Prevalence and correlates of repeat testing during pregnancy and postpartum in rural Kenya

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A thesis

Submitted in partial fulfillment of the

Requirements for the degree of

Master of Public Health

University of Washington

2018

Committee:

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Program Authorized to Offer Degree:

Epidemiology

University of Washington

Abstract

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Background: Repeat HIV testing during pregnancy and the postpartum period is crucial for early detection and treatment of incident maternal HIV infection, and to achieve elimination of mother-to-child HIV transmission (MTCT). World Health Organization (WHO) guidelines recommend repeat testing of peripartum HIV negative women but data on implementation are lacking. The objective of this study is to determine the uptake and correlates of repeat HIV testing during pregnancy, delivery, and postpartum. **Methods:** HIV seronegative women seeking care during the 3rd trimester, delivery, or at 6 weeks, 6 months, or 9 months postpartum were enrolled in a cross-sectional study in rural Kenya. Prior HIV testing history was abstracted from maternal child health (MCH) booklets to estimate prevalence of repeat testing at different timepoints. Poisson generalized linear models were used to determine correlates of repeat testing. We externally validated a risk score tool to predict maternal HIV infections using area under the curve (AUC) and Brier score. **Results:** Among 1558 women enrolled, the median age was 23 years, 60% of women were married and the median number of times tested for HIV in the most recent pregnancy was 1 (interquartile range [IQR]: 1-2). Prevalence of new HIV

infection detected by the study was 0.4% with no difference between pregnant and postpartum women (Odds ratio: 0.8, 95% Confidence Interval [CI]: 0.2-3.7; p=0.8). Prevalence of programmatic repeat HIV testing at 6 weeks (51%) postpartum was significantly higher than in the 3rd trimester (22%), during delivery (5%) and 6 months postpartum (32%) (p= <0.001). In multivariate analysis, women with more lifetime number of sexual partners (Prevalence Ratio [PR]: 0.97 per 1 unit increase, CI: 0.95-0.99; p=.007), with history of sexually transmitted infection (STI) (PR: 1.18, CI: 1.10-1.27; p=<.001) and women who were 21-30 years were less likely than women <21 years (PR: 0.87, CI: 0.81-0.93; p=<.001) to receive ≥1 programmatic repeat tests. External validation of a risk score tool yielded an AUC of 0.82 (95%CI: 0.68-0.93) and Brier score 0.21. **Conclusion:** Prevalence of repeat testing was higher during the early postpartum period than in late pregnancy. Developing strategies that address barriers and increase antenatal care (ANC) attendance, could improve uptake of repeat testing during pregnancy.

Background

Over 2 million children were living with HIV at the end of 2016, the majority of whom acquired HIV from their mothers during pregnancy, delivery, or breastfeeding (1). Early detection and treatment of maternal HIV infection is critical to reduce pediatric HIV, making testing a crucial component of HIV prevention of mother-to-child HIV transmission (PMTCT) interventions. While integration of HIV testing in antenatal care (ANC) and universal antiretroviral therapy (ART) for HIV-infected pregnant/lactating women has been a highly effective strategy to reduce MTCT among pregnant women with chronic HIV infection, newly acquired HIV infections during pregnancy and postpartum may go undetected and untreated. Thus, the relative contribution of acute maternal HIV infection increases as programs reduce MTCT among mothers with established chronic infections (2).

HIV incidence is high among pregnant and postpartum women, with pooled incidence rate of 4.7 during pregnancy and 2.9 during the postpartum period, (3) which may be due to alterations in the genital tract mucosa, disturbances in the vaginal flora, changes in the sexual behaviors, or prevalence of sexually transmitted diseases during pregnancy(4–7). High viral loads following maternal HIV acquisition, low levels of passively transferred maternal antibodies, and lack of ART when infections are undetected, can contribute to increased MTCT(8). Incident maternal HIV infections are associated with increased MTCT risk (3), with MTCT rates ranging from 36% - 53%, among women who seroconverted during pregnancy or breastfeeding (9–11). In Botswana, over 40% of MTCT is estimated to be due to maternal seroconversion after initially testing HIV-negative during pregnancy. Unless repeat maternal HIV testing is conducted, pregnant and postpartum women who test negative for HIV during initial antenatal screening but acquire HIV later, will have undetected infection and miss benefits from PMTCT interventions.

WHO guidelines recommend repeat HIV testing among HIV negative pregnant women in late pregnancy/at delivery and postpartum, but data on implementation of repeat maternal HIV testing are lacking(12). Data on receipt of any repeat testing, frequency and timing of repeat testing, and infections detected as a result of repeat testing are essential to maximize resources for HIV prevention. Addressing these gaps is critical to prevent new pediatric infections and achieve elimination of MTCT. We measured the prevalence and cofactors of repeat HIV testing during pregnancy and postpartum. Additionally, we externally validated an HIV risk score tool developed specifically for this population.

Methods

Study design and participants

We conducted a cross-sectional study at the Ahero County and the Bondo sub-County Hospitals in the Nyanza region of Kenya among HIV-uninfected pregnant and HIV-uninfected/undiagnosed postpartum women seeking antenatal or postnatal/infant immunization care services between February 2017 and April 2018. Women were eligible for participation if they were ≥14 years, and willing to be tested for HIV and provide written informed consent. Additionally, pregnant women were eligible if they were ≥28 weeks gestation, and HIV-uninfected with documented HIV-negative test results during pregnancy and at least 3 months before study enrollment. Postpartum women were eligible for enrollment if they were 6 weeks, 6 months, or 9 months postpartum. Women with unknown HIV status (not tested for HIV in antenatal care) were eligible for enrollment at delivery and postpartum to measure missed opportunities for HIV testing. The Kenyatta National Hospital/University of Nairobi Ethics and Research Committee and the University of Washington Institutional Review Board approved all study procedures.

Study and laboratory procedures
At enrollment, a survey was administered by study nurses to collect socio-demographics, reproductive history, condom use, and male partner characteristics. Maternal HIV testing history and gestational age were obtained from MCH booklets. After survey administering, HIV testing was conducted. Women reported on their history of sexually transmitted infections, and if they indicated a history were asked which infection they had.

Women were tested using the Alere Ag/Ab Combo 4th generation test. This test can detect p24 antigens, an indicator of infection that proceeds production of antibodies, thereby shortening the window period between HIV acquisition and detection. Women with positive 4th generation tests received confirmatory testing using 3rd generation tests routinely used as the standard of care in Kenya (Alere Determine 3rd generation rapid test and First Response 3rd generation test). Women with discordant results had blood drawn for a tie-breaker test using Uni-Gold Recombigen to confirm diagnosis. Post-test HIV counseling was provided to all women regardless of their HIV status by study staff, and HIV-infected women were referred to the MCH clinics for follow-up care and treatment.

Statistical analysis
HIV infections detected among mothers who were prior negative were considered incident infections. To assess differences in HIV risk during pregnancy versus the postpartum period, we categorized women as pregnant if they were enrolled during the 3rd trimester or delivery, and postpartum if they were enrolled at 6 weeks, 6 months, or 9 months postpartum. The prevalence of new infections was compared between pregnant versus postpartum women using the Chi-square test.

To externally validate an HIV risk score tool (13), we measured partner HIV status, number of lifetime sexual partners, and syphilis status and used these measures to calculate simplified risk scores for each participant. History of syphilis infection was used as a proxy indicator for syphilis status at enrollment. Rapid plasma reagin (RPR) tests are typically conducted at the first ANC visit; thus, history of syphilis infection would include infections detected during pregnancy. Variables for risk score components that had missing values were given a score of 0 for that component. A ROC analysis was conducted to calculate the area under the curve[AUC] to assess discriminative ability of the risk score to predict incident maternal HIV infection(14). We also calculated the Brier Score to assess the overall model performance and quantify how close predictions of HIV acquisition were to observed incident HIV infections during pregnancy and postpartum, using a threshold of <0.25 to indicate the tool is informative for prediction(14).

To assess programmatic HIV testing history prior to enrollment, the prevalence of any repeat testing in the 3rd trimester, at delivery, at 6 weeks postpartum, or at 6 months postpartum was determined by reviewing maternal HIV testing histories during the most recent pregnancy and postpartum period, omitting initial HIV test results during pregnancy. Since all women enrolled in the study were tested as part of study procedures, and inclusion of repeat testing at the enrollment visit would overestimate programmatic repeat testing, all repeat maternal HIV tests offered as part of the study were also excluded from this calculation. We identified cofactors for any repeat testing at the 9 months postpartum visit, using univariate Poisson generalized linear model (GLM) with a log-link function; this approach is appropriate when the prevalence of the outcome is high (15,16). We also identified cofactors for receiving ≥ 2 repeat tests, which more closely aligns with current Kenyan guidelines for repeat testing. Since we detected differences in repeat testing by site, we clustered the Poisson GLM models by site. Maternal age, education, and marital status were identified as potential confounders a priori, and were included in multivariate Poisson GLMs. In addition, variables with p <0.1 were included in the multivariate models. If variables were collinear, we included variables with least amount of

missing data in the multivariate model. Statistical analyses were performed using STATA version 14.2 (College Station, TX).

Results

Study population

To date, we have enrolled 1558 women (34% of the target, n=4650); 496 (53%) seeking care at MCH clinic for ANC, 95 (10%) seeking maternity care, and 967 attending postpartum care/infant immunization visits; 330 (35%) at 6 weeks, 356 (38%) at 6 months and 281 (30%) at 9 months postpartum (Table 1). Median age was 23 years (interquartile range [IQR]: 20-26) and median duration of education was 12 years (IQR: 8-12). Of 1557 women enrolled, 247(16%) were currently in school at the time of enrollment. The majority (60%) of women were married, with a median relationship duration of 3 years and 2 lifetime sexual partners (IQR: 1-3). Condom less sex the month before enrollment was reported by 588 (38%) women. Male partners were older than women, with a median age difference of 5 years (IQR: 3-8). Median number of times tested for HIV in the most recent pregnancy was 1 (IQR: 1-2) and the majority (74%) of women discussed HIV testing with their partner prior to getting tested. Overall, 18 (1.2%) women reported having a history of sexually transmitted infection (STI), 9 (50%) of whom had a history of syphilis, 1 (5%) had chlamydia, 2 (11%) had trichomonas, 3 (16%) had genital ulcers and 3 (16%) had genital warts. Most (69%) women with partners said their partner got tested for HIV; 31%of women with partners did not know their partner's HIV status, 1% (n=11) reported having an HIV-infected partner and 68% reported their partner was HIV negative. Among 11 women with HIV-infected partners, 82% said their partner was on antiretroviral therapy (ART). There were 6 women who had not previously been tested during pregnancy and did not know their status at enrollment during the postpartum period; 5 at 6 weeks postpartum visit and 1 at 9 months postpartum.

Prevalence of new HIV infections

Overall, 7 (0.4%) of 1552 previously HIV seronegative women had incident maternal HIV infections; 3 during pregnancy (0.5%, 3 infections in the 3rd trimester) and 4 during the postpartum period (0.4%, 3 at 6 weeks, 1 at 6 months postpartum) (Table 2). All women with incident infections had received an initial HIV test during antenatal/postnatal care. Risk of incident maternal HIV infection was similar between pregnant and postpartum women (Odds Ratio 0.8, 95% Confidence Interval [CI]: 0.2-3.7; p=0.8).

External validation of a HIV risk score tool

The risk score was applied to 1558 women, including 7 women with incident maternal HIV infections. The risk score area under the curve (AUC) was 0.82 (95%CI: 0.68-0.93) and the Brier score was 0.21 (Figure 1). The risk score predicted HIV acquisition better than assessment of only lifetime number of sexual partners (AUC, 0.42 [95% CI: 0.19–0.63]), or syphilis (AUC, 0.49 [95% CI: 0.49–0.49]) but performed similarly to assessment of having a male partner with unknown HIV status (AUC, 0.83 [95% CI: 0.69–0.97]). Individual risk scores for women with incident maternal HIV infection are shown in Table 2. Using a risk score threshold of >6 identified 86% of incident HIV infections; however, 322 (21%) HIV-uninfected women also had risk scores >6.

Prevalence and cofactors for programmatic repeat testing

The prevalence of programmatic repeat testing was significantly higher (51%) at 6 weeks postpartum, than in the 3rd trimester (22%), at delivery (5%), and at 6 months postpartum (32%)

(Figure 2) (p<0.001). Among women enrolled at 9 months postpartum, 222 (79%) women received ≥1 repeat HIV test during pregnancy and before the 9 months postpartum visit; of whom 85 (38%) received 1 repeat test, 95 (43%) received 2 repeat tests, 34 (15%) received 3 repeat tests, 7 (3%) received 4 repeat tests, and 1 (<1%) received 5 repeat tests. Cofactors for receiving ≥1 repeat test by 9 months postpartum are summarized in Table 3. Receiving ≥1 repeat test was more common among women with higher gravidity (PR: 1.06, CI: 1.05-1.07), a history of STIs (PR: 1.27, CI: 1.05-1.54), and both parents alive (Prevalence Ratio [PR]: 0.96, Confidence Interval [CI]: 0.94-0.99). In addition, women with more lifetime sexual partners were more likely to receive a repeat HIV test (PR: 0.97 per 1 unit increase in number of partners, CI: 0.94-0.99). Household income, partner secondary education, polygamous marriage, partner HIV status and condom less sex were not associated with receiving ≥1 repeat tests (p>0.1). In multivariate analysis, lifetime number of sexual partners and history of STIs remained significant in the model and women who were 21-30 years were less likely than women <21 years to have a repeat test (PR: 0.87, CI: 0.81-0.93; p=<.001).

In univariate analysis of receiving ≥2 repeat tests, we found that women with higher gravidity were more likely to receive ≥2 repeat tests (PR: 1.13, CI: 1.07-1.18; p=<.001) (Table 4); however only maternal age (PR: 0.83, CI: 0.73-0.94; p=0.003) remained significant in the multivariate model.

Discussion

In this cross-sectional study we found a lower incidence of HIV infection among pregnant and postpartum women than has been reported in Kenya(17–19). This may be due to programmatic repeat testing that previously detected incident HIV infections and referred women to PMTCT. Our study focused on HIV-negative women and thus excluded HIV-positive women who may have acquired infection prior to study enrollment. We found a similar prevalence of new HIV infections in pregnant (0.5%) and postpartum (0.4%) women. This is consistent with results from a meta-analysis of incident maternal HIV infection in which no difference in incidence was noted between pregnant and postpartum women, (3) but differs from a recent study among women with serodiscordant partners, which noted higher HIV acquisition during the postpartum period compared to late pregnancy (20). We had limited statistical power to compare the two periods given the low total number of new maternal infections.

Despite guidelines to conduct repeat maternal HIV testing during pregnancy, at labor/delivery, and in the postpartum period, we found that repeat HIV testing is inconsistently conducted in PMTCT programs. Our prevalence of repeat testing in late pregnancy was similar to a Zambian study; which found 25% women receive repeat HIV testing but is higher than a Kenyan study which found only 10% of pregnant women received a repeat HIV test (22,23). Repeat testing was more consistently implemented during the postpartum period (51% at 6 weeks and 32% at 6 months postpartum) than in late pregnancy (22%) or at the time of delivery (5%). The higher prevalence of repeat testing at 6 weeks postpartum may be a result of prioritization of this visit based on high attendance or provider perceptions of HIV risk during the peripartum period. While all women enrolled during pregnancy or at delivery in our study had already received an initial HIV test during pregnancy, some Kenyan women may miss the opportunity to receive a repeat test at these time points due to health care-seeking behaviors. Addressing these barriers may be useful to improve repeat HIV testing rates.

There have been temporal changes in Kenyan guidelines for repeat maternal HIV testing, with initial recommendations to conduct repeat tests in pregnancy and recent recommendations to test multiple times during pregnancy and while breastfeeding. Scale-up of repeat testing guidelines during pregnancy may account for differences in the prevalence of repeat testing in our study and in Rogers et al study (23). Wider implementation of repeat testing at multiple times during pregnancy and postpartum also seems apparent as 26% of women received at least 1 repeat test, and 20% of women received ≥2 repeat tests in our study. As scale-up of repeat testing increases, the number of incident maternal HIV infections detected during the postpartum period may decrease as women who acquire HIV earlier are no longer at risk. This could explain the lower prevalence of incident infection in the postpartum period in our study.

We detected differences in repeat testing by study site and clustered our analysis by this variable in the analysis; however, site-level differences in repeat testing may suggest differential guideline implementation between sites. Women with riskier sexual histories (more lifetime sexual partners and history of STIs) received repeat testing more frequently, which may suggest providers may offer repeat testing differentially based on sexual risk factors. In addition, older women (age 21-30) were less likely to receive repeat testing than younger women. While the proportion of women offered ≥ 2 repeat tests was higher among married women, these results were not statistically significant. A prior study conducted in Kenya reported repeat testing rates that were higher among married women (23). Unmarried women may delay seeking ANC for fear of experiencing stigma and discrimination, which could lead to late initiation of ANC and lack of need for repeat testing. Alternatively, health care providers may consider married women at higher risk of HIV acquisition.

In our validation of a simplified risk score tool developed for pregnant and postpartum women (13), we found the risk score had a good predictive ability to identify women who are more likely to acquire HIV, identifying 86% of incident maternal HIV infections; however, 322 (21%) HIV-uninfected women also had risk scores at or above the threshold. Tools that can help identify women with high risks of HIV acquisition during pregnancy and postpartum may be very useful, as incident maternal HIV infection substantially increases risk of MTCT compared chronic infections (3). Pre-exposure prophylaxis (PrEP) during pregnancy and postpartum has been shown to be safe and effective for HIV prevention, and would also confer PMTCT benefits(24). Pregnant and postpartum who have high risks of HIV infection may have greater benefit and may be good candidates for PrEP (22). PrEP is recommended by WHO for pregnant and lactating women in settings of high HIV incidence based on a systematic review and meta-analysis (25,26). However, best practices for PrEP implementation to maximize prevention efforts and limited resources while minimizing potential risks associated with PrEP use have not been defined. Our data suggest the risk assessment tool may be useful to identify high risk pregnant and postpartum women who would benefit more from PrEP interventions, reducing unnecessary PrEP exposure.

Our study had several strengths. We were able to abstract information on repeat maternal HIV testing across the pregnancy-postpartum continuum to assess programmatic repeat testing during and after pregnancy. We also assessed several risk factors that are routinely captured in MCH booklets to calculate risk scores. The study also had limitations. The study was conducted in high volume government run public health facilities that serve low- to middle-income, rural population in western Kenya and study findings may not be generalizable to other settings. In addition, our prevalence of incident maternal HIV infection may be underestimated

as scale-up of repeat maternal testing practices in Kenya occurs, and women with incident maternal HIV infections being screened out of our pool of study participants. Furthermore, we did not collect data on number of ANC/postnatal care visits in the current pregnancy and were not able to determine whether differences in patterns of accessing care may explain differences in repeat testing. Although RPR tests are typically conducted at the first ANC visit, and our measure of a history of syphilis infection would include infections detected during pregnancy, this metric cannot discriminate between older infections and may result in some women being misclassified as having syphilis during the most recent pregnancy, which may alter their risk. Finally, since the study is ongoing, we were lacked power to identify differences in the prevalence of incident HIV-infection between pregnant and postpartum women.

In conclusion, repeat maternal HIV testing is inconsistently implemented in Kenya. Service delivery gaps in offering repeat maternal HIV testing in Kenya should be explored further to mitigate missed opportunities to detect and treat new maternal HIV infections and move towards elimination of mother-to-child-transmission (eMTCT) efforts.

Table 1: Participant characteristics, by enrollment visit

Enrollment characteristics	***All women (n=1558)***		***≥28 weeks gestation (n=496)***		***Delivery/labor (n=95)***		***6 weeks (n=330)***		***6 months (n=356)***		***9 months (n=281)***	
	N	*Median (IQR) or n (%)*	*N*	*Median (IQR) or n (%)*	*N*	*Median (IQR) or n (%)*	*N*	*Median (IQR) or n (%)*	*N*	*Median (IQR) or n (%)*	*N*	*Median (IQR) or n (%)*
Sociodemographic												
Age category (years)	1558		496		95		330		356		281	
<21		455 (29)		120 (24)		29 (31)		116 (35)		110 (31)		80 (28)
21-30		982 (63)		333 (67)		59 (62)		192 (58)		220 (62)		178 (63)
30+		121 (8)		43 (9)		7 (7)		22 (7)		26 (7)		23 (8)
Completed secondary education	1557	807 (52)	496	289 (58)	95	41 (43)	330	160 (48)	355	172 (48)	281	145 (52)
Completed education (years)	1555	12 (8-12)		12 (8-14)		10 (8-12)		11 (8-12)		11 (8-12)		12 (8-12)
Both parents alive	1557	984 (63)		326 (66)		64 (67)		207 (63)		225 (63)		162 (58)
Monthly household income ≥ 10,000 KSH	1558	384 (25)		142 (29)		29 (31)		85 (26)		74 (21)		54 (19)
Relationships and sexual behavior												
Married	1558	942 (60)		334 (67)		53 (56)		175 (53)		215 (60)		165 (59)
Currently in a relationship	1558	1030 (66)		355 (72)		58 (61)		197 (60)		237 (67)		183 (65)
Relationship duration (years)[1]	1030	3 (2-6)	355	3 (2-7)	58	4 (2-8)	197	3 (2-6)	237	4 (2-6)	183	4 (2-6)
Partner completed secondary education	1012	695 (69)	348	248 (71)	55	39 (71)	196	126 (64)	235	164 (70)	178	118 (66)
Partner age difference (years older)	978	5 (3-8)	341	5 (3-7)	50	5 (4-7)	186	6 (3-8)	227	6 (4-8)	174	5 (3-7)
Frequency of sex (last month)[2]	1463	0 (0-2)	463	0 (0-2)	95	0	317	0 (0-1)	331	0 (0-5)	257	1 (0-4)
Frequency of condom less sex (last month)	592	2 (2-5)	178	2 (1-4)	20	3 (2-5)	90	2 (1-6)	164	3 (2-5)	136	3 (2-5)
Age of sexual debut[2]	1468	15 (15-18)	469	15 (15-18)	79	15 (14-18)	314	15 (15-17)	340	16 (15-18)	266	15 (15-18)

Lifetime number of sexual partners	1544	2	(1-3)	490	2	(1-3)	95	2	(1-3)	324	2	(1-3)	355	2	(1-3)	280	2	(1-3)
Reproductive history																		
Gravidity	1558	1	(1-2)	496	2	(1-2)	95	2	(1-2)	330	1	(1-2)	356	1	(1-2)	281	1	(1-2)
Number of living children[3]	730	2	(1-3)	252	1	(1-2)	49	2	(2-3)	143	2	(2-3)	159	2	(2-3)	127	2	(2-3)
Facility delivery[4]	584	527	(90)	139	119	(86)	41	39	(95)	136	125	(92)	150	134	(89)	118	110	(93)
Clinical and HIV testing history																		
Ever diagnosed with STI	1552	18	(1)	495	5	(1)	94	1	(1)	330	3	(1)	356	6	(2)	277	3	(1)
Tested for HIV in last pregnancy[3]	723	700	(97)	250	244	(98)	48	47	(98)	141	138	(98)	158	153	(97)	126	118	(94)
Total number of HIV tests [5]	1549	1	(1-2)	494	1	(1)	93	1	(1)	326	1	(1-2)	355	2	(2-3)	281	2	(2-3)
Discussed HIV test with partner prior to test[1]	1022	758	(74)	354	262	(74)	57	47	(82)	197	141	(72)	234	174	(74)	180	134	(74)
Partner HIV status[1]	1030			355			58			197			237			183		
Negative		699	(68)		247	(70)		37	(65)		121	(62)		167	(71)		127	(69)
Positive		11	(1)		4	(1)		0			0			1	(<1)		6	(3)
Unknown		315	(31)		103	(29)		20	(35)		74	(38)		68	(29)		50	(27)
Partner currently on ART [6]	11	9	(82)	4	2	(50)	0	0		0	0		1	1	(100)	6	6	(100)
Incident HIV-infections	1558	7	(<1)		3	(<1)		0			3	(<1)		1	(<1)		0	

[1]Among women with current partners, [2] Excluded women who did not know, [3]Among women with previous pregnancies, [4]Among multiparous women including postpartum women who delivered, [5] Including all HIV tests during most recent pregnancy and postpartum, excluding the study visit, [6]Among women with current partners with HIV.

STI, sexually transmitted infection; ART, antiretroviral therapy; IQR, interquartile range

Table 2: Risk scores for women with incident maternal HIV infections detected

ID	Visit incident infection detected	Sexual partners [1]	Partner HIV status unknown [2]	Syphilis [3]	Risk Score
1	30 weeks gestation	1	6	0	7
2	31 weeks gestation	1	6	0	7
3	36 weeks gestation	2	0	0	2
4	6 weeks postpartum	1	6	0	7
5	6 weeks postpartum	3	6	0	9
6	6 weeks postpartum	3	6	0	9
7	6 months postpartum	1	6	0	7

[1] 1 point per each lifetime sexual partner, [2] Score is 6 if the male partner HIV status is unknown, [3] Score is 5 for history of syphilis and 0 otherwise. Self-reported history of syphilis infection was used rather than the rapid plasma reagin (RPR) test used in the original risk score.

Table 3: Correlates of receiving repeat maternal HIV testing by 9 months postpartum (N=281)

	Received repeat HIV test										
	N	No [N=59] n (%) or median (IQR)		N	Yes [N=222] n (%) or median (IQR)		P-value	Crude PR[1] (95% CI)	P-value	Adjusted PR[1] (95% CI)	P-value
Sociodemographic characteristics											
Age category (years)	59			222							
<21		13	(22)		67	(30)	0.7	Ref		Ref	
21-30		40	(68)		138	(62)		0.93 (0.82-1.05)	0.2	0.87 (0.81-0.93)	<.001
>30		6	(10)		17	(8)		0.88 (0.39-1.96)	0.8	0.70 (0.29-1.68)	0.4
Completed secondary education	59	34	(58)	222	111	(50)	0.3	0.94 (0.84-1.04)	0.2	1.02 (0.95-1.09)	0.6
Both parents alive	59	36	(61)	222	126	(57)	0.4	0.96 (0.94-0.99)	.009	1.01 (0.94-1.09)	0.8
Monthly household income ≥10,000KSH	59	14	(24)	222	40	(18)	0.4	0.92 (0.77-1.12)	0.4		
Relationships and sexual behavior											
Married	59	31	(53)	222	134	(60)	0.6	1.07 (0.92-1.24)	0.4	1.00 (0.79-1.26)	0.9
Polygamous marriage [2]	31	2	(6)	151	9	(6)	0.9	0.99 (0.65-1.49)	0.9		
Partner completed education secondary [2]	28	24	(86)	150	94	(63)	0.4	0.85 (0.66-1.21)	0.4		
Partner HIV status unknown/positive [3]	31	8	(26)	152	48	(32)	0.7	1.05 (0.83-1.33)	0.7		
Frequency of condom less sex (last month) [4]	29	24	(83)	107	89	(83)	0.9	1.01 (0.65-1.56)	0.9		
Lifetime number of sexual partners	59	2	(1-3)	222	2	(1-3)	0.4	0.97 (0.94-0.99)	0.03	0.97 (0.95-0.99)	0.007
Reproductive history											
Gravidity	59	1	(1-2)	222	1	(1-3)	0.01	1.06 (1.05-1.07)	<.001	1.11 (0.97-1.27)	0.1
Facility delivery [4]	17	14	(82)	101	96	(95)	0.08				
Ever diagnosed with STI	59	0		222	3	(1)	0.5	1.27 (1.05-1.54)	0.01	1.18 (1.10-1.27)	<.001

[1] Using robust standard errors, [2] Among women with current partner, [3] Included if partner HIV status is unknown or positive among women with current partner, [4] Among multiparous women. Due to collinearity between facility delivery and partner education, facility delivery was excluded from the multivariate model. Variables identified as potential confounders a priori were included in multivariate Poisson GLMs; maternal age, education, and marital status.

STI, sexually transmitted infection; PR, prevalence ratio; CI, confidence interval, IQR, interquartile range.

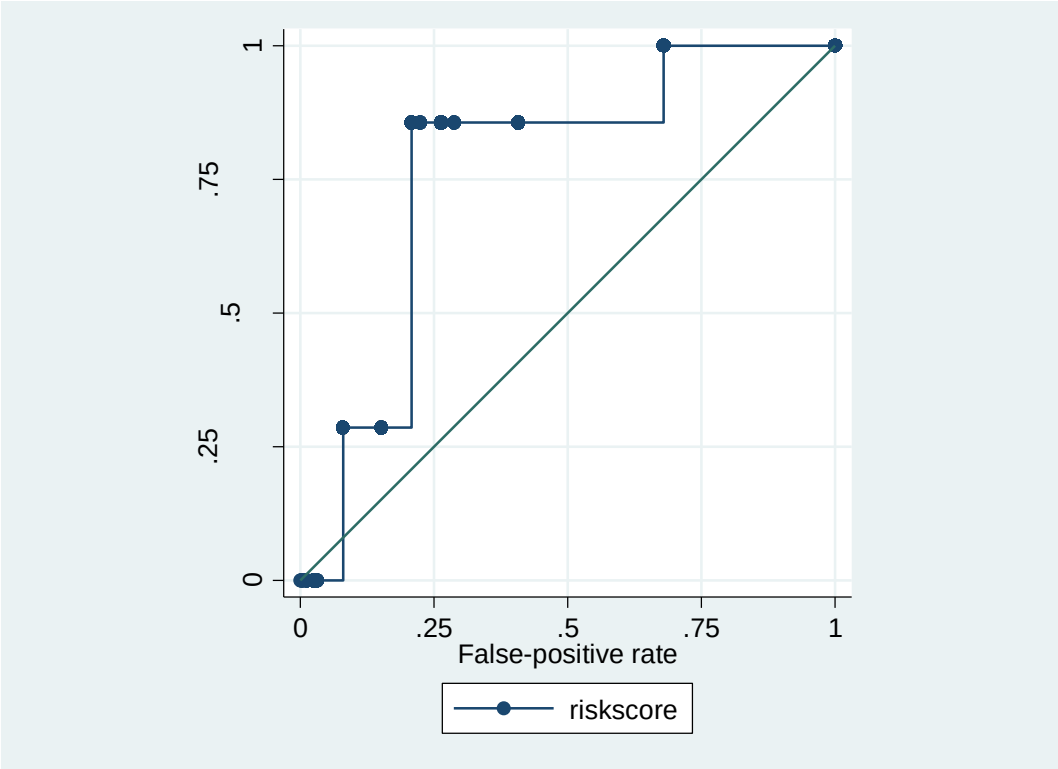
Table 4: Correlates of receiving ≥ 2 repeat maternal HIV tests by 9 months postpartum (N=281)

	Received ≥ 2 repeat HIV tests										
	N	No (N=144) n (%) or median (IQR)		N	Yes (N=137) n (%) or median (IQR)		p- value	Crude PR[1] (95% CI)	p-value	Adjusted PR[1] (95% CI)	p- value
Sociodemographic characteristics											
Age category (years)	144			137			0.9				
<21		40	(28)		40	(29)		Ref		Ref	
21-30		93	(65)		85	(62)		0.96 (0.69-1.36)	0.8	0.83 (0.73-0.94)	.003
>30		11	(8)		12	(9)		1.04 (0.34-3.16)	0.9	0.78 (0.27-2.27)	0.7
Completed secondary education	144	81	(56)	137	64	(47)	0.4	0.82 (0.59-1.14)	0.2	0.91 (0.70-1.17)	0.5
Both parents alive	144	86	(60)	137	76	(55)	0.4	0.92 (0.78-1.07)	0.3		
Monthly household income ≥10,000KSH	144	29	(20)	137	25	(18)	0.9	0.94 (0.56-1.56)	0.8		
Relationships and sexual behavior											
Married	144	70	(49)	137	95	(69)	0.4	1.59 (0.86-2.92)	0.1	1.55 (0.78-3.05)	0.2
Polygamous marriage [2]	79	4	(5)	103	7	(7)	0.8	-			
Partner completed secondary education [2]	75	52	(69)	103	66	(64)	0.5	0.91 (0.60-1.37)	0.6		
Partner HIV status Unknown/positive [3]	80	26	(33)	103	30	(29)	0.7	0.93 (0.71-1.22)	0.6		
Frequency of condom less sex (last month)	67	57	(85)	69	56	(81)	0.4	-			
Lifetime number of sexual partners	144	2	(1-3)	137	2	(1-3)	0.8	0.98 (0.88-1.09)	0.7		
Reproductive history											
Gravidity	144	1	(1-2)	137	2	(1-3)	0.02	1.13 (1.07-1.18)	<.001	1.07 (0.95-1.19)	0.3
Facility delivery [4]	53	48	(91)	65	62	(95)	0.4	-			
Ever diagnosed with STI	144	1	(1)	137	2	(1)	0.3	1.37 (0.92-2.04)	0.1		

[1] Using robust standard errors, [2] Among women with current partner, [3] Included if partner HIV status is unknown or positive among women with current partner, [4] Among multiparous women. Due collinearity with marital status, condom less sex, facility delivery and polygamous marriage were excluded from the multivariate analysis. Variables identified as potential confounders a priori were included in multivariate Poisson GLMs; maternal age, education, and marital status.

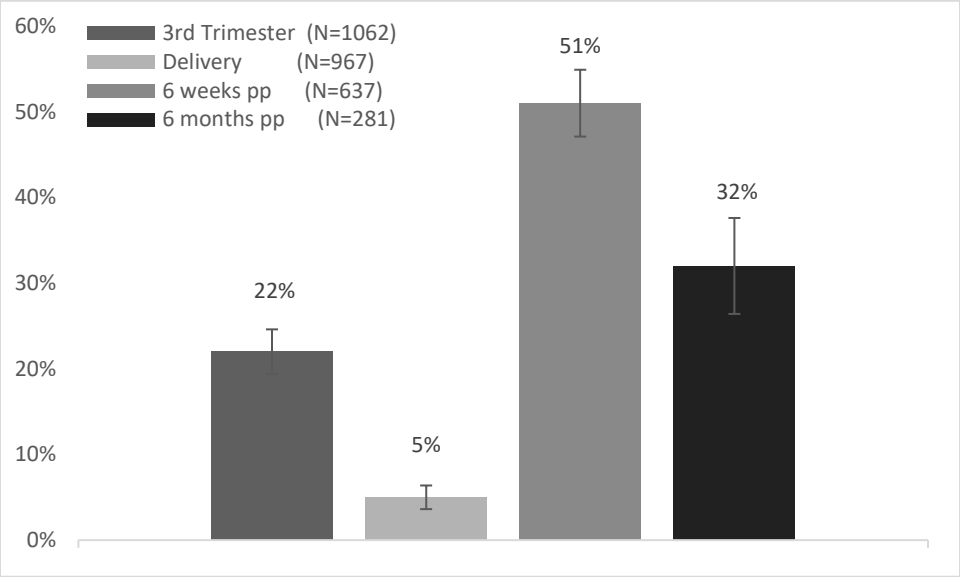
STI, sexually transmitted infection; PR, prevalence ration; CI, confidence interval, IQR, interquartile range.

Figure 1: Receiver operating characteristic curve and cut-points of risk score



	Sensitivity and Specificity of the Simplified Risk Score at Different Score Cuts							
	≥3	≥4	≥5	≥6	≥7	≥8	≥9	≥10
Sensitivity	86%	86%	86%	86%	86%	29%	29%	0%
Specificity	59%	71%	74%	78%	79%	85%	92%	97%

Figure 2: Prevalence of repeat maternal HIV testing, by visit



pp, postpartum.

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