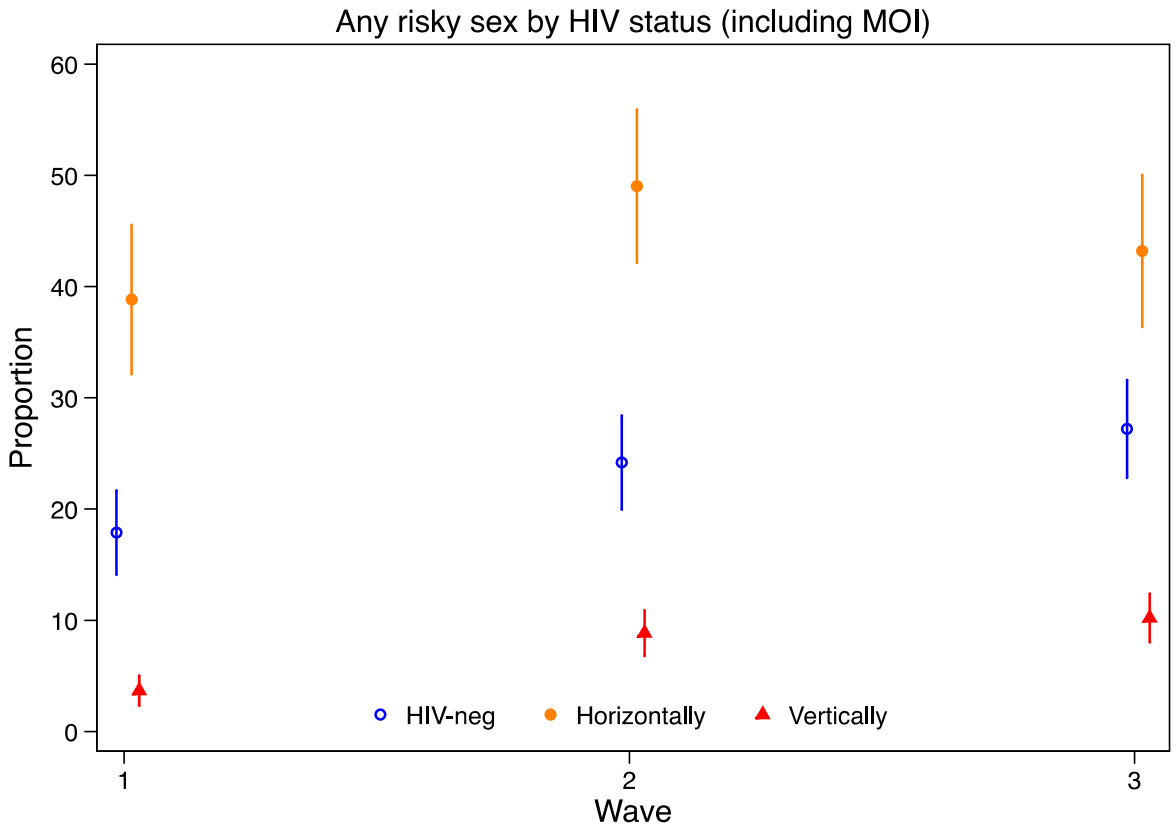

Figure 3: *Proportion (with 95% confidence intervals) of adolescents who reported any risky sexual behaviours by HIV status and across waves. (From Table TS2a-b).*

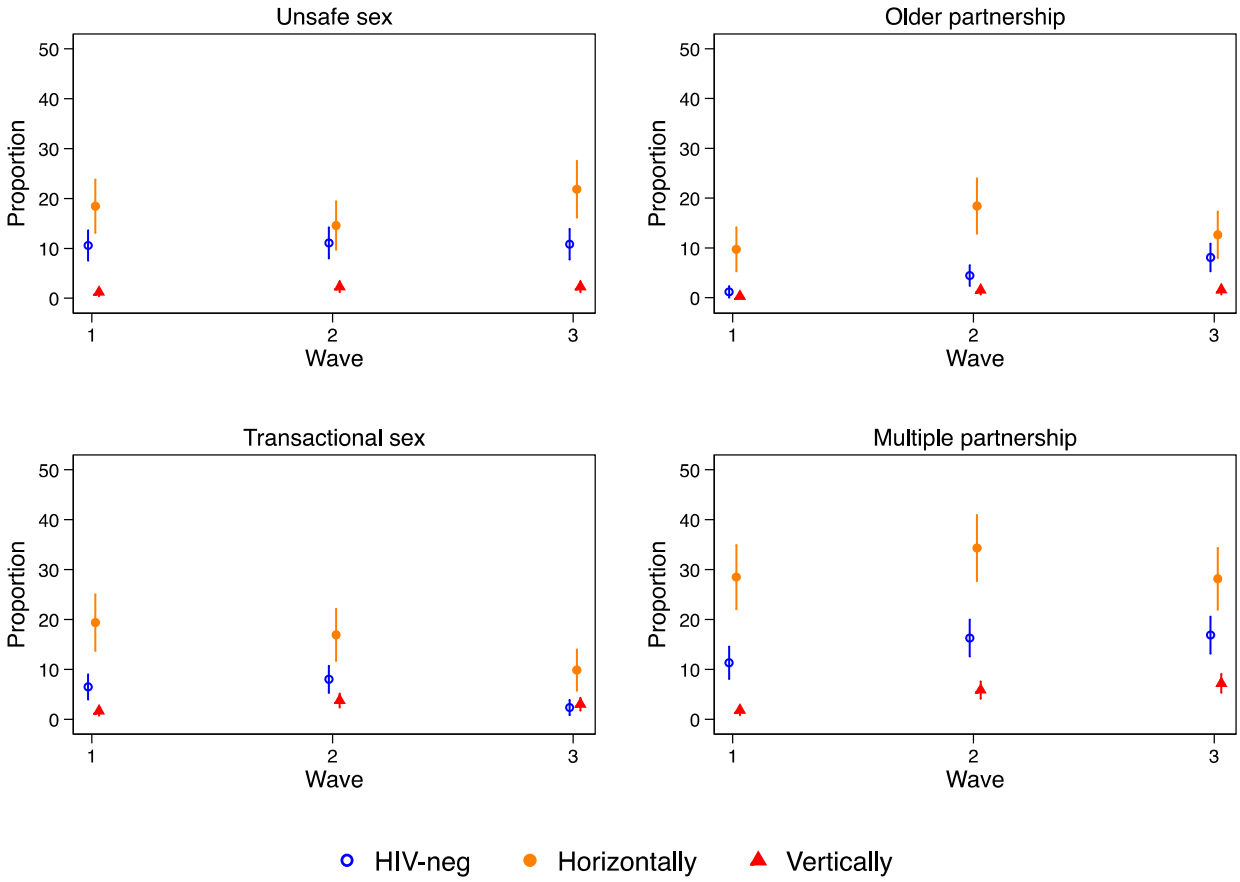

Figure 4: *Proportion (with 95% confidence intervals) of adolescents who reported risky sexual practices by mode of HIV infection and across waves. (From Table TS3a-b).*

Table TS1a: Distribution of outcomes and explanatory variables across waves among HIV negative

	Wave 1		Wave 2		Wave 3	
	No.	**%**	**No.**	**%**	**No.**	**%**
Gender						
Male	163	41.1	163	41.1	163	41.1
Female	234	58.9	234	58.9	234	58.9
Age group						
10–14 years	199	50.1	154	38.8	119	30
15–24 years	198	49.9	243	61.2	278	70
Place of residence						
Urban	283	71.3	290	73.2	290	73
Rural	114	28.7	106	26.8	107	27
Poverty	259	65.2	327	82.4	255	64.2
Food security	307	77.3	296	74.6	297	74.8
Any risky sex	71	17.9	96	24.2	108	27.2
Unsafe sex	42	10.6	44	11.1	43	10.8
Older partnership	4	1.2	17	4.5	30	8.1
Transactional sex	24	6.5	31	8	9	2.4
Multiple partnership	42	11.3	63	16.3	67	16.9

Table TS1b: Distribution of outcomes and explanatory variables across waves among sexually infected HIV participants

	Wave 1		Wave 2		Wave 3	
	No.	**%**	**No.**	**%**	**No.**	**%**
Gender						
Male	58	28.2	58	28.2	58	28.2
Female	148	71.8	148	71.8	148	71.8
Age group						
10–14 years	51	24.8	23	11.2	8	3.9
15–24 years	155	75.2	183	88.8	198	96.1
Place of residence						
Urban	138	67.3	150	73.5	152	74.1
Rural	67	32.7	54	26.5	53	25.9
Poverty	158	76.7	170	82.5	149	72.3
Food security	139	67.5	140	68	141	68.4
Any risky sex	80	38.8	101	49	89	43.2
Unsafe sex	38	18.4	30	14.6	45	21.8
Older partnership	17	9.7	35	18.4	25	12.6
Transactional sex	37	19.4	34	16.9	20	9.9
Multiple partnership	55	28.5	69	34.3	58	28.2

Table TS1c: Distribution of outcomes and explanatory variables across waves among vertically infected HIV participants

	Wave 1		Wave 2		Wave 3	
	No.	**%**	**No.**	**%**	**No.**	**%**
Gender						
Male	363	49.4	363	49.4	363	49.4
Female	372	50.6	372	50.6	372	50.6
Age group						
10–14 years	563	76.6	427	58.1	303	41.2
15–24 years	172	23.4	308	41.9	432	58.8
Place of residence						
Urban	549	74.8	555	75.6	561	76.3
Rural	185	25.2	179	24.4	174	23.7
Poverty	481	65.4	562	76.5	488	66.4
Food security	588	80	527	71.7	580	78.9
Any risky sex	27	3.7	65	8.8	75	10.2
Unsafe sex	9	1.2	17	2.3	17	2.3
Older partnership	2	0.3	11	1.6	11	1.6
Transactional sex	12	1.7	27	3.8	21	3
Multiple partnership	13	1.8	42	5.9	53	7.2

Table TS2a: Distribution of outcomes and explanatory variables across waves among males

	Wave 1		Wave 2		Wave 3	
	No.	**%**	**No.**	**%**	**No.**	**%**
HIV status						
HIV-negative	163	27.9	163	27.9	163	27.9
Horizontally infected	58	9.9	58	9.9	58	9.9
Vertically infected	363	62.2	363	62.2	363	62.2
Age group						
10–14 years	405	69.3	309	52.9	222	38
15–24 years	179	30.7	275	47.1	362	62
Place of residence						
Urban	435	74.6	446	76.6	449	76.9
Rural	148	25.4	136	23.4	135	23.1
Poverty	375	64.2	462	79.1	376	64.4
Food security	473	81	431	73.8	469	80.3
Any risky sex	43	7.4	105	18	107	18.3
Unsafe sex	12	2.1	24	4.1	19	3.3
Older partnership	1	0.2	21	3.8	18	3.4
Transactional sex	7	1.2	45	8	22	4
Multiple partnership	40	7.1	83	14.7	95	16.3

Table TS2b: Distribution of outcomes and explanatory variables across waves among females

	Wave 1		Wave 2		Wave 3	
	No.	**%**	**No.**	**%**	**No.**	**%**
HIV status						
HIV-negative	234	31	234	31	234	31
Horizontally infected	148	19.6	148	19.6	148	19.6
Vertically infected	372	49.3	372	49.3	372	49.3
Age group						
10–14 years	408	54.1	295	39.1	208	27.6
15–24 years	346	45.9	459	60.9	546	72.4
Place of residence						
Urban	535	71	549	73	554	73.6
Rural	218	29	203	27	199	26.4
Poverty	523	69.4	597	79.2	516	68.4
Food security	561	74.4	532	70.6	549	72.8
Any risky sex	135	17.9	157	20.8	165	21.9
Unsafe sex	77	10.2	67	8.9	86	11.4
Older partnership	22	3.2	42	5.8	48	6.6
Transactional sex	66	9.2	47	6.4	28	3.8
Multiple partnership	70	9.7	91	12.3	83	11

Table TS3a: Distribution of outcomes and explanatory variables across waves among adolescents aged <15

	Wave 1		Wave 2		Wave 3	
	No.	**%**	**No.**	**%**	**No.**	**%**
HIV status						
HIV-negative	199	24.5	154	25.5	119	27.7
Horizontally infected	51	6.3	23	3.8	8	1.9
Vertically infected	563	69.2	427	70.7	303	70.5
Gender						
Male	405	49.8	309	51.2	222	51.6
Female	408	50.2	295	48.8	208	48.4
Place of residence						
Urban	601	73.9	448	74.3	316	73.5
Rural	212	26.1	155	25.7	114	26.5
Poverty	516	63.5	467	77.3	273	63.5
Food security	659	81.1	447	74	338	78.6
Any risky sex	6	0.7	14	2.3	5	1.2
Unsafe sex	2	0.2	7	1.2	2	0.5
Older partnership	0	0	3	0.5	1	0.2
Transactional sex	0	0	7	1.2	1	0.2
Multiple partnership	4	0.5	7	1.2	3	0.7

Table TS3b: Distribution of outcomes and explanatory variables across waves among adolescents aged 15-19

	Wave 1		Wave 2		Wave 3	
	No.	**%**	**No.**	**%**	**No.**	**%**
HIV status						
HIV-negative	189	38.4	197	32.8	185	28.2
Horizontally infected	136	27.6	114	19	90	13.7
Vertically infected	167	33.9	289	48.2	382	58.1
Gender						
Male	173	35.2	241	40.2	296	45.1
Female	319	64.8	359	59.8	361	54.9
Place of residence						
Urban	347	70.8	448	74.9	500	76.1
Rural	143	29.2	150	25.1	157	23.9
Poverty	353	71.7	476	79.3	438	66.7
Food security	358	72.8	428	71.3	509	77.5
Any risky sex	154	31.3	173	28.8	143	21.8
Unsafe sex	77	15.7	51	8.5	50	7.6
Older partnership	17	4.1	31	5.5	30	5
Transactional sex	60	13.2	59	10.2	26	4.2
Multiple partnership	95	20.7	115	20	102	15.5

Table TS3c: Distribution of outcomes and explanatory variables across waves among adolescents aged >19

	Wave 1		Wave 2		Wave 3	
	No.	**%**	**No.**	**%**	**No.**	**%**
HIV status						
HIV-negative	9	27.3	46	34.3	93	37.1
Horizontally infected	19	57.6	69	51.5	108	43
Vertically infected	5	15.2	19	14.2	50	19.9
Gender						
Male	6	18.2	34	25.4	66	26.3
Female	27	81.8	100	74.6	185	73.7
Place of residence						
Urban	22	66.7	99	74.4	187	74.8
Rural	11	33.3	34	25.6	63	25.2
Poverty	29	87.9	116	86.6	181	72.1
Food security	17	51.5	88	65.7	171	68.1
Any risky sex	18	54.5	75	56	124	49.4
Unsafe sex	10	30.3	33	24.6	53	21.1
Older partnership	6	23.1	29	23.2	35	14.4
Transactional sex	13	41.9	26	19.5	23	9.2
Multiple partnership	11	35.5	52	39.1	73	29.1

Table TS4: Random-effects estimates (unadjusted odds ratios) of the relationship between HIV status and any risky sex

HIV status	All adolescents [1]	Girls [2]	Boys [3]
HIV-positive (vs. HIV-negative) [unadjusted OR (95%CI); p-value]	**0.65 (0.49–0.87);0.003**	**0.61 (0.43–0.87);0.006**	0.71 (0.43–1.15);0.163
Observations	4014	2062	1752
Individuals	1353	766	587
HIV mode of infection	AYLHIV [5]	Adolescent girls living with HIV [6]	Adolescent boys living with HIV [7]
Horizontally-infected (vs. Vertically-infected) [unadjusted OR (95%CI); p-value]	**5.42 (3.68–7.99);<0.001**	**6.89 (4.34–10.93);<0.001**	**5.24 (2.42–11.33);<0.001**
Observations	2823	1560	1263
Individuals	941	520	421

Table TS4a: Random-effects estimates (unadjusted odds ratios) of the relationship between HIV status and unsafe sex

HIV status	All adolescents [1]	Girls [2]	Boys [3]
HIV-positive (vs. HIV-negative) [unadjusted OR (95%CI); p-value]	**0.63 (0.46–0.84);0.002**	**0.65 (0.47–0.91);0.013**	**0.54 (0.29–0.99);0.047**
Observations	4014	2062	1752
Individuals	1353	766	587
HIV mode of infection	AYLHIV [5]	Adolescent girls living with HIV [6]	Adolescent boys living with HIV [7]
Horizontally-infected (vs. Vertically-infected) [unadjusted OR (95%CI); p-value]	**5.94 (3.97–8.90);<0.001**	**7.87 (4.75–13.06);<0.001**	2.24 (0.87–5.79);0.095
Observations	2823	1560	1263
Individuals	941	520	421

Table TS4b: Random-effects estimates (unadjusted odds ratios) of the relationship between HIV and older sexual partnership

HIV status	All adolescents [1]	Girls [2]	Boys [3]
HIV-positive (vs. HIV-negative) [unadjusted OR (95%CI); p-value]	0.64 (0.40–1.01);0.054	0.72 (0.42–1.26);0.252	0.57 (0.25–1.26);0.166
Observations	3813	2170	1643
Individuals	1352	765	587
HIV mode of infection	AYLHIV [5]	Adolescent girls living with HIV [6]	Adolescent boys living with HIV [7]
Horizontally-infected (vs. Vertically-infected) [unadjusted OR (95%CI); p-value]	**9.19 (5.26–16.04);<0.001**	**9.08 (4.49–18.37);<0.001**	**8.99 (3.18–25.42);<0.001**
Observations	2675	1488	1187
Individuals	940	519	421

Table TS4c: Random-effects estimates (unadjusted odds ratios) of the relationship between HIV and transactional sex

HIV status	All adolescents [1]	Girls [2]	Boys [3]
HIV-positive (vs. HIV-negative) [unadjusted OR (95%CI); p-value]	1.00 (0.71–1.41);0.991	1.23 (0.78–1.94);0.364	0.66 (0.34–1.27);0.213
Observations	3910	2228	1682
Individuals	1353	766	587
HIV mode of infection	AYLHIV [5]	Adolescent girls living with HIV [6]	Adolescent boys living with HIV [7]
Horizontally-infected (vs. Vertically-infected) [unadjusted OR (95%CI); p-value]	**3.04 (2.00–4.61);<0.001**	**3.61 (2.12–6.15);<0.001**	**3.60 (1.23–10.54);0.019**
Observations	2727	1522	1205
Individuals	941	520	421

Table TS4d: Random-effects estimates (unadjusted odds ratios) of the relationship between HIV and multiple sexual partnership

HIV status	All adolescents [1]	Girls [2]	Boys [3]
HIV-positive (vs. HIV-negative) [unadjusted OR (95%CI); p-value]	**0.68 (0.49–0.93);0.017**	0.78 (0.52–1.15);0.213	**0.56 (0.33–0.97);0.039**
Observations	3973	2253	1720
Individuals	1353	766	587
HIV mode of infection	AYLHIV [5]	Adolescent girls living with HIV [6]	Adolescent boys living with HIV [7]
Horizontally-infected (vs. Vertically-infected) [unadjusted OR (95%CI); p-value]	**5.33 (3.37–8.42);<0.001**	**7.55 (4.33–13.14);<0.001**	**7.56 (2.94–19.43);<0.001**
Observations	2773	1540	1233
Individuals	941	520	421

Table TS5: Random-effects estimates (unadjusted and adjusted odds ratios) of the relationship between HIV and any risky sex: with (first order) lagged explanatory variables

	All adolescents [1]		Girls [2]		Boys [3]		Gender * HIV status [4]
HIV status	Unadjusted	Adjusted	Unadjusted	Adjusted	Unadjusted	Adjusted	Adjusted
HIV-positive (vs. HIV-negative) [OR (95%CI); p-value]	**0.54 (0.36–0.82);0.003**	**0.70 (0.48–1.00);0.050**	**0.48 (0.29–0.81);0.006**	**0.61 (0.38–0.99);0.046**	0.63 (0.33–1.20);0.160	0.81 (0.46–1.44);0.473	0.80 (0.45–1.43);0.458
Observations	2706	2700	1532	1529	1174	1171	2700
Individuals	1353	1353	766	766	587	587	1353
	AYLHIV [5]		Girls LHIV [6]		Boys LHIV [7]		Gender * MOI [8]
HIV mode of infection	Unadjusted	Adjusted	Unadjusted	Adjusted	Unadjusted	Adjusted	Adjusted
Horizontally-infected (vs. Vertically-infected) [OR (95%CI); p-value]	**11.06 (6.10–20.07);<0.001**	**3.37 (1.97–5.76);<0.001**	**15.32 (7.34–31.97);<0.001**	**5.29 (2.66–10.51);<0.001**	**8.32 (3.00–23.11);<0.001**	1.75 (0.72–4.23);0.217	1.59 (0.74–3.40);0.233
Observations	1882	1877	1040	1037	842	840	2700
Individuals	941	941	520	520	421	421	1353

*Adjusted models are controlled for gender, age, location, poverty, and food security at T1 and T2, and baseline any risky sex.

Table TS5a: Random-effects estimates (unadjusted and adjusted odds ratios) of the relationship between HIV and unsafe sex: with (first order) lagged explanatory variables

	All adolescents [1]		Girls [2]		Boys [3]		Gender * HIV status [4]
HIV status	Unadjusted	Adjusted	Unadjusted	Adjusted	Unadjusted	Adjusted	Adjusted
HIV-positive (vs. HIV-negative) [OR (95%CI); p-value]	**0.53 (0.34–0.81);0.004**	**0.60 (0.40–0.91);0.016**	**0.54 (0.32–0.90);0.019**	**0.58 (0.35–0.96);0.034**	0.49 (0.22–1.07);0.072	0.61 (0.28–1.33);0.215	0.60 (0.27–1.34);0.213
Observations	2706	2700	1532	1529	1174	1171	2700
Individuals	1353	1353	766	766	587	587	1353
	AYLHIV [5]		Girls LHIV [6]		Boys LHIV [7]		Gender * MOI [8]
HIV mode of infection	Unadjusted	Adjusted	Unadjusted	Adjusted	Unadjusted	Adjusted	Adjusted
Horizontally-infected (vs. Vertically-infected) [OR (95%CI); p-value]	**8.75 (5.29–14.45);<0.001**	**3.80 (2.20–6.54);<0.001**	**12.85 (6.71–24.61);<0.001**	**5.75 (2.82–11.72);<0.001**	2.26 (0.87–5.85);0.094	1.30 (0.44–3.83);0.633	1.39 (0.47–4.13);0.558
Observations	1882	1877	1040	1037	836	834	1871
Individuals	941	941	520	520	418	418	938

*Adjusted models are controlled for gender, age, location, poverty, and food security at T1 and T2, and baseline unsafe sex.

Table TS5b: Random-effects estimates (unadjusted and adjusted odds ratios) of the relationship between HIV and older partnership: with (first order) lagged explanatory variables

	All adolescents [1]		Girls [2]		Boys [3]		Gender * HIV status [4]
HIV status	Unadjusted	Adjusted	Unadjusted	Adjusted	Unadjusted	Adjusted	Adjusted
HIV-positive (vs. HIV-negative) [OR (95%CI); p-value]	**0.59 (0.35–1.00);0.048**	0.84 (0.52–1.38);0.499	0.67 (0.34–1.29);0.229	0.93 (0.50–1.73);0.808	0.57 (0.25–1.26);0.166	0.75 (0.33–1.74);0.509	0.74 (0.32–1.72);0.484
Observations	2372	2368	1350	1348	1020	1018	2366
Individuals	1237	1237	696	696	540	540	1236
	AYLHIV [5]		Girls LHIV [6]		Boys LHIV [7]		Gender * MOI [8]
HIV mode of infection	Unadjusted	Adjusted	Unadjusted	Adjusted	Unadjusted	Adjusted	Adjusted
Horizontally-infected (vs. Vertically-infected) [OR (95%CI); p-value]	**11.85 (6.07–23.17);<0.001**	**4.34 (2.09–8.99);<0.001**	**13.34 (5.49–32.39);<0.001**	**3.99 (1.54–10.34);0.004**	**8.99 (3.18–25.42);<0.001**	**4.69 (1.60–13.77);0.005**	**4.79 (1.53–15.01);0.007**
Observations	1691	1687	946	944	745	566	1510
Individuals	882	882	487	487	395	313	800

*Adjusted models are controlled for gender, age, location, poverty, and food security at T1 and T2, and baseline older partnership.

Table TS5c: Random-effects estimates (unadjusted and adjusted odds ratios) of the relationship between HIV and transactional sex: with (first order) lagged explanatory variables

	All adolescents [1]		Girls [2]		Boys [3]		Gender * HIV status [4]
HIV status	Unadjusted	Adjusted	Unadjusted	Adjusted	Unadjusted	Adjusted	Adjusted
HIV-positive (vs. HIV-negative) [AOR (95%CI); p-value]	0.97 (0.59–1.59);0.904	1.27 (0.79–2.05);0.323	1.42 (0.73–2.78);0.300	1.64 (0.84–3.18);0.145	0.61 (0.29–1.31);0.206	0.96 (0.47–1.96);0.910	0.95 (0.47–1.90);0.876
Observations	2504	2498	1431	1428	1073	1070	2498
Individuals	1293	1293	730	730	563	563	1293
	AYLHIV [5]		Girls LHIV [6]		Boys LHIV [7]		Gender * MOI [8]
HIV mode of infection	Unadjusted	Adjusted	Unadjusted	Adjusted	Unadjusted	Adjusted	Adjusted
Horizontally-infected (vs. Vertically-infected) [OR (95%CI); p-value]	**5.36 (2.78–10.31);<0.001**	1.57 (0.79–3.11);0.197	**6.89 (3.19–14.89);<0.001**	2.18 (0.91–5.21);0.080	**4.31 (1.22–15.22);0.023**	1.07 (0.33–3.44);0.915	1.09 (0.38–3.19);0.868
Observations	1757	1752	988	985	769	767	1752
Individuals	908	908	503	503	405	405	908

*Adjusted models are controlled for gender, age, location, poverty, and food security at T1 and T2, and baseline transactional sex.

Table TS5d: Random-effects estimates (unadjusted and adjusted odds ratios) of the relationship between HIV and multiple partnership: with (first order) lagged explanatory variables

	All adolescents [1]		Girls [2]		Boys [3]		Gender * HIV status [4]
HIV status	Unadjusted	Adjusted	Unadjusted	Adjusted	Unadjusted	Adjusted	Adjusted
HIV-positive (vs. HIV-negative) [AOR (95%CI); p-value]	**0.59 (0.38–0.90);0.015**	0.78 (0.52–1.16);0.218	0.71 (0.42–1.20);0.200	0.86 (0.51–1.45);0.567	**0.45 (0.22–0.95);0.036**	0.67 (0.36–1.28);0.226	0.69 (0.38–1.26);0.226
Observations	2570	2564	1460	1457	1110	1107	2564
Individuals	1300	1300	736	736	564	564	1300
	AYLHIV [5]		Girls LHIV [6]		Boys LHIV [7]		Gender * MOI [8]
HIV mode of infection	Unadjusted	Adjusted	Unadjusted	Adjusted	Unadjusted	Adjusted	Adjusted
Horizontally-infected (vs. Vertically-infected) [OR (95%CI); p-value]	**9.99 (5.07–19.70);<0.001**	**3.20 (1.67–6.16);<0.001**	**13.11 (5.93–28.97);<0.001**	**4.03 (1.74–9.34);0.001**	**14.21 (3.76–53.73);<0.001**	2.63 (0.87–7.97);0.087	2.38 (0.91–6.22);0.076
Observations	1806	1801	1009	1006	797	795	1801
Individuals	914	914	508	508	406	406	914

*Adjusted models are controlled for gender, age, location, poverty, and food security at T1 and T2, and baseline multiple partnership.

Table TS6: *Spearman correlation coefficients between risky sexual behaviours*

	Unsafe sex	Older sexual partnership	Transactional sex	Multiple sexual partnership
Unsafe sex	1			
Older sexual partnership	0.2428*	1		
Transactional sex	0.2301*	0.2042*	1	
Multiple sexual partnership	0.2997*	0.2974*	0.3454*	1

* $p<0.05$