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Partner Characteristics Associated with HIV Acquisition among Youth in Rakai, Uganda

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Abstract

Background—HIV risk is influenced by multiple factors including the behaviors and characteristics of sexual partners. We examined the association between partner characteristics and HIV acquisition among young people in rural Uganda, controlling for individual-level risk factors.

Methods—We used self-reported data from 15–24 year olds (n=1,969 males and n= 2,826 females) from a population-based cohort (2005–2011) in Rakai, Uganda. Respondents could report characteristics for up to four sexual partners in the last year. Poisson regression was used to estimate HIV incidence rate ratios (IRR).

Results—In regression analyses controlling for marital status, young women's risk of HIV acquisition increased if their partner was a truck driver, drank alcohol before sex, and used condoms inconsistently. In young men, the risk of HIV acquisition increased with partners who were not enrolled in school, in partnerships with higher coital frequency, and in partnerships where respondents were unable to assess the HIV risk of their partner. Mixed-model regressions adjusting for respondent's individual-level risk factors, showed that young women's risk of HIV acquisition increased with each non-marital sexual partner (IRR: 1.54 [1.20–1.98]), each partner who drank alcohol before sex (IRR: 1.60 [1.11–2.32]), and each partner who used condoms inconsistently (IRR: 1.99 [1.33–2.98]). Among young men, having non-marital partnerships increased HIV acquisition (IRR for each partner: 1.54[1.20, 1.98]).

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Contributions Statement

John S. Santelli conceptualized the study. Sanyukta Mathur and Ying Wei designed and wrote the paper, and coordinated and contributed to each revision. Ying Wei, Xiaobo Zhong, and Xiaoyu Song conducted all data analyses, participated in data interpretation, and wrote parts of the Methods section. Tom Lutalo, Ron Gray, Maria Wawer, Fred Nalugoda, and David Serwadda oversaw the implementation of the project and collection of data; and reviewed drafts of the paper. All authors reviewed all draft versions and approved the final version.

Implications—Partner characteristics predicted HIV acquisition among youth. HIV prevention programs should emphasize awareness of partner’s risk characteristics to avoid high risk relationships.

Keywords

Partner characteristics; HIV acquisition; HIV risk; youth; Uganda

Introduction

Risk factor studies often examine characteristics of those receiving or acquiring HIV infections and sometimes they examine characteristics of relationships or partners. Yet, risk factor studies seldom examine characteristics of those transmitting the infection.^{1,2} Individual characteristics and behaviors *and* characteristics of partners and relationships are helpful in considering prevention strategies.

Youth in sub-Saharan Africa (SSA) bear a heavy burden of HIV; nearly 3.8 million 15–24 year olds or approximately 76% of the world’s HIV-positive youth population live in SSA.³ Extensive research has documented individual-level risk factors for HIV infection among heterosexual youth in SSA including age, gender, use of alcohol, number of sexual partners, sexual concurrency, STIs, patterns of condom use, and type of sexual acts.⁴ In turn, prevention efforts have often focused on individual-level behavior change, such as increasing condom use with all partners, promoting fidelity, and avoiding new or multiple partners.⁵ Previous studies in SSA have found an association between older partner age, partners’ multiple sexual partnerships, substance abuse, travel, and intimate partner violence as associated with HIV.^{6–12} Still, less is known about how partner characteristics influence youth risk of HIV acquisition.

A recent review identified some key gaps in knowledge on the influence of partner characteristics on HIV risk among youth.¹ First, many studies of partner characteristics associated with HIV infection come from high-income/developed countries; fewer have been conducted in contexts with generalized HIV epidemics. Second, select partner factors – such as partner age disparity and partner’s concurrency - have received the most attention in studies of HIV risk in low and middle income country contexts. Third, much of the research relies on self-reported HIV status and is unable to link select partner characteristics with biomedically confirmed HIV-status. Finally, most studies assessed partner characteristics associated with prevalent HIV, rather than HIV acquisition. Studies of prevalent HIV cannot assess the temporal relationship between partner characteristics and HIV acquisition.

Our study investigates a range of sexual partner characteristics associated with HIV acquisition among youth in rural Rakai district of southwestern Uganda. Uganda has a mature and generalized HIV epidemic with a national prevalence of 7.3 percent.¹³ While Uganda experienced substantial declines in HIV prevalence after 1990, recent sero-behavioral surveys indicate small increases in prevalence among young people and adults.¹³ Understanding risk characteristics of sexual partners might provide insights for developing more effective HIV prevention programs aimed at youth.

This study builds on an earlier analysis from Rakai, Uganda on HIV incidence among youth that found the risk of HIV acquisition was associated with *individual level factors* including gender, age, multiple sexual partners, sexual concurrency, alcohol use, and STI symptoms.¹⁴ The current study extends these analyses to examine *risk characteristics from multiple sexual partners* as reported by young women and young men, and how these characteristics independently contribute to HIV acquisition, after controlling for individual-level factors.

Methods

Rakai Community Cohort Study (RCCS)

We use data from the RCCS, a longitudinal population-based cohort which has been described more fully elsewhere.¹⁵ Briefly, 50 communities are surveyed approximately annually. At each survey round, a household census is conducted, and eligible, consenting participants aged 15–49 years are administered an interview and are asked to provide biological specimens for HIV and STI testing. The RCCS questionnaire elicits socio-demographic information, behaviors, health status, and HIV knowledge. Respondents also provide detailed information about their most recent sexual partners. Household characteristics are derived from the censuses.

Study Design and Sample

This study focuses on the partner characteristics reported by male and female respondents aged 15–24 years. We limit the analysis to four rounds of RCCS data collection (2005–2011) as these survey rounds captured detailed partner-related information on up to four sexual partners in the past year.

HIV status of the respondent was determined by two separate enzyme-linked immuno assays confirmed by Western blot, as previously described.¹⁴ HIV acquisition was defined as having a positive HIV test after a negative HIV test, and it was assumed infection occurred at the midpoint between the last negative and first positive test. In order to ascertain HIV acquisition, we restricted our analyses to initially HIV-negative youth who were followed up at one or more study visits with no more than one survey round missing between them.¹³ Youth were excluded from analysis, if they were not tested in the previous two rounds, were sexually inexperienced, or did not have at least one sexual partner in the last year.

We examined the influence of a broad range of partner characteristics grouped into three categories – partner's socio-demographic characteristics, sexual activity characteristics, and partner's HIV risk on HIV acquisition among youth respondents (see Figure 1). We grouped sexual partnerships into marital and non-marital categories (including boyfriend/girlfriend and casual partnerships).

The partner's socio-demographic characteristics included the partner age, living situation, occupation. The partner age variable was classified as older, younger, or the same age as the respondent. We also assessed whether or not the partner lived in the same household as the respondent, and the distance between where the partner lived and the respondent's place of residence for those not living in the same household. Partner's main occupation was a categorical variable of three main occupation types: trucker, bar worker or student. In

previous studies, truckers and bar workers have been associated with higher HIV prevalence,^{16–18} while being a student was protective against HIV acquisition.¹⁴

We examined a set of sexual activity characteristics. We examined how long respondents had known each other before they had sex the first time - grouped as less than one month, one to two months, and more than two months. We examined partner's alcohol use before sex at the last sexual encounter. We generated an annual coital frequency variable. We also assessed condom use and consistency with each sexual partner.

To assess partner's risk of HIV, we examined the respondent's assessment of the partner's sexual concurrency (number of other sexual partners in the last year), the partner's HIV risk, and whether or not the partner had shared his or her HIV test results with the respondent in the past 12 months.

Statistical Methods and Analysis

We summarized partner characteristics using contingency tables, stratified by the gender of the respondent and marital or non-marital relationship status. We used chi-square tests to determine whether the characteristics of partners were significantly different between female and male respondents, and between marital and non-marital partners.

HIV incidence rate was estimated per 1000 person-years. To analyze the association between partner-related risk factors and HIV acquisition of the index respondent, we used a Poisson regression model to estimate the incidence rate ratio (IRR) and 95% confidence intervals (CI). To control for multiple partnerships with a single index respondent, we made two assumptions. One is a common effect assumption, i.e., if two partners have the same characteristics, their contributions to the HIV acquisition of the index respondent are equivalent. Second, we modeled the risk of HIV acquisition per partner, and if a respondent had multiple partners with a particular high risk characteristic, then the risk of HIV acquisition was multiplicative.

To illustrate the model, we denote Y_{ij} as the indicator of HIV acquisition. $Y_{ij}=1$ if the i -th respondent changed HIV position in his/her j -th visit, and $Y_{ij}=0$ otherwise. We then denote X_{ijk} as a risk factor of the k -th partner of the i -th respondent on the j -th visit. If X is a categorical variable with L levels, then X_{ijk} is a vector with $(L-1)$ binary indicators. We also define d_{ij} as the exposure time of the i -th respondent on the j -th visit since the $(j-1)$ -th visit. With these notations, we build the following adjusted poisson regression model.

$$\ln\left(\frac{Y_{ij}}{d_{ij}}\right) = \beta_0 + \sum_{k=1}^4 X'_{ijk} \beta_1 + \varepsilon_{ij} \quad (1)$$

Under model (1), $\exp(\beta_0)$ is the incidence rate per person year if all of the partners are at the reference level. We used generalized estimation equations with autoregressive working correlation to accommodate the within-subject correlation from the longitudinal data structure. We used Wald tests to determine statistical significance.

Since we observed big differences between marital and non-marital partners, we further adjusted the model by including the marital status. The expanded model writes

$$\ln\left(\frac{Y_{ij}}{d_{ij}}\right) = \beta_0 + \sum_{k=1}^4 X'_{ijk}\beta_1 + \sum_{k=1}^4 M'_{ijk}\beta_2 + \varepsilon_{ij}, \quad (2)$$

where M_{ijk} is the marital status (marital vs non-marital) of the k -th partner of the i -th respondent on his/her j -th visit. $\text{Exp}(\beta_{11})$ in model (2) is the relative risk for HIV acquisition adjusting for the marital status of the partners. Likelihood ratio tests were used to test potential interactions. The comparison between models (1) and (2) addressed the question, whether the contribution was directly associated with the risk factor itself or due to the underlying marital status. We further expanded model (2) to include other partner related risk factors and individual risk behaviors/characteristics. The forward model selection with Akaike Information Criterion (AIC) was used to identify the final multivariate model.¹⁹ Specifically, we started with the most predictive bivariate model and added variables sequentially, to arrive at a set of variables that best predict the respondent's HIV incidence risk.

Based on the above, we present four sets of regression results (Tables 3.1 and 3.2): (a) unadjusted IRR between individual characteristics (of the partner and the respondent) and HIV acquisition; (b) adjusted IRR for the type of relationship with each partner (marital or non-marital); (c) separate multivariate models among respondent and partner related risk factors; and (d) the final mixed-model to take into account both significant partner-related risk factors and characteristics of the respondents previously found to be associated with HIV acquisition among youth in Rakai.¹³

Results

There were 4,646 partner characteristics for 1,969 male youth respondents (i.e., 2.4 partners per respondent) and 4,416 partner characteristics for 2,826 female youth respondents (i.e., 1.6 partners per respondent). Among them, there were 45 male HIV incident cases and 96 female incident cases detected in the four rounds of data collection.

Respondent characteristics previously found to be significantly associated with HIV acquisition among Rakai youth¹³ are summarized in Table 1. The median ages for female and male respondents were 22 and 21 years. Respondents were mostly rural. Sixty two percent of young men had never been married, while 67% of young women were currently married. Ninety five percent of female youth reported only one sexual partner in past 12 months. Among male youth respondents 26% reported two partners and 13% reported three or more partners in the past 12 months. STD symptoms were not uncommon amongst all youth, but female youth were more likely to report genital ulcers. Finally, 22% of male respondents and 20% of female respondents reported alcohol use before sex.

Description of Partner Characteristics

Partner characteristics varied among male and female respondents (Table 2). For male respondents, 91% reported non-marital partners ($n=4,226$) and 9% were marital partners. In

contrast, among the partners reported by female respondents, 63% were non-marital and 37% were marital partners.

Several socio-demographic characteristics of marital and non-marital partners were different for male and female respondents. Male respondents generally had partners who were younger, while most female respondents had partners who were older, regardless of the type of partnership. Almost all marital partners lived in households with respondents. Fifty one percent of non-marital partners of female youth respondents lived in the same household, while only 13% of non-marital partners of male youth respondents shared the same household with the respondents. Forty seven percent of non-marital partners of male respondents were students, while only two percent of marital partners were students. In comparison, only seven percent of female respondents reported non-marital partners who were still in school.

Sexual activity characteristics also varied among marital and non-marital partners for male youth respondents, but less so for females youth respondents. With 37% of non-marital partners, male respondents engaged in sexual activity within one month of knowing their partner compared to an interval <1 month for 17% of marital partners. This differential between marital and non-marital partners was not observed in female respondents. Compared to male respondents, female respondents waited for significantly longer time before initiating sexual activity with their partners. Both young men and young women had sex more frequently. Coital frequency was higher with marital than non-marital partners for male and female youth respondents. Partners' alcohol use before sex was not common among male respondents, whereas female respondents reported that 29% of their non-marital and 31% of their marital partners consumed alcohol before last sex. Condom use was very low for young men and young women. Both young men and young women reported more consistent condom use with non-marital partners than marital partners (60% vs. 7% for male respondents and 31% vs. 2% for female respondents).

Similarly, partners' HIV risk varied between marital and non-marital partners for male and female youth respondents. Young men and young women reported that more non-marital partners were engaged in other sexual relationships than their marital partner (33% vs. 4% for men and 49% vs. 38% for women). However, when assessing their partner's HIV risk, young men attributed significantly higher perceived HIV risk for their non-marital partners, while young women perceived HIV risk of their marital and non-marital partners as approximately equal. Male respondents knew the HIV status of 49% of their non-marital partners and 32% of their marital partners. In comparison, female respondents knew the HIV status of 56% of their non-marital partners and marital partners. Marital partners were more likely to receive couple counseling with the respondents than non-marital partners.

Partner Characteristics Associated with HIV Acquisition

Tables 3.1 and 3.2 present the IRRs for HIV acquisition among female and male respondents. IRRs reflect the risk of HIV acquisition per partner. Per our model assumptions, if a young woman has two non-marital partners her relative risk of HIV incidence is 1.60² or 2.56 compared to a young woman who only has a marital partner.

The first column presents the unadjusted IRR of HIV acquisition based on respondent and partner characteristics. For young women (Table 3.1), having a partner who was older, lived outside the same household, lived further away, was not a marital partner, worked as truck driver, drank alcohol before having sex, had one additional sexual partner, and was at least somewhat likely to be exposed to HIV significantly increased their risk of HIV acquisition. Moreover, for female respondents, receiving couple counseling with her partner was protective against HIV acquisition. For male respondents (Table 3.2), having a partner who was younger or older than the respondent, a partner who was not his current wife, a partner who had sex within 1 month of knowing the respondent, a partner who had sex more than 48 times (once a week in average) in the past 12 months, a partner who used condom inconsistently, a partner who had more than two sexual partners, and a partner who was not perceived to be at risk of HIV significantly increased the risk of HIV acquisition.

The second column in Tables 3.1 and 3.2 provide IRRs adjusted for the type of partnership. For female youth (Table 3.1) and independent of the type of partnership, partner's occupation as a truck driver (adjusted IRR: 1.97 [1.12–3.47]), a partner who drank alcohol before sex (adjusted IRR: 1.71 [1.24–2.36]) and a partner who used condoms inconsistently (adjusted IRR: 2.15 [1.49–3.11]) increased the risk of HIV acquisition. For male youth (Table 3.2), having a partner who was not a student (adjusted IRR: 1.59 [1.15, 2.18]), who had increased coital frequency (adjusted IRR: 1.50 [1.01, 2.21]), and whose HIV risk was unknown (adjusted IRR: 3.13 [1.19–8.20]) significantly increased the risk HIV acquisition.

The third column in Tables 3.1 and 3.2 present the results of the multivariate analyses. Model 1 presents the significant respondent-specific risk factors for HIV acquisition. For female youth, individual level risk factors associated with HIV acquisition included living in a trading village, being separated or divorced, having two or more partners in the last year, and presence of genital warts. For male youth, the same individual-level risk factors were associated with HIV acquisition, but risk was increased with currently being married.

Model 2 presents factors associated with HIV acquisition among all the partner-related risk factors. After adjustment, a non-marital partner ($IRR_{\text{Model 2}}: 2.10 [1.54–2.86]$), a partner who drinks alcohol before sex ($IRR_{\text{Model 2}}: 1.76 [1.24–2.50]$) and inconsistent condom use ($IRR_{\text{Model 2}}: 2.30 [1.53–3.46]$) were significant factors for HIV acquisition among female youth (Table 3.1). For male youth respondents (Table 3.2), after adjustment, the following partner related factors remain significantly associated with the HIV acquisition: partner was not a student ($IRR_{\text{Model 2}}: 1.50 [1.10 – 2.30]$), and the partner's HIV risk was unknown to the respondent ($IRR_{\text{Model 2}}: 2.35 [0.98, 5.64]$).

Finally, the fourth column in Tables 3.1 and 3.2 presents the IRRs of the mixed-model multivariate analyses (model 3) that assess HIV acquisition risk based on significant partner-related risk factors and adjust for the respondent's own risk factors. For young women, non-marital partners ($IRR_{\text{Model 3}}: 1.60 [1.11–2.32]$), partners who drank alcohol before sex ($IRR_{\text{Model 3}}: 1.57 [1.11–2.21]$), and used condoms inconsistently ($IRR_{\text{Model 3}}: 1.99 [1.33–2.98]$) were significantly associated with the HIV acquisition (Table 3.1). Whereas, for young men, non-marital partners ($IRR_{\text{Model 3}}: 1.54 [1.20 – 1.98]$) were significantly

associated with HIV acquisition after adjustment for individual respondent characteristics (Table 3.2).

Discussion

Partner characteristics independently influenced HIV risk among youth in Rakai. For both young men and young women, after controlling for individual-level risk factors, sex with non-marital partners increased the likelihood of HIV acquisition. Additionally, for women the behaviors of their male partners – alcohol use and inconsistent condom use – enhanced the risk of HIV. Risk of HIV acquisition increased if respondents had a partner with multiple high risk characteristics or multiple partners with one or more high risk characteristics.

Previous research has shown considerable variation in reported marital and non-marital sexual partnerships among youth.^{20,21} Opio et al. found increases in reports of non-spousal sexual activity among young men in Uganda between 2001 and 2005, at a time when Uganda was no longer experiencing declines in HIV prevalence.²² Young men in our sample, were more likely to have non-marital partners, compared to young women. For young men, non-marital partnerships were characterized by greater age disparities, partners from outside the household, partners who were enrolled in school, shorter relationship durations, increased sexual concurrency, stronger suspicions of HIV risk, and limited knowledge of partner HIV status compared to their marital partner characteristics. Among young women's non-marital partners, characteristics of note include living outside the household, higher coital frequency, greater partner concurrency, and limited knowledge of the partner's HIV status compared to marital partner characteristics. We find that non-marital partnerships add substantial risk of HIV acquisition to both young men and young women in Rakai. Greater exploration of couple-dynamics within marital and non-marital partnerships is needed.

Our study confirms previous research that partner characteristics are an important determinant of HIV risk for female youth.⁴ Type of partnership and the context of sexual activity with partner's influenced young women's risk of HIV acquisition. Partner's use of alcohol before engaging in sexual activity enhanced risk of HIV acquisition among young women in Rakai. Similarly, inconsistent condom use significantly predicted HIV acquisition when we controlled for the type of partnership for female youth. Age discrepant relationships did not increase the likelihood of HIV acquisition when controlling for other partner-related factors, as found in previous studies.²³ For young men, it was primarily the type of relationship that they were engaged in, rather than their partner's socio-demographic, sexual activity, or HIV risk characteristics that increased their risk for HIV acquisition. It is likely that young women's limited ability to negotiate the risk behaviors of their partners is putting them at risk for HIV; while young men might have greater control over the behavior of their partners.

Limitations

Partner risk characteristics were reported by the respondents, and were subject to potential reporting errors and biases. Future research linking respondent information with marital and non-marital partners' information could help assess potential bias, but such linked

partnership data is difficult to capture. We did not have data on the exact age difference between the respondent and the partner. Previous analysis in Rakai showed that use of alcohol was associated with HIV incidence,¹³ while we have consistent alcohol use information on the partners, respondent's own alcohol use questions were not consistently asked across all survey rounds and were not included in this analysis.

Implications

Partner attributes contribute substantially to HIV risk among youth in rural Uganda independent of individual characteristics and risk behaviors. HIV prevention programs targeting youth need to address risk from marital and non-marital partners. At the individual-level HIV prevention programs should emphasize knowledge of partner characteristics that increase HIV risk, in addition to current emphasis on abstinence, condom use, partner reduction, and HIV testing and disclosure. Young people need increased access to couple counseling and HIV testing. Further, HIV prevention efforts might need to take into account how to tailor HIV risk and prevention messages for different types of partners. Since partner characteristics can influence HIV risk, youth also need greater access to life skills programs that help them negotiate and potentially influence the behaviors of their partners within the relationship context.

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Figure 1.
Analytical Framework: Partner Characteristics and HIV Acquisition among Youth

Table 1

Respondent characteristics of sexually experienced male and female youth **at baseline** in Rakai, Uganda 2005–2011.

Risk factor	Male respondents (n=1969)	Female respondents (n=2826)
Age of respondent		
15–19	739 (38)	852 (30)
20–24	1230 (62)	1974 (70)
Community		
Rural	303 (15)	486 (17)
Trading village	1650 (84)	2307 (82)
Unknown	16 (<1)	33 (1)
Marital status		
Never married	1423 (72)	814 (29)
Divorced/Widowed	46 (2)	110 (4)
Currently married	500 (25)	1902 (67)
Current student		
No	1572 (80)	2501 (88)
Yes	397 (20)	325 (12)
Number of sex partners		
1	1199 (61)	2678 (95)
2	511 (26)	135 (5)
3+	259 (13)	13 (<1)
Painful urination		
No	1806 (92)	2508 (89)
Yes	163 (8)	312 (11)
Unknown	0 (0)	6 (<1)
Genital warts		
No	1948 (99)	2759 (98)
Yes	21 (1)	65 (2)
Unknown	0 (0)	2 (<1)
Genital ulcer		
No	1791 (91)	2422 (86)
Yes	178 (9)	402 (14)
Unknown	0 (0)	2 (<1)
Drank alcohol in the last 30 days ^I		
No	619 (31)	1084 (38)
Yes	431 (22)	556 (20)
Unknown	919 (47)	1186 (42)

^I Respondent's alcohol use was only collected in two survey rounds.

Table 2

Partner characteristics as reported by male and female youth respondents, stratified by type of partnership in Rakai, Uganda 2005–2011

Risk factors	Male respondent			Female respondent		
	Type of Partnerships		P-value ²	Type of Partnerships		P-value ²
	Non-marital (N%)	Marital (N%)		Non-marital (N%)	Marital (N%)	
N (number of partner characteristics, row %)	4226 (91)	420 (9)		2782 (63)	1634 (37)	
<i>Socio-Demographic</i>						
Age difference of partner						
Same age	670 (16)	29 (7)	<0.0001	122 (4)	21 (1)	<0.0001
Younger	3108 (74)	372 (89)		29 (1)	9 (<1)	
Older	436 (10)	17 (4)		2620 (95)	1600 (98)	
Residence of partner						
In same household	556 (13)	416 (99)	<0.0001	1407 (51)	1631 (99)	<0.0001
Out of household	3670 (87)	4 (<1)		1375 (49)	3 (<1)	
Proximity of partner's residence						
1 hour walk or 3 miles	1159 (49)	417 (99)	<0.0001	1646 (73)	1631 (99)	<0.0001
>1 hour walk or 3 miles	1218 (51)	1 (<1)		621 (27)	3 (<1)	
Partner works as a trucker						
Yes	N/A	N/A	N/A	151 (5)	59 (4)	0.0053
No	N/A	N/A		2602 (95)	1568 (96)	
Partner is currently a Student						
Yes	1973 (47)	3 (2)	<0.0001	182 (7)	2 (<1)	<0.0001
No	2206 (53)	415 (98)		2571 (93)	1625 (99)	
Partner works as a bar worker						
Yes	37 (<1)	0 (0)	0.0449	14 (<1)	10 (<1)	0.6748
No	4142 (99)	418 (100)		2739 (99)	1617 (99)	
<i>Sexual Activity</i>						
Relationship duration before 1 st sexual activity with partner						
< 1 month	1580 (37)	71 (17)	<0.0001	303 (11)	190 (12)	0.7287

Risk factors	Male respondent			Female respondent		
	Type of Partnerships		P-value ²	Type of Partnerships		P-value ²
	Non-marital (N%)	Marital (N%)		Non-marital (N%)	Marital (N%)	
1–2 months	1460 (35)	180 (43)		859 (31)	508 (31)	
> 2 month	1185 (28)	169 (40)		1613 (58)	934 (57)	
Coital frequency with the partner in the past year						
48	3509 (83)	104 (25)	<0.0001	1579 (57)	473 (29)	<0.0001
> 48	715 (17)	316 (75)		1191 (43)	1146 (71)	
Partner used alcohol before sex						
No	3897 (92)	375 (89)	0.0382	1971 (71)	1120 (69)	0.1097
Yes	328 (8)	45 (11)		809 (29)	513 (31)	
Frequency of condom use with the partner in past 12 month						
Used consistently	1839 (60)	7 (4)	<0.0001	572 (31)	14 (2)	<0.0001
Used inconsistently	1029 (33)	84 (53)		717 (39)	257 (39)	
Never used condom	209 (7)	67 (42)		541 (30)	392 (59)	
HIV Risk						
Number of other sexual partners that the partner has in past 12 months						
0	837 (67)	170 (96)	<0.0001	713 (51)	531 (62)	<0.0001
1	215 (17)	5 (3)		520 (37)	238 (28)	
>1	201 (16)	2 (1)		161 (12)	85 (10)	
Partner's HIV risk assessed by index persons						
Not at all	231 (5)	32 (8)	<0.0001	145 (5)	100 (6)	0.6471
Low risk	1625 (38)	222 (53)		768 (28)	464 (28)	
Median risk	1912 (45)	138 (33)		1097 (39)	618(38)	
High risk	394 (9)	21 (5)		695 (25)	408 (25)	
Unknown risk	63 (1)	7 (2)		76 (3)	43 (3)	
Partner informed respondent of HIV status						
Inform HIV status	1606 (49)	115 (32)	<0.0001	1274 (56)	787 (56)	<0.0001
Not inform HIV status	470 (14)	93 (26)		576 (25)	284 (20)	
Unknown HIV status	1139 (35)	99 (28)		281 (12)	144 (10)	

Risk factors	Male respondent			Female respondent		
	Type of Partnerships		P-value ²	Type of Partnerships		P-value ²
	Non-marital (N%)	Marital (N%)		Non-marital (N%)	Marital N(%)	
Received couple counseling	57 (2)	49 (14)		160 (7)	193 (14)	

² Chi-square tests

Table 3.1
Likelihood of HIV acquisition (Incidence Rate Ratios for new HIV infection) among female respondents

<i>Characteristics of Respondents</i>	Categories	Likelihood of HIV acquisition			
		Unadjusted IRR (95% CI) ¹	Adjusted IRR (95% CI) ²	Multivariate model 1 IRR (95% CI) ³	Multivariate model 3 IRR (95% CI) ⁴
Age of respondent	15–19	ref			
	20–24	0.90 (0.56–1.42)			
Community	Rural	ref			
	Trading village	1.93 (1.25–2.97)		1.70 (1.09–2.66)	1.74 (1.13–2.69)
Marital status	Never married	ref			
	Divorced	2.97 (1.65–5.32)		2.02 (1.09–3.77)	2.12 (1.11–4.05)
	Current married	0.53 (0.34–0.82)		0.45 (0.28–0.72)	0.75 (0.44–1.26)
Currently a student	Yes	ref			
	No	1.96 (0.80–4.80)			
Number of partners in the last year	1	ref			
	2	3.03 (1.69–5.42)		2.08 (1.11–3.92)	
	3+	6.10 (1.74–21.42)		2.95 (0.85–10.23)	
Painful urination	No	ref			
	Yes	1.27 (0.71–2.26)			
Symptomatic genital warts	No	ref			
	Yes	3.30 (1.58–6.91)		2.76 (1.31–5.82)	2.36 (1.07–5.21)
Alcohol use in last 30 days ⁵	No	ref		NA	NA
	Yes	1.49 (0.84–2.64)		NA	NA
<i>Characteristics of Partner</i>	Categories	Unadjusted IRR (95% CI)	Adjusted IRR (95% CI) ²	Multivariate model 2 IRR (95% CI) ³	
Relationship with Partner	Marital	ref	NA		
	Non-marital	2.41 (1.81–3.20)	NA	2.10 (1.54–2.86)	1.60 (1.11–2.32)
<i>Socio-Demographic</i>					
Age of partner	Same age	ref	ref		
	Younger	1.69 (0.23–12.48)	0.61 (0.08–4.76)		

<i>Characteristics of Respondents</i>	Categories	Likelihood of HIV acquisition			
		Unadjusted IRR (95% CI) ¹		Multivariate model 1 IRR (95% CI) ³	Multivariate model 3 IRR (95% CI) ⁴
Partner Residence	Older	2.59 (1.62–4.14)	1.08 (0.65–1.78)		
	In same household	ref	ref		
	Out of household	2.07 (1.59–2.69)	1.27 (0.84–1.91)		
Proximity of Partner residence	1 hour walk or 3 miles	ref	ref		
	>1 hour walk or 3 miles	2.13 (1.47–3.08)	1.32 (0.88–1.99)		
	Non-trucker	ref	ref		
Partner works as a trucker	Trucker	2.63 (1.45–4.78)	1.97 (1.12–3.47)		
	Student	ref	ref		
	Non-Student	2.13 (1.17–3.90)	0.93 (0.56–1.54)		
Partner works as a bar worker	Non-bar-worker	ref	ref		
	Bar worker	1.81 (0.26–12.71)	1.56 (0.21–11.83)		
<i>Sexual Activity</i>	> 2 month	ref	ref		
	1–2 months	2.48 (1.58–3.89)	1.23 (0.79–1.90)		
	< 1 month	2.27 (1.33–3.89)	1.22 (0.78–1.90)		
Partner used alcohol before sex	No	ref	Ref		
	Yes	1.97 (1.34–2.90)	1.71 (1.24–2.36)	1.76 (1.24–2.50)	1.57 (1.11–2.21)
Coital frequency with the partner in the past year	48	ref	Ref		
	> 48	0.82 (0.55–1.21)	1.02 (0.69–1.50)		
Frequency of using condom with the partner in the past year	Used consistently	ref	Ref		
	Used inconsistently	2.78 (1.85–4.19)	2.15 (1.49–3.11)	2.30 (1.53–3.46)	1.99 (1.33–2.98)
	Never used condom	1.25 (0.71–2.19)	1.20 (0.70–2.06)	1.13 (0.65–1.97)	1.18 (0.68–2.04)
<i>HIV Risk</i>					
	0	ref	ref		
	1	1.83 (1.22–2.77)	1.36 (0.90–2.04)		
Number of other sexual partners that the partner has in past year	>1	1.35 (0.65–2.83)	0.98 (0.47–2.06)		
	Not at all	ref	ref		
	Low risk	1.80 (0.99–3.27)	0.81 (0.47–1.41)		

Characteristics of Respondents	Categories	Likelihood of HIV acquisition		
		Unadjusted IRR (95% CI) ¹	Multivariate model 1 IRR (95% CI) ³	Multivariate model 3 IRR (95% CI) ⁴
Partner informed respondent of HIV status	Median risk	2.69 (1.68–4.30)	1.21 (0.74–1.97)	
	High risk	3.09 (2.02–4.71)	1.40 (0.86–2.26)	
	Unknown risk	2.81 (0.68–11.55)	1.26 (0.33–4.80)	
	Inform HIV status	ref	ref	
	Not inform HIV status	0.58 (0.32–1.04)	0.55 (0.31–0.97)	
	Unknown HIV status	1.17 (0.65–2.10)	0.95 (0.56–1.63)	
	Received couple counseling	0.22 (0.05–0.91)	0.26 (0.07–1.01)	

¹Unadjusted IRR: associations between risk factors and HIV acquisition for respondent and partner characteristics

²Adjusted IRR: association between partner characteristics and HIV acquisition adjusted for the relationship with partners

³Multivariate Models 1 & 2: Separate regressions of the influence of respondent's own risk factors and of partner characteristics on HIV acquisition

⁴Multivariate 3: Final mixed model regression incorporating significant respondent and partners characteristics to predict HIV acquisition

⁵This variable was excluded from all multivariate models because it was not available in all survey rounds.

Table 3.2
Likelihood of HIV acquisition (Incidence Rate Ratios for new HIV infection) among male respondents

<i>Characteristics of Respondents</i>	Categories	Likelihood of HIV acquisition		
		Unadjusted IRR (95% CI) ¹	Multivariate model 1 IRR (95% CI) ³	Multivariate model 3 IRR (95% CI) ⁴
Age of respondents	15–19	ref		
	20–24	2.55 (1.09–6.00)		
Community	Rural	ref		
	Trading village	2.14 (1.12–4.10)	2.23 (1.16–4.30)	2.14 (1.08–4.37)
	Never married (ref)	ref		
Marital status	Divorced	8.37 (3.42–4.10)	4.93 (1.82–13.36)	5.30 (1.95–14.38)
	Current married	2.57 (1.38–4.79)	2.26 (1.22–4.20)	2.75 (1.48–5.10)
Currently a student	Yes	ref		
	No	8.48 (1.17–61.79)		
Number of partners in the last year	1	ref		
	2	3.03 (1.69–5.42)	2.35 (1.13–4.91)	
	3+	6.10 (1.74–21.42)	3.12 (1.39–7.01)	
Symptomatic genital ulcer	No	ref		
	Yes	3.64 (1.93–6.87)	2.38 (1.18–4.81)	2.17 (1.08–4.37)
Alcohol use in the last 30 days ⁵	No	ref	NA	NA
	Yes	3.12 (1.09–8.91)	NA	NA
<i>Characteristics of Partner</i>	Categories	Unadjusted IRR (95% CI)	Adjusted IRR (95% CI) ²	Multivariate model 2 IRR (95% CI) ³
Relationship with Partner	Married	ref	NA	
	Not married	1.70 (1.34–2.17)	NA	1.13 (0.62–2.05)
<i>Socio-demographic</i>				
Age of partner	Same age	ref	ref	
	Younger	1.54 (1.09–2.16)	1.12 (0.68–1.84)	
	Older	2.24 (1.60–3.12)	1.55 (0.82–2.94)	
Residence	In same household	ref	ref	

<i>Characteristics of Respondents</i>	Categories	Likelihood of HIV acquisition		
		Unadjusted IRR (95% CI) ¹	Multivariate model 1 IRR (95% CI) ³	Multivariate model 3 IRR (95% CI) ⁴
Proximity of residence	Out of household	1.39 (1.09–1.79)	0.47 (0.30–0.74)	
	1 hour walk or 3 miles	ref	ref	
	>1 hour walk or 3 miles	1.35 (0.94–1.96)	0.91 (0.60–1.39)	
Partner is currently a student	student	ref	ref	
	Non-student	1.88 (1.52–2.32)	1.59 (1.15–2.18)	1.59 (1.10–2.30)
	Non-bar-worker	ref	ref	
Partner works as a bar worker	Bar worker	1.39 (0.49–3.96)	0.88 (0.26–3.03)	
<i>Sexual Activity</i>				
Duration before 1st sexual activity with partner	> 2 month	ref	ref	
	1–2 months	1.44 (0.99–2.12)	1.04 (0.69–1.55)	
	< 1 month	1.57 (1.01–2.43)	1.24 (0.87–1.78)	
Partner used alcohol before sex	No	ref	ref	
	Yes	1.32 (0.80–2.18)	1.00 (0.60–1.66)	
	48	ref	ref	
Coital frequency with the partner in the past year	> 48	1.74 (1.17–2.60)	1.50 (1.01–2.21)	
Frequency of using condom with the partner in the past year	Used consistently	ref	ref	
	Used inconsistently	1.52 (1.13–2.04)	1.14 (0.83–1.57)	
	Never used condom	1.44 (0.69–3.04)	1.20 (0.58–2.47)	
<i>HIV risk</i>				
Number of other sexual partners that the partner has in past year	0	ref	ref	
	1	1.34 (0.68–2.64)	0.90 (0.44–1.83)	
	>1	2.10 (1.28–3.46)	1.52 (0.91–2.54)	
Partner's HIV risk assessed by the index respondent	Not at all	ref	ref	
	Low risk	1.59 (1.03–2.46)	1.43 (0.57–3.59)	1.07 (0.5–2.29)
	Median risk	1.61 (1.24–2.09)	1.45 (0.61–3.45)	1.04 (0.50–2.19)
	High risk	1.84 (1.31–2.58)	1.65 (0.71–3.84)	1.19 (0.58–2.44)
	Unknown risk	3.51 (2.21–5.57)	3.13 (1.19–8.20)	2.35 (0.98–5.64)
Partner informed	Inform HIV status	ref	ref	

<i>Characteristics of Respondents</i>	Categories	Likelihood of HIV acquisition		
		Unadjusted IRR (95% CI) ¹	Multivariate model 1 IRR (95% CI) ³	Multivariate model 3 IRR (95% CI) ⁴
respondent of HIV status	Not inform HIV status	1.40 (0.64–3.07)	1.16 (0.58–2.31)	
	Unknown HIV status	1.23 (0.82–1.84)	0.96 (0.69–1.35)	
	Received couple counseling	2.28 (0.73–7.17)	2.63 (0.87–7.95)	

¹ Unadjusted IRR: associations between risk factors and HIV acquisition for respondent and partner characteristics

² Adjusted IRR: association between partner characteristics and HIV acquisition adjusted for the relationship with partners

³ Multivariate Models 1 & 2: Separate regressions of the influence of respondent's own risk factors and of partner characteristics on HIV acquisition

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⁵ This variable was excluded from all multivariate models because it was not available in all survey rounds.