Evaluating Measures of HIV Risk Perception with a Mixed Method Approach Among Adolescent Girls and Young Women Using PrEP in Kenya

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Abstract

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Introduction: Pre-exposure prophylaxis (PrEP) for HIV prevention is a promising HIV prevention option for young African women. The evidence of effective PrEP use in this population group is mixed, and has been tied to poor adherence. Discordance between assessed HIV risk and the actual experience of risk may underlie the dissonance observed between epidemiologic risk, risk perception, uptake of and adherence to prevention measures. We examined the contribution of research methods used in characterising HIV risk to this dissonance by contrasting HIV risk awareness as assessed by standard structured questionnaires and qualitative in-depth interviews.

Methods: We conducted secondary analysis of data from a trial of African women aged 18 to 24 years interested in taking PrEP. Enrollment took place at two sites in Thika and Kisumu, Kenya, and participants were followed up for a period of 24 months between 2017 and 2020. We conducted a multi-step mixed methods assessment of HIV risk awareness and related decision-making behaviour. First, a quantitative analysis of survey data with descriptive statistics to characterize the cohort, proportion testing for trend and generalised estimating equations to assess the association between predictors of risk and risk perception. Secondly, an inductive content analysis of interview data for narrative themes; and lastly, joint display methodology to summarise findings from the two analytical methods.

Results: We enrolled 350 young women with a median age of 21 years (IQR 19, 22). At baseline, 182 (52%) participants reported feeling at risk for HIV. In multivariable analysis, reporting a lot of HIV worry was significantly

associated with higher odds of risk perception (OR 1.95 [CI 1.31, 2.91]), while significantly lower odds were associated with visits at month 12 (OR 0.30 [CI 0.18, 0.48]) and 24 (OR 0.21 [CI 0.09, 0.20]), living with other family or employer (OR 0.56 [CI 0.33, 0.95]) and being single with a steady partner (OR 0.48 [CI 0.33, 0.70]). Qualitative data from 75 serial interviews provided insight into the changes observed over time in report of both risk awareness and sexual behavioural choices. We identified three major themes from the combined qualitative and quantitative analysis: risk dynamism, behavioural risk patterns and the influence of the social environment. HIV risk awareness and decision making was both intentional and contextual; driven primarily by HIV literacy, PrEP use, assessment of a partner's HIV risk profile and the self-agency to exercise held knowledge. Effective risk mitigation was contingent on intimate partner relationship dynamics and was hindered by the fear of intimate partner violence. Supportive social environments enabled disclosure and promoted the self-agency to effectively mitigate risk. Knowledge of partner status and PrEP use emerged as the primary determinants of risk awareness and related decision making, informing both risk perception and mitigation.

Conclusion: We observed complementarity and contrast between the two quantitative and qualitative data in how HIV risk was defined and rationalised, and identified factors at the individual, partnership and societal levels that informed risk awareness and related decision-making. Interview data expounded on the quantitative findings and revealed a more dynamic and rationalised experience of risk than was observed in survey data. The experience of HIV risk by young African women was not haphazard, but rather was rationalised based on HIV and PrEP literacy, current knowledge of partner status and attitudes, and prevailing sexual and economic needs. HIV related decision making was dependent not just on having access to preventive measures, but also on the agency and wherewithal to actualize known mitigation measures. Further work on how knowledge of partner HIV status and PrEP use can be leveraged to support HIV prevention and other sexual reproductive health programs targeting young women is warranted.

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1 INTRODUCTION:

In Kenya, the HIV Estimates Report attributed 46% of new infections in 2015 to youth aged 15-24 years, with young women accounting for a third of all new cases. Additionally, HIV prevalence reported for this group was disproportionally higher than that of comparable males at 2.7% and 1.7% respectively[1]. This is of particular concern, as adolescents and young people aged 15-24 years make up approximately 20% of Kenya's population[2]. In this context of continued high incidence within a significant youth bulge, targeted and innovative prevention efforts for youth, particularly young women, are urgently required.

One such approach is the use of antiretroviral-based pre-exposure prophylaxis (PrEP). There is robust evidence from multiple trials supporting the efficacy of PrEP in diverse populations[3, 4], and given its relative independence from direct partner involvement, PrEP is seen as a promising option for women. However, evidence of effective use in this population group is mixed, with some trials among younger women demonstrating none[5]. Poor adherence to dosing regimens is posited as the likely reason for this finding[6-8], secondary to poor risk perception and understanding of how PrEP works, and disenfranchising gendered social constructs [9-11]. Even so, the evidence for a direct relationship between risk awareness and optimal PrEP use is mixed, with low adherence sometimes demonstrated even in those considered educated on their risk for HIV and with unhindered access to PrEP[12, 13].

One possible reason for this disconnect between perception and adherence is the discordance between risk assessment and the actual experience of risk, as evidenced by the lack of alignment between perceived and epidemiologic risk [10, 14]. Defining and measuring risk is complex, further complicated by contextual factors such as individual life experiences that not only influence how one defines and rationalises one's own risk, but also how one responds to standard risk assessments. Furthermore, as HIV risk is circumstantial and dynamic in nature, standard surveys are often not equipped to comprehensively examine the numerous ways in which risk perception is framed, and the rationalisation processes that inform risk related decision making.

Disharmony between observed, reported and actual lived experience of risk may have implications on the successful implementation of HIV prevention services such as PrEP programs[15]. However, the extent to which such disconnect exists, and its impact on delivery and uptake of services is not fully understood. To this end, we conducted a mixed-methods study contrasting assessments of HIV risk perception and epidemiologic predictors of HIV risk using standard structured questionnaires with that from qualitative in-depth interviews in young African women vulnerable to HIV infection involved in a HIV prevention program.

2 METHODS

2.1 Ethical Approval

This study analysed data that had already been collected with ethical approval granted by the KEMRI Ethics Review Committee and the Institutional Review Boards of the Massachusetts General Hospital and the University of Washington.

2.2 Study Overview and Setting

This secondary data analysis utilised data from the completed randomized control trial 'Next generation real-time monitoring for PrEP adherence in young Kenya women' (MPYA) (ClinicalTrials.gov Identifier: NCT02915367). The MPYA trial enrolled young women at high risk for HIV infection interested in taking PrEP and was conducted between 2017 and 2020 at two clinical research sites in Kenya: Thika, a periurban town northeast of the capital Nairobi and at a periurban clinic in Kisumu, western Kenya. The regional HIV prevalence is estimated at 4% in Thika and at 16% in Kisumu.[16] The primary objective of the MPYA trial was to evaluate the use of a wireless device for monitoring PrEP adherence and patterns of PrEP discontinuation and re-initiation using a combination of

quantitative and qualitative methods. Participants were randomised 1:1 to either receive short message service (SMS) adherence reminders or not.

2.3 Study Participants

The study population for this analysis was comprised of all participants enrolled in the MPYA trial.[17] This trial enrolled ciswomen meeting the following eligibility criteria and able and willing to provide informed consent: age 18-24 years, HIV-uninfected, not pregnant, wanting to and clinically safe to receive PrEP, sexually active (defined as vaginal or anal sex within the last 3 months), and determined at high risk for HIV infection based on a score of $\geq$ 5 on a validated risk score (the VOICE risk score)[18] or by being in an HIV serodifferent relationship. A VOICE risk score of $\geq$ 5 was associated with HIV incidence of > 5 per 100 person-years. Study participants were recruited through a combination of community-based outreach and health worker or peer referrals.

2.4 Study Procedures

At the baseline (enrolment) visit, participants were clinically evaluated for PrEP safety and initiated on PrEP. Data on potential demographic, sexual and social behavioural influencers of PrEP use were also collected. A safety monitoring visit was conducted one-month post PrEP initiation to address PrEP start-up symptoms and initial adherence challenges. Thereafter, study visits were scheduled quarterly for a total duration of 24 months for each participant. Longitudinal study visits involved PrEP dispensing as desired, adherence and risk reduction counselling, clinical monitoring including pregnancy and HIV testing and socio-behavioural data completion. Data were entered into a password-secured REDCap database.

Serial qualitative interviews were scheduled in a subset of 50 participants (25 at each site) to gain an in-depth understanding of user experiences with PrEP use and adherence monitoring. Interviews were scheduled to take place within a week of PrEP initiation and after approximately three months and 12 months of PrEP experience. Participants were purposefully sampled to reflect a range of age and adherence. Qualitative interviews followed a semi-structured topic guide, were conducted in the participant's preferred language and were digitally recorded.

2.5 Statistical Analysis and Methods

Our analysis was conducted in three steps: first, a quantitative analysis of standard survey data for the correlates and statistical association between risk perception and traditional risk factors for HIV, secondly a qualitative analysis of interview data for narrative themes on the interpretation of HIV risk and related decision making behaviour, and lastly a joint display contrasting and comparing the findings from the two research methods. All analyses were done independent of the randomisation group as the purpose of randomisation in the MPYA trial, namely evaluating the effect of SMS reminders on PrEP adherence, was unrelated to the goal of this secondary data analysis.

Descriptive statistics were used to characterize the cohort. Baseline demographic characteristics were summarized using proportions and medians with interquartile ranges (IQR). Our outcome of interest was whether or not participants thought themselves as being at risk for HIV. This was assessed by the question asked to all participants at the baseline(enrolment), mid- study (month 12) and last study visit (month 24): "In thinking about the past month, do you think you were at risk for getting HIV?"; with expected responses as either "Yes", "No" or "Not Sure''. Responses to this question were dichotomized into either "Yes" vs. "No/Not Sure.'' We examined for associations between risk perception and demographic characteristics: age, years of education completed, marital status, living conditions (with whom participant lived), main source of income and socioeconomic stability as assessed by reported food security; with psychosocial wellbeing: reported alcohol use and abuse as assessed by the Rapid Alcohol Problems Screen(RAPS-4)[19], depression using the Patient Health Questionnaire (PHQ)-2 depression scale [20] and perceived stigma as measured using the HIV Stigma Scale[21]; the sexual reproductive health indicators of condom and contraception use and pregnancy history; sexual behavioural history reported for the month preceding the study visit; partner and partnership characteristics: HIV status of partner, relationship power as

measured using the sexual relationship power sub-scale[22]any report of intimate partner violence (IPV) and other social harms; and with the baseline VOICE risk score, report of worry about being at risk for HIV, and if was currently prescribed PrEP.

In assessing the association between each covariate and risk perception, generalised estimating equations (GEE) with a logit link, robust standard errors, and an exchangeable correlation matrix were used to account for intra-individual correlation across multiple visits. These analyses included all visits at which risk perception was assessed (i.e. baseline, month 12 and month 24) and estimates presented using odds ratios (OR) and 95% confidence intervals (CI). Predictor variables with a significant association in the bivariable analysis were included simultaneously in a multivariable model. We also evaluated for significance in the differences observed in the predictor variables between baseline and month 12 and month 24, using proportion tests to compare categorical variables and the Kolmogorov-Smirnov test for equality in distribution for frequency variables. Statistical significance was defined as 2-sided p value <0.05. Data were analyzed using Stata version 15.1 (StataCorp, College Station, Texas).

Qualitative interview data was analysed for narrative themes on HIV risk awareness. A coding scheme was developed using ten percent of randomly selected transcripts. Transcripts were purposefully-selected to reflect a range of PrEP experience and to ensure thematic saturation. Inductive content analysis for themes centered on interpretation of and framing of perceived HIV risk; including HIV literacy, sexual behaviour, partner and partnership factors and socio-environmental factors including HIV and PrEP stigma. Interview data were also examined for risk-related decision-making patterns and rationale, including potential facilitators and barriers to effective decision making. Interview data were analysed using NVivo version 12 (QSR International).

Finally, a mixed-methods design at the technique level with a joint display approach[23] was used to examine and present findings from the standard quantitative survey and qualitative interview assessments on the central themes of risk awareness and risk-related decision-making.

3 RESULTS:

3.1 Demographic and Psychosocial Characteristics

We enrolled 350 young women who had a median age of 21 years (IQR 19, 22) (Table 1), of whom 136 (39%) were students, with a median of 12 years of education completed (IQR 10,13). The majority reported living with either their parents or other family member or employer (219, 62%), were single with a steady partner (194, 55%) and had never been pregnant (194, 55%). Half the cohort experienced food insecurity 180 (51%), and 22 (6%) had signs of depression. At baseline assessment, one fifth (78, 22%) had high perceived HIV stigma. About one-third (116, 33%) had some alcohol use in the past year, of whom 66 (57%) reported hazardous use; use of other drugs and substances was reported by 6 (2%) and 19 (6%) reporting ever smoking tobacco cigarettes or using other drugs. Data from 284 (81%) participants at month 12 and 280 (80%) at month 24 was available for analysis. There were no significant differences by sociodemographic and behavioural characteristics between those lost to follow up and those retained in the study.

A total of 50 participants completed serial in depth interviews (Table 1). Compared to the parent cohort at baseline, a higher proportion of interview participants lived alone (34 vs 23%), were employed or self-employed (40 vs 32%), and reported food insecurity (62 vs 51%). A lower proportion reported being single with no steady partner (18 vs 38%) or married (2 vs 7%), living with other family or employer (18 vs 26%), being unemployed (22 vs 29%), and hazardous alcohol use (5 vs 57%).

Table 1: Demographic and psychosocial characteristics of MPYA trial participants at study enrolment

		All Participants n=350 (%)	Qualitative Interview Participants n=50(%)
Age in years (median, range)	Age in years	21(19, 22)	21(19, 22)
Education (median, range)	Number of school years completed	12 (10, 13)	12 (9, 13)
Marital status	Single with no steady partner	133 (38)	21 (18)
	Single with a steady partner	194(55)	28(56)
	Married	23(7)	1(2)
Living Situation	Alone	80 (23)	17(34)
	With parents	127 (36)	18(36)
	With other family/ employer	92 (26)	9(18)
	With spouse or sexual partner	26 (7)	3(6)
	With friends or at hostel	25 (7)	3(6)
Pregnancy history	Ever Pregnant	156 (45)	23(46)
	At least 1 child at enrolment	149 (43)	21(42)
Main source of income	Student	136 (39)	19(38)
	Employed /Self Employed	112(32)	20(40)
	Unemployed	102(29)	11(22)
Socio-economic stability	Often/sometimes worry about enough food	180(51)	31(62)
Psychosocial wellbeing	PHQ 2 depression scale score ≥ 3	22(6)	3(6)
	Any alcohol use (past year)	116 (33)	19(38)
	Rapid Alcohol Problems Screen-4 ≥ 1[1]	66 (57)	1(5)
	Ever smoke cigarettes	6(2)	2(4)
	Ever use other drugs	19 (6)	3(6)
Perceived HIV stigma	High	78(22)	65(22)

Key: [1] among those reporting any alcohol use

3.2 Sexual Reproductive Health (SRH) Indicators

Approximately one-half of participants reported use of any of modern contraception (Table 2); and remained unchanged with time from baseline (p =0.4). The most common method of contraception reported at baseline was the implant (76, 22%). Condom use for contraception was reported by 51(15%) participants at baseline and also remained unchanged with time (p= 0.2). Ninety-nine participants had 113 incident pregnancies through the 24 month duration of the study, of which 76 (67%) were reported as unintended. There were a total of four confirmed HIV seroconversion cases, all reported at the Kisumu clinical site. Although aetiological screening and diagnosis of reproductive tract infections (RTI) was not available for this cohort, 16 (5%) participants received syndromic management. At baseline, all sexual reproductive health indicators were comparable between interview participants and the parent cohort.

Table 2: Cohort characteristics by sexual reproductive health Indicators at baseline, month 12 and month 24

	All Participants			Interview Participants
	Baseline n= 350 (%)	Month 12 n =284(%)	Month 24 n=280(%)	Baseline n=50(%)
Sexual Reproductive Health Indicators				
Modern contraception (past 6 months)				
Any	196(56)	156(55)	143(51)	24(48)
Condom use	51(15)	41(14)	26(9)	5(10)
Incident pregnancy[1]				
Total number	-	-	113	20
Unintended	-	-	76(67)	14(70)
Incident HIV infection				
Confirmed HIV seroconversion	-	1(0)	3(1)	1(2)[2]

Key:[1]Incident pregnancy for entire study period, [2] Seroconversion at Month 9 of follow up

3.3 Sexual Behavioural, Partner and Partnership Characteristics

The majority (64%) of participants reported one sexual partner in the month preceding the study visit (Table 3). The proportion of those reporting one sexual partner did not change significantly across subsequent visits ($p = 0.2$). The proportion of participants reporting not having a sexual partner increased significantly from baseline ($p < 0.001$), while that of those reporting at least two partners decreased significantly ($p < 0.001$). At baseline, 260 (75%) participants reported sexual activity with a main partner in the month preceding the study visit, this proportion was significantly lower at follow up visits ($p < 001$). Among girls reporting sexual activity with a main sexual partner, the median sexual frequency (2, [IQR 1, 4]) and the proportion reporting any condom less sex (72%) remained statistically unchanged from baseline to the month 12 and 24 study visits ($p = 0.8$). Approximately one-third of participants (119, 34%) reported sexual activity with a casual partner at baseline. This proportion decreased significantly at the month 12 and 24 study visits ($p < 0.001$). The difference in median frequency of sex with a casual partner between baseline (2, [IQR 1, 4]), month 12 (2, [IQR 0, 4]) and month 24 (4, [IQR 2, 8]) was statistically significant ($p = 0.002$). Of those reporting sexual activity with a casual partner, the proportion reporting any condom less sex did not change significantly ($p = 0.4$) from that reported at baseline (27%).

Knowledge of a partner's positive HIV status remained unchanged at 5% at baseline and the month 12 and 24 study visits ($p = 0.5$). Knowledge of partners' negative HIV status increased with time from 170 (49%) at baseline, 165(67%) at month 12 and 159 (70%) at month 24 ($p = 0.01$). Not knowing a partner's HIV status decreased over time from 160 (46%) at baseline, 70 (28%) at month 12 and 58 (25%) at month 24 ($p < 0.001$). Among young women self-identified to have a primary sexual partner, 275 at baseline, 192 at month 12 and 197 at month 24, there was gradual but significant decrease in reports of low sexual relationship power from 269 (98%) participants at baseline, to 177 (92%) at month 12 ($p < 0.001$) and 170 (87%) at month 24. Reports of intimate partner violence or social harm changed from 10% at baseline, to 16% at month 12, and to 5% at month 24 ($p < 0.001$).

Compared to the parent cohort at baseline, a higher proportion of young women participating in qualitative interviews reported two or more sexual partners (54 vs 35%), condomless sex with a main partner (79 vs 72%) and sexual activity with a casual partner (48 vs 34%) in the preceding month, and not knowing their partners' HIV status (54 vs 46%). A lower proportion reported one sexual partner (46 vs 64%) and any condomless sex with a casual partner (10 vs 27%), and knowing partners' HIV status as negative (40 vs 49%).

Table 3: Cohort characteristics by sexual behaviour and partnership characteristics at baseline, month 12 and month 24

	All Participants			Interview Participants
	Baseline n= 350 (%)	Month 12 n =284(%)	Month 24 n=280(%)	Baseline n=50(%)
Sexual Behaviour:				
Number of sex partners (past month)				
No partners†	2(1)	38(13)	52(19)	0(0)
1 partner	224(64)	189(67)	19 (70)	23(46)
≥ 2 partners†	123(35)	57(20)	33(12)	27(54)
Report sex with main partner (past month)				
Yes†	260(75)	154(53)	152(54)	39(78)
Frequency (median, IQR)	2(1, 4)	2 (1, 4)	2(1, 5)	2(1, 6)
Any condomless sex[1]	188(72)	111(72)	113(74)	31(79)
Report sex with casual partner (past month)				
Yes†	119(34)	68(24)	47(17)	24(48)
Frequency† (median, IQR)	2(1,4)	2(0,4)	4(2, 8)	2(1, 4)
Any condomless sex[2]	33(27)	16(23)	9(19)	5(10)
Any sex exchange for gifts or money[3]				
Any reported	-	-	32(11)	9(18)
Partnership Characteristics:				
HIV status of sex partners				
Positive	17(5)	11(5)	11(5)	3(6)
Negative†	170(49)	165(67)	159(70)	20(40)
Not known†	160(46)	70(28)	58(25)	27(54)
Sexual relationship power[4]				
High†	5(2)	15(8)	27(13)	1(2)
Low†	270(98)	177(92)	170(87)	39(98)
Intimate partner violence (past year)				
Any†	36(10)	46(16)	14(5)	4(8)

Key:
† Significant difference between baseline and month 12 and 24 (p value > 0.05)
[1]Among those reporting sex with a main partner
[2]Among those reporting sex with a casual partner
[3]Transactional sex assessed only at study exit visit, (n=163)
[4]Among those identifying a primary sexual relationship (n=275 at baseline, n=192 at month 12, n=197 at month 24, n=40 interview participants)

3.4 VOICE Risk Score, Risk Perception, HIV Worry and PrEP use

Two hundred and six (49%) participants had a VOICE risk score[18] of ≥ 7 at study enrolment (Table 4). Reporting 'some worrying' about getting HIV decreased significantly (p < 0.001) from a baseline of 98(28%) to 46(16%) at month 12 and 30(11%) at month 24; as did reporting 'a lot of worry' which decreased significantly (p < 0.001) from a baseline of 145(41%) to 58(20%) at month 12 and 50(18%) at month 24. Those reporting 'no worry' increased significantly (p < 0.001) from a baseline of 107(31%) to 180(64%) at month 12 and 200(71%) at month 24. One hundred and eighty-two (52%) participants thought they were at risk of HIV in the month preceding the study at baseline, decreasing significantly (p < 0.001) to 52(19%) at month 12 and to 35(13%) at month 24. Those responding 'no' to the question of whether they thought themselves at risk of HIV increased significantly (p < 0.001) from a baseline of 147 (42%) participants to 212 (76%) at month 12 and to 228 (82%) at month 24. There

was no significant change from a baseline of 5% in those responding 'not sure' (p =0.9). All participants were prescribed PrEP at study enrolment. This proportion decreased significantly (p < 0.001) to 67% at month 12 and 62% at month 24.

In comparing the young women participating in the qualitative interviews to the full cohort, 70% of qualitative study participants had a voice risk score ≥ 7 compared to 59% in the larger cohort. The proportion of those reporting 'a lot of worry' about getting HIV in the month preceding the study visit was also higher among interview participants (46%) compared to the larger cohort (41%). The proportion of those responding 'yes' to whether they thought they were at risk for HIV was also lower among interview participants (44%) vs 52% in the larger cohort, as did those reporting some worry about getting HIV: 24% among interview participants and 28% among the larger cohort.

Table 4: Cohort characteristics by risk assessments and PrEP use at baseline, month 12 and month 24

	All Participants			Interview Participants
	Baseline n= 350 (%)	**Month 12 n =284(%)**	**Month 24 n=280(%)**	**Baseline n=50(%)**
VOICE risk score				
Score = 4	3(1)	-	-	0(0)
Score 5-6	141(40)	-	-	15(30)
Score ≥ 7	206(59)	-	-	35(70)
Think at risk for HIV (past year)				
Yes†	182(52)	52(19)	35(13)	22(44)
No†	147(42)	212(76)	228(82)	26(52)
Not Sure	18(5)	14(5)	14(5)	2(4)
Worry about getting HIV				
Not Worried†	107(31)	180(64)	200(71)	15(30)
Report some worry†	98(28)	46(16)	30(11)	12(24)
Report a lot of worry†	145(41)	58(20)	50(18)	23(46)
Currently prescribed PrEP				
Yes†	350(100)	193(67)	173(62)	50(100)

Key:
† Significant difference between baseline and month 12 and 24 (p value > 0.05)

3.5 Correlates of Risk Perception

In the univariable analysis (Table 5), we observed significantly higher odds of risk perception in participants enrolled at the Thika site compared to those at the Kisumu site (OR 1.36 [CI 1.02, 1.81]). Other factors associated with greater odds of risk perception included having one (OR 1.93 [CI 1.07, 3.48]) or at least two sexual partners (OR 4.57 [CI 2.49, 8.42]), report of any sex with a main partner (OR 2.33 [CI 1.38, 3.94]), not knowing a partner's HIV status (OR 1.93 [CI 1.41, 2.63]), reporting some (OR 2.04 [CI 1.37, 3.04]) or a lot of HIV worry (OR 3.01 [CI 2.17, 4.19]) and being currently prescribed PrEP (OR 3.51 [CI 2.23, 5.51]). Lower odds of risk perception were associated with visits at month 12 (OR 0.21 [CI 0.15, 0.30]) and 24 (OR 0.13 [CI 0.09, 0.20]), and either living with other family or employer (OR 0.64 [CI 0.41, 1.01]) or spouse or a sexual partner (OR 0.49 [CI 0.30, 0.80]). Lower odds were also observed in those single but with a steady partner (OR 0.69 [CI 0.50, 0.95]) or married (OR 054 [CI 0.35, 0.84]), and in those reporting high sexual relationship power (OR 0.29 [CI 0.11, 0.79]).

There was no evidence of a statistically significant association between risk perception and age by category, years of education by category, income source or socio-economic stability, sexual reproductive indicators, report of any sex work or transactional sex, report of condomless sex with either a main or casual partner, and the VOICE risk score at baseline.

In multivariable analysis (Table 5), reporting a lot of HIV worry remained significantly associated with higher odds of risk perception (OR 1.95 [CI 1.31, 2.91]). Visits at month 12 and 24 continued to be associated with significantly lower odds (OR 0.30 [CI 0.18, 0.48]) and (OR 0.21 [CI 0.09, 0.20]) respectively, as did living with other family or employer (OR 0.56 [CI 0.33, 0.95]) and being single but with a steady partner (OR 0.48 [CI 0.33, 0.70]). There was a trend towards an association between risk perception and living with spouse or partner (OR 0.25 [CI 0.06, 1.02]).

Table 5: Association between risk perception and sociodemographic characteristics, psychosocial wellbeing, sexual reproductive health indicators and behaviour, partner and partnership characteristics, risk assessments and PrEP use

	Univariable Model OR (95% CI)	p value	Multivariable Model OR (95% CI)
Sociodemographic Indicators			
Clinic site			
Kisumu	Ref		
Thika	1.36 (1.02, 1.81)	0.038	1.50 (0.95, 2.37)
Time in study			
Baseline	Ref		
Month 12	0.21 (0.15, 0.30)	< 0.001	0.30 (0.18, 0.48)
Month 24	0.13 (0.09, 0.20)	< 0.001	0.21 (0.89, 0.50)
Age category at baseline in years			
18 years and younger	Ref		
19-20 years	1.29 (0.88, 1.91)	0.196	
21 years and older	0.92 (0.63, 1.35)	0.692	
Years of education completed at baseline			
9 years and below	Ref		
10-14 years	0.93 (0.85, 1.04)	0.211	
15 years and above	1.02 (0.82, 1.28)	0.849	
Living Situation			
Alone	Ref		
With parents	0.98 (0.66, 1.50)	0.991	1.18 (0.70, 2.02)
With other family/ employer	0.64 (0.41, 1 01)	0.058	0.56 (0.33, 0.95)
With spouse or sexual partner	0.49 (0.30, 0.80)	0.004	0.25 (0.06, 1.02)
With friends or at hostel	1.00 (0.50, 1.98)	0.990	0.89 (0.39, 2.05)
Marital Status			
Single no steady partner	Ref		
Single with steady partner	0.69 (0.50, 0.95)	0.023	0.48 (0.33, 0.70)
Married	0. 54 (0.35, 0.84)	0.006	2.20 (0.53, 9.18)
Main source of income			
Student	Ref		
Employed /Self Employed	0.72 (0.51, 1.02)	0.068	
Unemployed	0.73 (0.51, 1.04)	0.079	
Socio economic stability			
Low	Ref		
High	0.80 (0.58, 1.05)	0.097	
Psychosocial wellbeing			
Depression			
PHQ 2 depression scale score <3	Ref		
PHQ 2 depression scale score ≥ 3	1.11 (0.60, 2.04)	0.746	

Alcohol Use (past 3 months)			
No alcohol use	Ref		
Any alcohol use	1.78 (1.30, 2.44)	< 0.001	0.95 (0.62, 1.45)
Rapid Alcohol Problems Screen-4 < 1[1]	Ref		
Rapid Alcohol Problems Screen-4 ≥ 1	2.30 (0.82, 6.40)	0.113	
HIV Stigma			
Low Perceived HIV stigma	Ref		
High Perceived HIV stigma	1.56 (1.11, 2.20)	0.011	1.32 (0.87, 2.00)
Sexual Reproductive Health Indicators			
Modern contraception (past 3 months)			
No contraception use	Ref		
Any contraception use	1.05 (0.79, 1.40)	0.716	
Condom use (past month)			
No condom use	Ref		
Any condom use	1.09 (0.70, 1.69)	0.699	
Pregnancy History (baseline)			
Ever Pregnant- Never	Ref		
Ever Pregnant- Yes	0.98 (0.62, 1.55)	0.943	
No children at enrolment	Ref		
At least 1 child at enrolment	0.87 (0.55, 1.38)	0.566	
Incident pregnancy during follow up			
None	Ref		
Any pregnancy	0.67 (0.22, 2.01)	0.476	
Pregnancy intended	Ref		
Pregnancy not intended	0.55 (0.60, 5.17)	0.608	
Sexual Behaviour:			
Any sex in exchange for gifts or money[2]			
No	Ref		
Yes	1.26 (0.51, 3.08)	0.615	
Number of sex partners (past month)			
No partners	Ref		
1 partner	1.93 (1.07, 3.48)	0.029	0.98 (0.50, 1.93)
≥ 2 partners	4.57 (2.49, 8.42)	< 0.001	1.60 (0.79, 3.19)
Report sex with main partner (past month)			
No	Ref		
Yes	2.33 (1.38, 3.94)	0.001	1.73 (0.97, 3.11)
No condomless sex	Ref		
Any condomless sex	1.40 (0.93, 2.12)	0.106	
Report sex with casual partner (past month)			
No	Ref		
Yes	1.72 (0.91, 3.23)	0.090	
No condomless sex	Ref		
Any condomless sex	0.90 (0.45, 1.80)	0.773	
Partnership Characteristics:			
HIV status of sex partners			
Negative	Ref		
Positive	1.10 (0.57, 1.86)	0.768	1.00 (0.36, 2.81)
Not known	1.93 (1.41, 2.63)	<0.001	1.27 (0.88, 1.84)
Sexual relationship power[3]			
Low	Ref		
High	0.29 (0.11, 0.79)	0.016	0.67 (0.24, 1.86)
Intimate partner violence or social harm			
None	Ref		
Any	2.80 (1.41, 5.55)	0.003	0.98 (0.45, 2.13)
Risk Assessments:			
VOICE risk score at baseline			
Score 4-6	Ref		
score ≥ 7	1.18 (0.88, 1.58)	0.257	

	HIV Worry			
	Not Worried	Ref		
	Report some worry	2.04 (1.37, 3.04)	< 0.001	1.09 (0.67, 1.76)
	Report a lot of worry	3.01 (2.17, 4.19)	< 0.001	1.95 (1.31, 2.91)
PrEP Use				
	Currently prescribed PrEP			
	No	Ref		
	Yes	3.51 (2.23, 5.51)	< 0.001	1.11 (0.56, 2.21)

Key:
[1] Among those reporting any alcohol use
[2] Transactional sex assessed only at exit study visit, (n=163)
[3]Among those identifying a primary sexual relationship (n=275 at baseline, n=192 at month 12 and n=197 at month 24)

3.6 Findings from Qualitative Interviews

Data from 60 transcribed and translated in-depth interviews (30 at each site, 10 from each analysis time point) were included in the qualitative analysis. Characteristics of interview participants are as described in Tables 1-4 above. Analysis centered on the exploration of themes associated with HIV risk awareness; principally on how HIV risk was identified and expressed, and the processes, including rationalisation, of risk related decision making. Specific examples of themes identified and illustrative quotes from participants are provided below.

HIV Literacy: Participants demonstrated awareness of being at increased risk of HIV by virtual of age, gender, economic need and peer culture. However, misconceptions about how HIV is acquired were found to either inflate perceived risk or result in poor risk mitigation.

> *"young women are at risk… you see he will come to you and you have many problems like you haven't paid rent or your child has been sent away from school and you haven't been paid at work. You will sleep with him because of the money. If he says he won't use a condom you will have no alternatives because you need money"*

> *"Your decision making process can be impaired so you can't make good decisions. At times you see your friend doing something and then you are like why not do it too"*

> *"I thought I was at high risk ... After every month, I rush to the hospital to find out my status... sometimes I work with people who are HIV positive; sometimes I think I have been infected by maybe touching someone who is HIV infected..."*

> *"Since I was told if the person has not reached full blown HIV AIDS it is not easy to get infected, I do not know if that is the truth, so you are like, let us see, hope all goes well."*

HIV and PrEP Stigma: Stigma presented as an inability to effectively seek available prevention services or needed psychosocial support for fear of being chastised for sexual behaviour or being seen as HIV infected. This is despite demonstrating knowledge of the benefits, for example of PrEP disclosure and participation in prevention services. Consequence of this included sub-optimal utilisation of prevention services and limited partner involvement in discussions around HIV risk and its mitigation.

> *"… when I leave to go to work I used to say that I might meet someone who will not accept to use condoms and for us [sex workers] we are scared of going to the hospital because at times when you go to the hospital you find the doctor in a bad mood and then you want to tell them that you are a sex worker and you have been raped, or that you slept with someone (have sex) and the condom burst, he will respond to you rudely."*

"You know that telling people may make you die fast. People will be pointing at you when you pass. You would think they are talking about you even if they are not, this is because of stigma. You see? We keep it between the two of us [with provider]. I do not share things."

"I knew that if I told him that I am on PrEP he would interpret that I am HIV infected. So I did not want to tell him."

Risk Depersonalisation: Participants often framed HIV risk as it related to other people, and interviewers often had to probe severally and in depth for responses on an individual's assessment of their own risk. This trend was observed even among participants reporting similar risk profiles to those they identified in others.

Interviewer(I): And you know your risks... how well do you know your risks?
Response(R): I don't know.
I: May be you can tell if you are at risk of getting infected how well do you know that risk.
R: I don't know what to say on that.
I: Why.
R: I can't say how well I know my risks.
I: Why?"

Same participant:
"my neighbour he is a young man but he has had like 15 wives, in a year he can marry 3 wives one comes after a month she gets pregnant and leaves she gets another one, so I know that he is at high risk because he cannot know the status of all those women he brings home also the worst is that he drinks alcohol you know that someone who drinks alcohol his mind does not function well."

Partnership Characteristics and Relationship Power: The identification of own risk was intricately linked to the assessment of a sexual partner's risk- particularly on whether a partner was considered main or casual, whether a partner's HIV status was known or suspected, and the knowledge or misgivings of a partner's involvement in other sexual relationships. Risk depersonalisation was also evident in these discussions, with HIV risk often framed on partner factors such as suspected concurrent relationships even when reporting similar behaviour. This risk profiling of partners was a key motivator for PrEP use, and a key determinant of risk related decision-making behaviour. Although main partners were considered less risky, there was also evidence of less negotiating power with them.

R: "if it was a new sexual partner I had to use a condom but if it was my regular sexual partner, I had no choice, we had to have sex 100% without condom.
I: Why are you saying that?
R: (Chuckles) because, okay let me say that I trust him but the other sexual partners, I do not know them that well; I doubt them."
R: "I'm cautious as in with my main one I have no problem but with the other one it is a must we use a condom because we never know ..."

"...okay I have more than one partner and most of the time we don't use protection and we haven't been tested together with both of them and all the time … after having sex with them I will be worried, what if this man is positive what if he infected me"

Whether a partner was considered main or not, and the role of that partner in the relationship e.g. whether sexual and/or economic also determined the relational dynamics of the partnership. This was evidenced by a fear of IPV and/or abandonment especially with main partners, and the reluctance to negotiate condom use or disclose PrEP use with them.

> *"So long as he provides, he is the boss."*
>
> *"The partner that I have doesn't want to know anything about HIV, as long as you have told him you are HIV negative, he feels that he is okay he is not interested to know whether you are telling the truth or lying, it also means that when he says that he is HIV negative you have to believe in him and in between the relationship you will find that he finds another girl and you don't know the status of that girl like so will you ask him that do you even know the status of that girl you are dating, so it will bring chaos so instead of interrogating him more about the other outside relationship is better you protect yourself*"
>
> *"I was not married when I started taking PrEP and I had many boyfriends. Then I got married and my husband knew that I was taking PrEP one month later. He told me to stop taking PrEP after we both knew our HIV status. He told me that there was no need of taking PrEP. I knew if I continued taking PrEP he would have second thought about me. So I just decided to stop"*

Participants were split on the how marital status impacted HIV risk. Some participants described marriage as protective from HIV risk, and therefore a logical stopping point for PrEP use; concurrent with an expectation of monogamy for married couples. Those of the opposite view gave as examples the difficulties with exclusivity faced by spouses living or working away from each other. Cultural expectations of marriage were also seen to limit negotiating power, particularly over PrEP and condom use.

> *"Like for me if I was married, I wouldn't personally come for PrEP very much because maybe the trust you have for your partner or spouse, the kind of trust is different from the one that you have while you are dealing with other people. This one (single) is higher than this one (married) because the person you are married to; you know each other better than the other person. So the single is higher than the married"*
>
> *"For someone who is not married, he is free and can use condoms. You will really wonder where HIV came from in marriage. People who are in marriage have a problem.*
> *I: What about people who are not married?*
> *R: They can try protecting themselves.*
> *I: Why?*
> *R: He or she has control over his or her risks. You use protection when you wish to but marriage you have no control over your spouse."*

PrEP Use: HIV risk was also often framed in terms of before and after PrEP initiation, with recognition of feeling or being at very high risk before PrEP and this risk reducing with continued PrEP use. Risk was often attributed to the partner factors described above, particularly not knowing a partner's HIV status or suspecting them of multiple partnerships.

"Initially, I would be worried about getting HIV from my partner but now I no longer worry; I am tested and given PrEP. I am sure of my HIV status and safety."

"Since I started taking this drug there is no point I have been at risk; I don't think there is.
I: You can tell me more briefly.
R: Because I started taking this drug when I was here in Kisumu so when I went home I told you that I got tested with my partner and we were all negative and he is the only one I have so I knew that am not at risk."

Even so, PrEP use was tailored to the risk perceived or anticipated at the time, for example whether away at school where risk for HIV was often expressed as higher, or when with a sexual partner considered risky.

"I think when you are in school you don't feel safe because a lot of things happen, you get high, you go drinking alcohol and there are things you do when you are not of sound mind and then in the morning you are like what! So it is better to be protected … but at the moment the situation is that am at home at the moment so I don't feel like am at risk at all. You know African parents, so I will not go anywhere. I have been at home for like three months so I have not been using PrEP"

I: And how long do you think you will need to take PrEP?
R: It will depend when I will have a high risk of getting infected with HIV like right now I'm still at high risk of contracting HIV. I will use PrEP but when I leave my job and decide to be calm I can stop taking them because it is not something that I need to take for the rest of my life.
I: You can please explain to me when you say a high risk what do you mean?
R: A high risk is like the way we walk with different men (have sex) you cannot know all their status, yeah.

Self-Efficacy- Participants demonstrated resilience in their ability to negotiate challenges such as stigma and objections from family, partners and peers in being able to successfully access, use and store PrEP, and in their decisions to leave partnerships felt to be disrespectful or unsupportive.

"What I see is that the fact that he has a problem with it cannot stop me from using the drug."

"Okay if he wants to be with me he has to accept that I have to use the drugs because I have to protect myself and if he doesn't want me to protect myself then he should be using condom and if he doesn't want to use condom I will just maintain using the drugs and if he doesn't want me to use the drugs let him leave."

There was also evidence of intentionality in partner selection, including in number of partners. Decisions on type and number of partners were rationalised on being young, mobile with work or school, on economic needs, and often on being unmarried, with the argument that dating for mate selection was expected at their age.

"'I have a relationship and also according to the main relationship I have it is not stable but according to the other…I had more than one with a reason because mostly the person I'm dating as the main one is not coming from the same region. Yeah you may find him go away even for two weeks…"

"you know earlier on I used to have one partner but right now I would not mind to date even ten because I know am safe. Sometimes I have sex with other people because he travels to Uganda for one month and

even two months but my body just remains that one with its sexual needs. Sometimes someone can tell me to go, I run there because I know I have Truvada. When I leave my house I swallow it."

''there is an age group of 21-25 years, that's when you choose who will be your partner so you just have everyone and most of us in college are in that age'

Rationalised thinking was also demonstrated in the decisions of if and when to use or stop PrEP or insist on condom use.

"I am always on the move and I cannot say that my ways are right. I am sure I would only stop using PrEP when I settle or when I decide to abstain. For now, let me use PrEP".

"So you know that this guy needs this and that in order to give you this and you reach a point and tell him to put on a condom and he says he does not use that… so you have to take care of yourself and be one step ahead."

"I just take them when I know I will be at risk. Sometimes us women we know these things…, so you just take them before because I was told you don't have to take them every day if you are not at risk. Just take them seven days before and a couple of days after but if you are not at risk at all you don't have to but if you want to you can just take them."

Social Support: Participants with supportive social environments- from either family, peers and partners, reported being better able to mitigate their risk of HIV. Positive environments facilitated PrEP disclosure and adherence particularly through reminding of pill times.

"I told my mother before I came here about the study and PrEP. I explained to her that it is for HIV prevention. My mother knew my moves because she is the closest friend to me. She encouraged me to take it."

"Mostly my mother is the one I told and then again I look at the time so once it's nearly seven o'clock she has to remind me. Even if I was asleep she will wake me up."

"I: How does your main partner feel about you taking these drugs?
R: He told me that I am still young and a lot of men admire me and he is aware I will date many of them. So if that drug is what can protect me then help yourself so that you do not catch the disease."

Unsupportive environments were observed to be a major barrier to risk mitigation, particularly in the effective use of PrEP and its disclosure. Such environments were found to be primarily a consequence of PrEP mistrust, HIV stigma, and conservative attitudes restricting discussions on sex and sexual behaviour.

"She asked me what the medicine was for and told her that I was protecting myself against AIDS which she said that it wasn't good and you know how parents are they never want to be told about anything so I saw it was best if I obeyed her"

"There are times we almost broke up because he was saying that he does want me to use medicines (PrEP) that I don't know how they work and when I tried to explain to him, he didn't want to listen"

"I have a friend who is in a serious relationship and there was an issue of using the PrEP and he is like no because she is protected she would do whatever she wants because she is a party girl it could make it even

worse so she was terrified and the guy was like if you want to keep me you have to get rid of that, so I think they make it harder"

Challenges with Survey Items: Participants also related challenges experienced with responding to the standard survey questions administered during routine clinic visits; particularly on aggregated items such as frequency of sexual behaviour, and for partner characteristics when there was more than one partner.

"R: You know there is that question that asks how many times I have slept with a man in that week and answer yes or no. sometimes I get confused because he may leave for a week or come back twice so I end up answering no
I: What do you do when you get confused?
R: I always answer no because when he comes twice in a week maybe he is tired and you can't disturb him
I: So do you always say the truth or you twist it? How is it when you are answering them?
R: By then I am totally confused."

"You may find others who are still married still have other partners, so when asked like about if among your partners you fear one may be having the virus the person may get confused as she has many partners and maybe in all of them you don't have one who trust
I: So they get confused on how to answer them?
R: Yeah, maybe they answer yes but it was supposed to be a no. You can meet one whose status you don't know and refuses to use protection"

3.7 Joint Display of Main findings on Correlates of HIV Risk from Quantitative Surveys and Qualitative Interviews

We observed complementarity and contrast in the two analysis methods on how HIV risk was defined, articulated and rationalised. We identified factors at the individual, partnership and societal levels that informed risk awareness and related decision making, and used a joint display to summarise our findings from the two analytical methods into three major themes: risk dynamism, behavioural risk and social environment (Table 6).

Table 6: Joint Display Comparing the Main findings on Correlates of HIV Risk from Quantitative Surveys and Qualitative Interviews

Theme	Standard Quantitative Surveys	Qualitative Interviews
Risk Perception		
	• At baseline (PrEP initiation), 182 (52%) participants reported thinking that they were at risk for HIV in the past year. This proportion decreased significantly over the study visits, in tandem with an increase in those who did not think they were at risk. • The proportion of those reporting uncertainty about their HIV risk did not change.	• Although interview participants displayed awareness of factors and situations that would potentially put them at risk of HIV, they were more apt to describe a conditional and sometimes rapidly changeable experience of HIV risk that was dependent on circumstance and the mitigation measures at hand; for example, whether a sexual partner was casual or main, and if they were willing to use condoms or not. • Furthermore, participants displayed intentionality and future planning in their articulation of risk- risk was not only described in past tense, but also incorporated anticipated situations, such as going away to college, that could potentially increase HIV risk • In this way, participants displayed a broad, multidirectional, rationalised and adaptive awareness of HIV risk, exemplified by the mitigation measures adopted including PrEP uptake
Risk Dynamism		
Time	• Time in the study was significantly associated with lower odds of risk perception in both the univariable and multivariable models. The proportion of those reporting feeling at risk for HIV also decreased significantly with study visits • The proportion of participants reporting 'a lot' of HIV worry reduced significantly with time engaged in the study and the association between reporting 'a lot of worry' about HIV risk was significantly associated with the odds of a high perception of risk. This association with reporting a lot of worry remained significant in the multivariable model	• Knowledge of partner status and HIV related worry were the primary drivers of PREP initiation, and findings from qualitative interviews attributed the reduction in HIV risk perception with time to PrEP use. Participants reported a reduction in HIV worry with time, regardless of knowledge of partner HIV status, as they felt protected by PrEP • In addition, interview participants also reported on the circumstantial and fluctuating nature of HIV risk- for example depending on which partner they were with, and to adapting their risk mitigation strategies to the situation at hand.
Type of Sexual Partner	• Reporting any sexual activity with a main partner decreased significantly with study visits, and was associated with higher odds of HIV risk perception; significant in the univariable analysis and with a trend	• Contrary to standard survey findings, sexual activity with main partners was reported to carry less risk compared to that with casual partners as they were considered more stable and their risk behaviour better known

	towards significance in the multivariable model. • Although the proportion reporting sex with a casual partner also decreased significantly over the study visits, the association with risk perception was not significant • Condomless sex with either partner type was also not significantly associated with risk perception	• Risk profiling of partners was also seen to influence risk related decision making behaviour; for example condomless sex and PrEP use was reported more frequently with casual than with main partners or spouses
Living Situation	• Living with a spouse or main sexual partner was in the univariable model significantly associated with lower odds of risk perception • In both univariable and multivariable analysis, living with family or employer was significantly associated with lower odds of risk perception • There was no significant association with living with parents compared to living alone	• Interview participants described the circumstantial nature of HIV risk as it related to residence- with HIV risk and required mitigation conditional on where or with whom they were living with- for example lowered HIV risk and PrEP use was reported when living with parents compared to when alone or at school, attributed to restricted access to sexual partners
BEHAVIOURAL RISK		
VOICE Score	• As a composite, the VOICE score was not significantly associated with risk perception	• Participants reported knowing that the individual score components of young age, financial need and economic dependence on partners, and alcohol use increased the risk for HIV by limiting one's ability to negotiate for safer sex or by impairing risk related decision making. However, these risk factors were often depersonalised and were more comprehensively articulated when framed in terms of peers and especially partners. • Secondly, interview participants also reported challenges in responding to survey items that required aggregation over time or number of sexual partners
Marital status	• Being married or single with a steady partner were in the univariable model significantly associated with lower odds of risk perception. The association with being single with a steady partner remained significant in the multivariable analysis	• Although being single, with or without a steady partner was thought to increase HIV risk owing to a suspicion of multiple partnerships by male partners, the ability to mitigate this risk was thought to be higher in single people compared to those married given restrictive cultural gender norms.
HIV Status of Partner	• Not knowing a partner's HIV status significantly decreased with study visits, and was in the univariable model significantly associated with higher odds of risk perception.	• Unknown partner HIV status was cited as the most common reason for either initiation or stopping of PrEP, with reported HIV risk and worry increasing or decreasing in tandem with either knowing a partner's status or the use of PrEP.

Number of Sexual Partners	• Reporting at least one sexual partner was in the univariable analysis significantly associated with higher odds of risk perception.	• Interview participants tended to depersonalise their responses to questions on multiple sexual partnerships and HIV risk, often ascribing this risk to their male partners • Even so, interview participants displayed rationalised intentionality in decisions relating to sexual partnerships, including of number of partners, and the risk mitigation strategies employed for each
Contraception	• There was no significant association between use of modern methods of contraception, including condom use for contraceptive purposes, and risk perception	• Condom use, even as contraception, was also dependent on partner type and partnership factors- for example with low condom use reported with spouses and main sexual partners • In addition, prevention of unintended pregnancy was often viewed as a separate entity from HIV prevention. HIV risk perception was strongly tied to PrEP use, which has no known contraceptive properties.
Pregnancy History	• Pregnancy history and parity, both before study participation and during, were not significantly associated with risk perception	• Having dependent children was tied to increased financial need, which was thought to increase risk of HIV
The Social Environment		
Relationship Power	• In the univariable analysis, high relationship power was associated with lower odds of risk perception, while report of any IPV was associated with higher odds.	• In the qualitative interviews, relationship power and particularly the fear of IPV emerged as important in risk related decision making, particularly in the agency to mitigate own risk with a sexual partner
HIV Stigma	• High perceived HIV stigma was found to be significantly associated with higher odds of risk perception in univariable analysis.	• In qualitative interviews, HIV stigma was framed as a fear of the ostracisation associated with being infected with HIV, and was found to limit utilisation of prevention services and access to psychosocial support especially from partners and family members

4 DISCUSSION

In this study, we compared risk awareness and correlates of HIV risk as assessed using both standard quantitative surveys and qualitative interviews among young African women considered vulnerable to HIV infection and engaged in a PrEP program and identified three key findings. Firstly, we found that an analytic approach that examined and presented quantitative and qualitative data concurrently allowed for a more comprehensive exploration of the factors that determine HIV risk awareness and related mitigation. Qualitative data expanded on findings from the survey data, and provided insight not only into the sometimes contradictory findings from the surveys, but also the rationale and motivation informing risk awareness and related decision making. Secondly, qualitative data revealed a more nuanced and dynamic experience of HIV risk than was presented by survey data. We found the experience of HIV risk to be individualised and changeable; dependent on HIV and PrEP literacy, the self-agency to exercise held knowledge, and on specific circumstance such as the assessment of a partner's HIV risk profile. Lastly, this combined analysis revealed the broad and interrelated nature of HIV risk. We found that HIV risk awareness and decision making by young women was not solely an individual decision, but rather was contingent on intimate partner relationship dynamics and community perceptions of the sexual behaviour of young women. The social environment was found to significantly impact both the uptake and actual use of prevention measures including of PrEP uptake and use.

We observed complementarity and contrast in how HIV risk was defined and rationalised, and identified factors at the individual, partnership and societal levels that informed risk awareness and related decision making. Awareness of HIV risk was primarily influenced by knowledge of HIV partner status and PrEP use, while HIV related decision making was dependent not just on having access to preventive measures, but also on the agency and wherewithal to actualize known mitigation measures. We discuss our findings from the combined analysis as three major themes: risk dynamism, behavioural risk and impact of the social environment.

Risk Dynamism:

The effect of dynamism was demonstrated not only by the significant association of time with risk perception, but also by the significant differences between baseline and subsequent visits in the reporting of sexual behavioural, partner and partnership characteristics; displaying a shift in behavioral choices and consequently of factors epidemiologically associated with increased risk of infection. Data from the qualitative interviews provided insights into the motivation behind these shifts; primarily by exemplifying the dynamic nature of HIV risk and the rationalised adaptation of risk mitigation strategies to its perception, e.g. by choosing when to start and stop PrEP use. In addition, the observed decline in PrEP use and those reporting HIV worry was in tandem with the finding from interviews that not knowing a partner's status was a key motivator for initial PrEP uptake and reason for HIV worry.

The effect of time involved in a study or prevention program in either reducing HIV risk or actual acquisition of infection has been demonstrated in several studies; including from a cohort of young South African women which reported that 95% of HIV infections were detected within 48 weeks of enrolment[24], sex worker cohorts which demonstrated a consistent decline in HIV incidence soon after enrolment despite recruiting from populations with very high HIV prevalence[25, 26] and in a vaccine preparedness cohort of female sex workers that found that the majority of HIV infections occurred in the first six months after study enrolment, with a significant decline after the first year[27].

Although other unmeasured influences are possible, the failure to incorporate and adapt dynamism and cohort dependent factors into standard risk assessments may explain some of the inconsistent findings with standard epidemiologic risk predictors[28]. Further work is needed to better understand the mechanisms behind this reduction in HIV risk or infection related to involvement in a study or program that is seemingly independent of the actual intervention. Secondly, further research is needed to explore the utility of tailoring these effects to reach those unable or unwilling to join such cohorts, or participate in longer term prevention programs.

Behavioural Risk:

There was no evidence of change in the sexual reproductive health indicators of contraception and condom use; suggesting a disconnect between the prevention of HIV and that of other negative sexual reproductive health outcomes such as unintended pregnancy. Although access to modern methods of contraception in Kenya is high[29], and study participants were offered contraception counselling and access to various modern methods as part of their care package, unintended pregnancy was reported in more than two thirds of all incident pregnancies observed in this cohort; a finding also reported in other HIV prevention programs[30-32]. Our findings from the qualitative interviews suggest that HIV prevention is viewed through a different lens from that used for pregnancy prevention, especially by women of childbearing age in whom fecundity is expected to be high. In this cohort, HIV risk awareness was framed in terms of PrEP use; and as PrEP is not directly associated with contraception, the two may have been perceived as different unrelated entities. Condom use was intrinsically tied to partner type and partnership characteristics, with use mainly reported with casual partners who were considered riskier, and with whom they had more negotiating power but plausibly less fertility desire. Given these findings, and those from other HIV prevention trials,[30-32] bridging the gap between the HIV and other sexual reproductive health prevention pathways would require more than just unhindered access. Understanding the rationale for this piecemeal approach to reproductive health by young women would require an exploration of their priorities and of barriers faced, including their fertility desires, myths and misconceptions and the role of male partners.

Another key finding was the role of partner type in HIV risk assessment and related decision making behaviour. Findings from interview participants on partner characteristics differed from those from standard survey responses, particularly on the relative influence of main versus casual and married versus single partners, and specifically on the nature of sexual behaviour reported and of the risk mitigating strategies used with either partner. Contrary to findings from the standard survey participants, sexual activity with main partners was considered less risky by interview participants; a finding replicated in other studies involving young women[33-35]. Although our findings on the influence of marriage on HIV risk were inconclusive among interview participants, we observed significantly lower odds of risk perception in married participants, and in those living with a spouse or main sexual partners. This contradictory nature of marital status as an epidemiologic risk factor for HIV has also been described in other vulnerable populations including long distance truck drivers and in older women living in high endemic region[36-38].

Partnership characteristics including relational power, report of IPV and degree of economic and psychosocial dependence emerged as key to risk assessment, PrEP use and disclosure in both standard surveys and qualitative interviews. This finding is similar to that from studies in the African context examining the role of male partners and their involvement in contraception uptake[39, 40], the prevention of mother to child transmission (PMTCT) of HIV[41-43] and the uptake of PrEP among serodiscordant relationships [44, 45] and the well described challenges of the use of condoms by men for HIV prevention and contraception [46-48]. These studies found evidence of high uptake and successful use of services by women whose male partners were aware and supportive of their use of these interventions. However, data on the engagement of the male partners of young women in reproductive health services is scarce, and further research on the barriers and facilitators to their participation is urgently needed. Although the age of sexual partners was not explicitly assessed in the standard questionnaires, findings from interview data provide limited evidence of intergenerational sexual partnerships in this cohort, in contrast to findings from mainly South African cohorts where age disparate relationships have been found to fuel the epidemic in young women[3]. As such, interventions targeting male partners of young women would need to factor in such regional differences.

In the qualitative interviews, participants reported challenges with survey items that required the aggregation of frequency of sexual behaviour or of partner characteristics when there was more than one partner. This finding is consistent with that from research employing cognitive interviewing techniques in survey development and administration, which report inconsistencies in the comprehension and response to standard

questions, particularly those of a sensitive nature or conducted among vulnerable populations[15]. In addition, participants were more likely to depersonalise the identification and articulation of risk, with the finding of a more comprehensive risk characterisation when described in third person; conceivably arising from self-preservation or social desirability biases[49, 50]; or from a self-protecting coping instinct secondary to cognitive dissonance[51]. In addition, although we observed reporting of high HIV risk with individual items on the VOICE risk score, specifically age, financial dependence on a partner, a partner having other partners and alcohol use, these factors were not all significant, or the association in the expected direction. Our findings are consistent with the fact that despite the widespread use of the VOICE risk score, this scale has not been validated outside of South Africa for use in young women[52]. In as much as standardised tools are vital for the planning, monitoring and implementation of population level programs, enabling flexibility and tailoring to specific groups is vital, especially given the heterogeneous, interconnected and dynamic nature of HIV risk and the current move towards differentiated delivery of prevention services and integration into public primary care.

Social Environment

Besides sexual partnerships, other social networks including peers and family, and prevailing community attitudes also emerged as essential determinants of risk awareness; and even more so of risk-related decision-making. High perceived HIV stigma was associated with higher odds of risk awareness in standard surveys, but may have contributed to inflated or inaccurate risk perception as reported in the qualitative interviews. Even so, participants in enabling and supportive social environments reported being better able to navigate through the challenges of stigma to effective risk mitigation, a finding consistent with that from research on antiretroviral therapy (ART) adherence[53], PrEP adherence[54], sociobehavioural interventions[55] and community preparedness for PrEP scale-up[44]. These findings, together with those from among partners and partnerships, highlight the value of community participation, of social capita and the need for the involvement of social networks in HIV prevention services targeting young women. Identifying the key players in this networks, their relative contributions, and how best these can be leveraged in prevention services should be a target for further exploration.

Participants displayed resiliency and rationalised intentionality in their risk related decision making; a finding empirically challenging to ascertain from standard surveys, but evident in the qualitative interviews. We found evidence that risk taking and mitigation was not haphazard, but rather was calculated and rationalised based on HIV and PrEP literacy, current knowledge of partner status and attitudes, and prevailing sexual and economic needs. This was especially true for participants in enabling social environments, with those in unsupportive circumstances reporting being unable to mitigate their risk, despite being aware of it- a finding shared by several PrEP trials[13]. The failure to recognise and incorporate such intrapersonal factors in risk assessments could either inflate epidemiologic risk or miss those particularly vulnerable[56]. In addition, assigning a 'victim' label to all young women could have the unintended consequence of limiting their engagement with services and providers, and thereby inadvertently increasing their risk.

Strengths and Limitations

This study has several strengths. The assessment of HIV risk among participants considered vulnerable to HIV infection and already engaged in a HIV prevention program as opposed to a study conducted amongst the general population increased the sensitivity of our study to identify and characterise predictors of HIV risk and of risk awareness. The research design of longitudinal study visits alongside serial interviews allowed for concurrent examination of trend in the correlates of risk, particularly in behavioural choices and resultant change. The mixed methods design within the same participant cohort allowed us to compare and contrast quantitative and qualitative data findings, providing a comprehensive and in depth exploration of the complexity of HIV risk and its determinants. Finally, the joint presentation of study findings provides a template that efficiently displays the complementarity and contrast between the two methods in assessing HIV risk, allowing for a unified exploration of the major themes identified through the mixed assessment.

This study also has several limitations. Use of self-reported behavioral data may have resulted in recall bias or response error, especially for questions that required aggregation over time. The sensitive nature of questions may have also led to social desirability bias. We also observed participant loss to follow up at subsequent visits that may have led to selection bias. We however did not find evidence of significant differences between participants lost to follow up and those retained. Interview participants were purposefully selected to reflect a range of age and adherence and thus differed slightly from the parent cohort in socio-demographic and sexual behavioural characteristics, including marital status, number of sexual partners, reported sexual activity with main and casual partners and the VOICE score. Although a strength of the study, the use of data from a targeted population may limit the generalisability of our study findings, and findings may not apply to other vulnerable population groups.

Conclusions

Our study demonstrates the benefits of examining and presenting both qualitative and quantitative data concurrently. This approach provided some insight into the dissonance observed in epidemiologic HIV risk among young African women, and consequently on how to optimise development and delivery of suitable interventions. Our findings reveal the intricate and nuanced nature of HIV risk and risk awareness by young African women; the rationalisation that informs related decision making, and the influence of partners and key social gatekeepers in promoting self-agency and the environments that enable effective risk moderation. Qualitative data expanded on findings from qualitative surveys and provided insight into the breadth and influencers of risk awareness and related decision making; revealing the dynamic, individualised and rationalised approach to HIV risk adopted by young women. Knowledge of partner HIV status and PrEP use emerged as key determinants of risk awareness and mitigation in this cohort; and further work on how these can be leveraged to support HIV prevention and other SRH programs targeting young women is warranted.

5 REFERENCES

1. National AIDS Control Council. **Kenya HIV Estimates 2015**. In; 2015.
2. World Health Organisation. **Kenya Key Country Indicators**. In; 2016.
3. Abdool Karim Q, Baxter C, Birx D. **Prevention of HIV in Adolescent Girls and Young Women: Key to an AIDS-Free Generation**. *Journal of acquired immune deficiency syndromes* 2017; 75 Suppl 1:S17-s26.
4. Fonner VA, Dalglish SL, Kennedy CE, Baggaley R, O'Reilly KR, Koechlin FM, et al. **Effectiveness and safety of oral HIV preexposure prophylaxis for all populations**. *AIDS* 2016; 30(12):1973-1983.
5. Riddell J, Amico KR, Mayer KH. **HIV preexposure prophylaxis: a review**. *Jama* 2018; 319(12):1261-1268.
6. Baeten JM, Palanee-Phillips T, Brown ER, Schwartz K, Soto-Torres LE, Govender V, et al. **Use of a Vaginal Ring Containing Dapivirine for HIV-1 Prevention in Women**. *The New England journal of medicine* 2016; 375(22):2121-2132.
7. Marrazzo JM, Ramjee G, Richardson BA, Gomez K, Mgodi N, Nair G, et al. **Tenofovir-Based Preexposure Prophylaxis for HIV Infection among African Women**. *New England Journal of Medicine* 2015; 372(6):509-518.
8. Geary CW, Bukusi EA. **Women and ARV-based HIV prevention – challenges and opportunities**. *Journal of the International AIDS Society* 2014; 17(3S2):19356.
9. Maughan-Brown B, Venkataramani AS. **Accuracy and determinants of perceived HIV risk among young women in South Africa**. *BMC public health* 2018; 18(1):42.
10. Corneli A, Wang M, Agot K, Ahmed K, Lombaard J, Van Damme L, et al. **Perception of HIV Risk and Adherence to a Daily, Investigational Pill for HIV Prevention in FEM-PrEP**. *JAIDS Journal of Acquired Immune Deficiency Syndromes* 2014; 67(5):555-563.
11. Camlin CS, Koss CA, Getahun M, Owino L, Itiakorit H, Akatukwasa C, et al. **Understanding Demand for PrEP and Early Experiences of PrEP Use Among Young Adults in Rural Kenya and Uganda: A Qualitative Study**. *AIDS and Behavior* 2020.
12. Corneli AL, McKenna K, Headley J, Ahmed K, Odhiambo J, Skhosana J, et al. **A descriptive analysis of perceptions of HIV risk and worry about acquiring HIV among FEM-PrEP participants who seroconverted in Bondo, Kenya, and Pretoria, South Africa**. *Journal of the International AIDS Society* 2014; 17(3(Suppl 2)).
13. Corneli AL, Deese J, Wang M, Taylor D, Ahmed K, Agot K, et al. **FEM-PrEP: adherence patterns and factors associated with adherence to a daily oral study product for pre-exposure prophylaxis**. *Journal of acquired immune deficiency syndromes (1999)* 2014; 66(3):324.
14. Hill LM, Maseko B, Chagomerana M, Hosseinipour MC, Bekker L-G, Pettifor A, et al. **HIV risk, risk perception, and PrEP interest among adolescent girls and young women in Lilongwe, Malawi: operationalizing the PrEP cascade**. *Journal of the International AIDS Society* 2020; 23 Suppl 3(Suppl 3):e25502-e25502.
15. Milne J, Brady H, Shato T, Bohn D, Mdladla M, Ngcwayi N, et al. **Measuring HIV Risk Perception and Behavior: Results from Round 1 of the Cognitive Interviewing Project with young women and men who have sex with men in South Africa**. *AIDS and Behavior* 2020.
16. National AIDS Control Council. **Kenya HIV estimates: Report 2018**. In: NACC Nairobi; 2018.
17. ClinicalTrials.gov at US National Library of Medicine. *https://clinicaltrialsgov/ct2/show/NCT02915367?term=NCT02915367&draw=2&rank=1* 2016.
18. Balkus JE, Brown E, Palanee T, Nair G, Gafoor Z, Zhang J, et al. **An empiric HIV risk scoring tool to predict HIV-1 acquisition in African women**. *Journal of acquired immune deficiency syndromes (1999)* 2016; 72(3):333.
19. Cherpitel CJ, Ye Y, Bond J, Borges G, Cremonte M, Marais S, et al. **Cross-national performance of the RAPS4/RAPS4-QF for tolerance and heavy drinking: data from 13 countries**. *Journal of studies on alcohol* 2005; 66(3):428-432.
20. Kroenke K, Spitzer RL, Williams JB. **The Patient Health Questionnaire-2: validity of a two-item depression screener**. *Medical care* 2003:1284-1292.
21. Berger BE, Ferrans CE, Lashley FR. **Measuring stigma in people with HIV: Psychometric assessment of the HIV stigma scale**. *Research in nursing & health* 2001; 24(6):518-529.
22. Pulerwitz J, Gortmaker SL, DeJong W. **Measuring sexual relationship power in HIV/STD research**. *Sex roles* 2000; 42(7-8):637-660.
23. Guetterman TC, Fetters MD, Creswell JW. **Integrating Quantitative and Qualitative Results in Health Science Mixed Methods Research Through Joint Displays**. *The Annals of Family Medicine* 2015; 13(6):554-561.
24. Dong KL, Moodley A, Kwon DS, Ghebremichael MS, Dong M, Ismail N, et al. **Detection and treatment of Fiebig stage I HIV-1 infection in young at-risk women in South Africa: a prospective cohort study**. *The Lancet HIV* 2018; 5(1):e35-e44.
25. McKinnon LR, Izulla P, Nagelkerke N, Munyao J, Wanjiru T, Shaw SY, et al. **Risk Factors for HIV Acquisition in a Prospective Nairobi-Based Female Sex Worker Cohort**. *AIDS and Behavior* 2015; 19(12):2204-2213.

26. Kaul R, Kimani J, Nagelkerke NJ, Fonck K, Keli F, MacDonald KS, et al. **Reduced HIV risk-taking and low HIV incidence after enrollment and risk-reduction counseling in a sexually transmitted disease prevention trial in Nairobi, Kenya**. *Journal of acquired immune deficiency syndromes* 2002; 30(1):69-72.
27. Baeten JM, Richardson BA, Martin HL, Jr., Nyange PM, Lavreys L, Ngugi EN, et al. **Trends in HIV-1 incidence in a cohort of prostitutes in Kenya: implications for HIV-1 vaccine efficacy trials**. *Journal of acquired immune deficiency syndromes* 2000; 24(5):458-464.
28. Hill LM, Maseko B, Chagomerana M, Hosseinipour MC, Bekker LG, Pettifor A, et al. **HIV risk, risk perception, and PrEP interest among adolescent girls and young women in Lilongwe, Malawi: operationalizing the PrEP cascade**. *Journal of the International AIDS Society* 2020; 23(S3).
29. World Development Indicators: Reproductive Health. 2018; Accessed at http://wdi.worldbank.org/table/2.14 on July 28 2020
30. Callahan R, Nanda K, Kapiga S, Malahleha M, Mandala J, Ogada T, et al. **Pregnancy and Contraceptive Use Among Women Participating in the FEM-PrEP Trial**. *JAIDS Journal of Acquired Immune Deficiency Syndromes* 2015; 68(2):196-203.
31. Mugo NR, Hong T, Celum C, Donnell D, Bukusi EA, John-Stewart G, et al. **Pregnancy Incidence and Outcomes Among Women Receiving Preexposure Prophylaxis for HIV Prevention**. *JAMA* 2014; 312(4):362.
32. Akello CA, Bunge KE, Nakabiito C, Mirembe BG, Fowler MG, Mishra A, et al. **Contraceptive Use and Pregnancy Incidence Among Women Participating in an HIV Prevention Trial**. *Journal of Women's Health* 2017; 26(6):670-676.
33. Smith J, Nyamukapa C, Gregson S, Lewis J, Magutshwa S, Schumacher C, et al. **The Distribution of Sex Acts and Condom Use within Partnerships in a Rural Sub-Saharan African Population**. *PLoS ONE* 2014; 9(2):e88378.
34. Mathur S, Wei Y, Zhong X, Song X, Nalugoda F, Lutalo T, et al. **Partner Characteristics Associated With HIV Acquisition Among Youth in Rakai, Uganda**. *JAIDS Journal of Acquired Immune Deficiency Syndromes* 2015; 69(1):75-84.
35. Ziraba A, Orindi B, Muuo S, Floyd S, Birdthistle IJ, Mumah J, et al. **Understanding HIV risks among adolescent girls and young women in informal settlements of Nairobi, Kenya: Lessons for DREAMS**. *PLOS ONE* 2018; 13(5):e0197479.
36. Auvert B, Buvé A, Ferry B, Caraël M, Morison L, Lagarde E, et al. **Ecological and individual level analysis of risk factors for HIV infection in four urban populations in sub-Saharan Africa with different levels of HIV infection**. *AIDS* 2001; 15:S15-S30.
37. Glynn JR, Caraël M, Auvert B, Kahindo M, Chege J, Musonda R, et al. **Why do young women have a much higher prevalence of HIV than young men? A study in Kisumu, Kenya and Ndola, Zambia**. *AIDS* 2001; 15:S51-S60.
38. Johnson K, Way A. **Risk Factors for HIV Infection in a National Adult Population**. *JAIDS Journal of Acquired Immune Deficiency Syndromes* 2006; 42(5):627-636.
39. Olakunde BO, Sam-Agudu NA, Patel TY, Hunt AT, Buffington AM, Phebus TD, et al. **Uptake of permanent contraception among women in sub-Saharan Africa: a literature review of barriers and facilitators**. *Contraception* 2019; 99(4):205-211.
40. Phiri M, King R, Newell JN. **Behaviour change techniques and contraceptive use in low and middle income countries: a review**. *Reproductive Health* 2015; 12(1).
41. Auvinen J, Suominen T, Välimäki M. **Male participation and prevention of human immunodeficiency virus (HIV) mother-to-child transmission in Africa**. *Psychology, Health & Medicine* 2010; 15(3):288-313.
42. Kalembo FW, Zgambo M, Mulaga AN, Yukai D, Ahmed NI. **Association between Male Partner Involvement and the Uptake of Prevention of Mother-to-Child Transmission of HIV (PMTCT) Interventions in Mwanza District, Malawi: A Retrospective Cohort Study**. *PLoS ONE* 2013; 8(6):e66517.
43. Nyondo-Mipando AL, Chimwaza AF, Muula AS. **"He does not have to wait under a tree": perceptions of men, women and health care workers on male partner involvement in prevention of mother to child transmission of human immunodeficiency virus services in Malawi**. *BMC Health Services Research* 2018; 18(1).
44. Patel RC, Stanford-Moore G, Odoyo J, Pyra M, Wakhungu I, Anand K, et al. **"Since both of us are using antiretrovirals, we have been supportive to each other": facilitators and barriers of pre-exposure prophylaxis use in heterosexual HIV serodiscordant couples in Kisumu, Kenya**. *Journal of the International AIDS Society* 2016; 19(1):21134.
45. Cabral A, M. Baeten J, Ngure K, Velloza J, Odoyo J, E. Haberer J, et al. **Intimate Partner Violence and Self-Reported Pre-exposure Prophylaxis Interruptions Among HIV-Negative Partners in HIV Serodiscordant Couples in Kenya and Uganda**. *JAIDS Journal of Acquired Immune Deficiency Syndromes* 2018; 77(2):154-159.
46. Townsend L, Mathews C, Zembe Y. **A Systematic Review of Behavioral Interventions to Prevent HIV Infection and Transmission among Heterosexual, Adult Men in Low-and Middle-Income Countries**. *Prevention Science* 2013; 14(1):88-105.
47. Van Loggerenberg F, Dieter AA, Sobieszczyk ME, Werner L, Grobler A, Mlisana K. **HIV Prevention in High-Risk Women in South Africa: Condom Use and the Need for Change**. *PLoS ONE* 2012; 7(2):e30669.

48. Mbizvo MT, Bassett MT. **Reproductive health and AIDS prevention in sub-Saharan Africa: the case for increased male participation**. *Health policy and planning* 1996; 11(1):84-92.
49. Gallo MF, Warner L, Hobbs MM, Jamieson DJ, Hylton-Kong T, Steiner MJ. **Differences in Misreporting of Sexual Behavior Over Time**. *Sexually Transmitted Diseases* 2015; 42(3):160-161.
50. Rao A, Tobin K, Davey-Rothwell M, Latkin CA. **Social Desirability Bias and Prevalence of Sexual HIV Risk Behaviors Among People Who Use Drugs in Baltimore, Maryland: Implications for Identifying Individuals Prone to Underreporting Sexual Risk Behaviors**. *AIDS and Behavior* 2017; 21(7):2207-2214.
51. Festinger L. **Cognitive dissonance**. *Sci Am* 1962; 207:93-102.
52. Giovenco D, Pettifor A, Macphail C, Kahn K, Wagner R, Piwowar-Manning E, et al. **Assessing risk for HIV infection among adolescent girls in South Africa: an evaluation of the VOICE risk score (HPTN 068)**. *Journal of the International AIDS Society* 2019; 22(7).
53. Micheni M, Kombo BK, Secor A, Simoni JM, Operario D, van der Elst EM, et al. **Health Provider Views on Improving Antiretroviral Therapy Adherence Among Men Who Have Sex with Men in Coastal Kenya**. *AIDS Patient Care STDS* 2017; 31(3):113-121.
54. Ojeda VD, Amico KR, Hughes JP, Wilson E, Li M, Holtz TH, et al. **Low Disclosure of PrEP Nonadherence and HIV-Risk Behaviors Associated With Poor HIV PrEP Adherence in the HPTN 067/ADAPT Study**. *JAIDS Journal of Acquired Immune Deficiency Syndromes* 2019; 82(1):34-40.
55. Gregson S, Mushati P, Grusin H, Nhamo M, Schumacher C, Skovdal M, et al. **Social capital and women's reduced vulnerability to HIV infection in rural Zimbabwe**. *Population and development review* 2011; 37(2):333-359.
56. Psaros C, Milford C, Smit JA, Greener L, Mosery N, Matthews LT, et al. **HIV Prevention Among Young Women in South Africa: Understanding Multiple Layers of Risk**. *Archives of Sexual Behavior* 2018; 47(7):1969-1982.