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

Authors: Ying Wei[1], Sanyukta Mathur[2] Xiaobo Zhong[1], Zoe Edelstein[2], Mariko Rasmussen[2], Xiaoyu Song[1], Maria Wawer[3], Ron Gray[3], David Serwadda[4], and John S. Santelli[2]

[1] Department of Biostatistics, Columbia University Mailman School of Public Health [1]Heilbrunn
[2] Department of Population and Family Health, Columbia University Mailman School of Public Health
[3] Bloomberg School of Public Health, Johns Hopkins University
[4] Rakai Health Sciences Program, Uganda Virus Research Institute

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Abstract

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

Methods: We used self-reported data from 15-24 years-olds (n=2,884 males and n= 4196 females) from a population-based cohort (2005-2011). Respondents could report characteristics for up to four sexual partners in the last year. Poisson regression was used to calculate incident rate ratios (IRR).

Results: Characteristics of marital and non-marital partners varied substantially between young men and young women. In regression analyses adjusting for type of partnership, young women's likelihood of HIV acquisition increased if their partner was a truck driver, drank alcohol before sex, and used condom inconsistently. In similar analyses, young men's likelihood of HIV increased with partners who were not enrolled in school, in partnerships with higher coital frequency, and 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 likelihood 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: 1.57 [1.11-2.21]), and each partner who used condoms inconsistently (IRR: 1.99 [1.33-2.04]). Among young men, having non-marital partnerships increased HIV acquisition (IRR for each partner: 1.54[1.20, 1.98]).

Implications: Partner characteristics predicted HIV acquisition among youth. HIV prevention programs should emphasize knowledge of partners and characteristics of partners that increase HIV risk.

Introduction

Youth in sub-Saharan Africa (SSA) bear a heavy burden of the HIV pandemic; nearly 3.8 million 15-24 year olds or approximately 76% of the world's HIV-positive youth population live in SSA.[1] Extensive research has documented individual-level risk factors for HIV infection among heterosexual youth in SSA including age and gender, use of alcohol, number of sexual partners, sexual concurrency, STIs, patterns of condom use, and kinds of sexual acts. 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 partners.[2] However, risk of HIV infection among youth is also influenced by characteristics of sexual partners.[3, 4]

A recent review identified some key gaps in knowledge on the influence of partner characteristics on HIV risk among.[3] 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, certain partner factors – such as partner age and partner's concurrency - have received the most attention in studies of HIV risk in low and middle income country contexts. Third, most studies assessed partner characteristics associated with HIV prevalence, rather HIV acquisition. Studies of HIV prevalence may not reflect current HIV risk; they are unable to disentangle partner factors associated with recent and long-term HIV infections.

Prior research has demonstrated the influence of partner age and the age disparities between youth and partners on HIV and STI risk.[3] For instance, a study in rural Zimbabwe found an association between older partner age and increased HIV prevalence among young women and young men.[5] Another study in South Africa found an association between STI symptoms and unprotected sex among young women in age-disparate relationships.[6] A study in Uganda however, found an association between age disparity and HIV prevalence, but not HIV incidence.[7]

Similarly, high prevalence of concurrent sexual partnerships has also been associated with high HIV infection rates in some African populations.[8, 9] A study in Tanzania found that among pregnant young women in Tanzania, male partner characteristics were a strong predictor of HIV prevalence. In that study, women with partners who had other sexual partners were 15 times more likely to be HIV-positive compared to women whose partner did not have other sexual partners.[10] Additional partner characteristics, like alcohol use [11, 12], and characteristics of relationships, like inequitable power between partners or experiences of intimate partner violence [13] may also be associated with individual HIV risk among youth in SSA. Further, qualitative research in SSA has highlighted how different types of partnerships and partner's characteristics contribute to sexual risk among youth.[14] Overall, evidence suggests the need for further research into partner characteristics and their association with HIV acquisition among young men and young women in SSA.

Our study investigates sexual partner characteristics associated with HIV acquisition over the past year among young men and young women in the rural southwestern district of Rakai, Uganda. Uganda has a mature and generalized HIV epidemic with a national prevalence of 6.7 percent.[15] While Uganda experienced substantial declines in HIV prevalence after 1990, recent sero-behavioral surveys indicate small increases in prevalence among young people and adults.[15] Understanding risk characteristics of sexual partners might be able provide insights for developing more effective HIV prevention programs aimed at youth.

This study builds on an earlier analysis from Rakai, Uganda on HIV acquisition (i.e., incidence) among youth. In that analysis we found that risk of HIV acquisition was associated *individual level factors* like gender, age, multiple sexual partners, sexual concurrency, alcohol use, and STI symptoms.[16] This current study extends these analyses to examine *risk characteristics of sexual partners* as reported by young women and young men, and how these characteristics independently contribute to HIV acquisition. Thus, our paper explored partner risk of new HIV infection, controlling for individual-level factors; we examined risk factors previously associated with HIV and several which are new. .

Methods

Rakai Community Cohort Study

We use data from the Rakai Community Cohort Study (RCCS), a longitudinal population-based epidemiological cohort in the Rakai district of southwestern Uganda; it has been described more fully elsewhere.[17] Briefly, 50 communities are surveyed approximately annually. At each survey round, a household census is conducted, and eligible participants between the ages of 15-49 years are administered a survey and asked to provide biological specimens for HIV and STI testing identifying new infections between survey rounds. HIV status is determined by 2 separate enzyme-linked immunosorbent assay tests and confirmed by HIV-1 western blot, as previously described.[17] The RCCS questionnaire contains a wide range of behavioral and social questions including socio-demographic information, behavioral information, health status, HIV knowledge, and household characteristics. During the survey, the respondents also provide detailed information on their four most recent sexual partners in the past year. In the rest of the paper, we refer to the individuals who completed the survey as "respondents."

Study Design and Sample

This study focuses on the partner characteristics reported by male and female respondents aged 15-24 year old, who were sexually experienced, and had at least one sexual partner in the past year. We limit the analysis to the four most recent rounds of RCCS data collection (2005-2011) as these survey rounds captured detailed partner-related information on up to four sexual partners per respondent in the past year per index respondent. In earlier rounds, data were collected on only the two sexual partners.

HIV acquisition was defined as having a positive HIV test after a negative HIV test at either or both of the two previous rounds of the RCCS. Youth were excluded from analysis, if they were not tested in the previous two rounds. Given this exclusion, we had 2,884 male youth respondents and 4,196 female youth respondents in our study sample. Since respondents were in multiple survey rounds, male and female youth respondents accounted for 5,315 and 7,319 person-rounds, respectively.

We examined the influence of a broad range of partner characteristics on HIV acquisition among young men and young women respondents. We grouped sexual partnerships into marital and non-marital categories (including boyfriend/girlfriend and casual partnerships). The partner age variable described if the partner was older, younger, or the same age as the respondent. We also examined partner's living situation whether or not the partner was living in the same household as the respondent and the distance between where the partner lived and the respondent if the partner was not living in the same household. Partner's main occupation was a categorical variable; we focused specifically on three main occupation types: partners who were truckers, bar workers or those who were still students. In previous studies, occupations like truckers and bar workers have been associated with higher HIV prevalence,[18-20] while being a student was protective against HIV acquisition.[16] To further explore the nature of the relationship, 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. Based on a series of questions on coital frequency, we generated an annual coital frequency variable. We also looked at condom use consistency with each sexual partner. To assess partner's risk of HIV, we also examined the respondent's assessment of the partner's sexual concurrency, the partner's HIV risk, and whether or not the partner had shared his or her HIV test results with their partner in the past 12 months. All together we assessed 4,646 partner characteristics for male youth respondents and 4,416 partner characteristics for female youth respondents.

Statistical Methods and Analysis

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

To analyze the association between a partner-related risk factors and the HIV acquisition of the index respondent, we used Poisson regression to model the incidence rate per 1000 person-year. To adjust for the potential 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. The second is multiplicative contribution with multiple partners. In other words, we modeled the

risk of HIV incidence per partner, and if a respondent has multiple partners with a particular high risk characteristic, then risk of HIV acquisition is multiplicative. In addition, we used generalized estimation equations with autoregressive working correlation to accommodate the within-subject correlation from the longitudinal data structure. The autoregressive working correlation assumes the correlation between two repeated observations depends on their time difference; the smaller the correlation, the further apart the repeated measures. We used Wald tests to determine statistical significance.

Based on the above methods and assumptions, we used a four-step model to assess each partner's contribution to the risk of HIV acquisition for the index respondent. First, we examined unadjusted associations between individual characteristics (of the partner and the respondent) and HIV acquisition stratified by sex of the respondent. Second, we adjusted for the type of relationship with each partner (martial or non-marital). Likelihood ratio test was used to test potential interactive effects with the type of relationship. This adjustment allowed us to assess if the risk contribution was directly associated the risk factor itself or due to type of partnership. Third, we built separate multivariate models among respondent and partner related risk factors, using a forward model selection with Akaike Information Criterion (AIC). Specifically, we started with the most predictive bivariate model and added variables sequentially, to arrive at a set of variables that best predict the HIV incidence. Finally, to assess the independent influence of partner characteristics on HIV acquisition of youth respondents in Rakai, we expand the regression models to take into account both significant partner-related risk factors and characteristics of the respondents (e.g. age, school enrollment, alcohol use before sex) previously found to be associated with young men and young women's HIV acquisition in this study setting.[16]

Results

In total we had 2,884 male and 4,196 female youth respondents. Among them, 45 male HIV incident cases and 96 female incident cases were discovered in the four rounds of data collection. The median ages at report for female and male respondents were 22 and 21 years.

Respondent characteristics previously found to be significantly associated with HIV acquisition among Rakai youth [16] are summarized in Table 1. Most of the respondents were from rural areas. Sixty seven percent of young men had never been married, while 71% of young women were currently married. Ninety five percent of female youth reported only one sexual partner in past 12 months. Male youth respondents accounted for a higher number of partner characteristics in each survey round; 27% reported two partners, 9% reported three, and 5% reported 4 partners in the past 12 months. STD symptoms were not common (<15%) amongst all youth, but female youth were more likely to report genital ulcers. Finally, 41% of male respondents and 34% of female respondents reported alcohol use before sex.

Table 2 summarizes the partner characteristics as reported by male and female youth respondents. We stratify the partner characteristics by their relationship to the respondent. Specifically, among the 4,646 reported partner characteristics for male respondents, 91 % were non-martial partners (n=4,226) and 9 % were marital partners (n=420). In comparison, among the 4,416 reported partner characteristics for female respondents, 63 % were non-marital (n=2,782) and 37 % were marital partners (n=1,634).

Male respondents generally had partners who were younger, while most of the female respondents had partners who were older than them, regardless of the type of partnerhip. Except for a few, all the marital partners lived in households with male and female respondents (99 % and 99%, respectively). Fifty one percent of non-marital partners of female youth respondents lived in the same household, while only 13 % non-marital partners of male youth respondents shared the same household with the respondents (p-value<0.0001). Forty seven percent of non-marital partners of youth male respondents were students, while only 2% of marital partners were students (p-value <0.0001). Young women however, were much less likely to have non-marital partners who were still in school (7% vs. 47% for young men, p-value<0.0001). In part this difference between the partners of male and female youth is explained by the fact that most of young women were in sexual partnerships with men who were older to them.

Male youth respondents initiated sexual activity with their non-marital partners significantly faster than they did with their marital partners (p value <0.0001). With 37% of their non-marital partners, male respondents engaged in sexual activity within one month of knowing their partner. Comparable statistic for martial partners was only 17%. We did not find such differences between marital and non-marital partners for female respondents. Compared to male respondents, female respondents waited for significantly longer time before initiating sexual activity with their partners (p-value<0.0001). Our data also show that both young men and young women had sex more frequently with their marital partners than with their non-marital partners. Partners' alcohol use before sex was not very common among male respondents. Female respondents reported that 29% of their non-marital and 31% of their marital partners consumed alcohol before last sex. Condom use frequency was very low for young men and young women. Both young men and young women were more likely to use condom consistently with non-marital partners than marital partners (60 % vs. 7% for male respondents and 31% vs. 2% for female respondents).

More young women reported that their partners had other concurrent sexual partners. 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 gave significantly higher HIV risk to their non-marital partners (p-value <0.0001), while young women reported the HIV risk of their marital and non-martial partners as equal (p-value = 0.6471). Male respondents knew the HIV status of 49% of their non-marital partners and 32% of their martial partners. In

comparison, female respondents knew the HIV status of 56% their non-marital partners and marital partners. Martial partners were more likely to receive couple counseling with the respondents than non-martial partners.

Tables 3.1 and 3.2 present the Incidence Rate Ratios (IRR) for HIV acquisition among male and female respondents.

The first column presents the unadjusted likelihood of HIV acquisition among male and female respondents based on their own and specific partner characteristics. For young women in Rakai (Table 3.1), having a partner who was older in age (IRR: 2.59 [1.64-4.14]), lived outside the same household (IRR: 2.07 [1.59-2.69]), lived further away (IRR: 2.13 [1.47-3.08], was not a marital partner (IRR: 2.41 [1.81-3.20]), worked as truck driver (IRR: 2.63 [1.22-4.19]), drank alcohol before having sex (IRR: 1.97 [1.34-2.90]), had one additional sexual partner (IRR: 1.83 [1.20-2.69]), and was at least somewhat likely to be exposed to HIV (IRR: 2.69 [1.68-4.30]) increased their risk of HIV acquisition. Moreover, for young women respondents, receiving couple counseling with her partner was protective against HIV acquisition (IRR: 0.22 [0.05-0.91]).

For young men in Rakai (Table 3.2), living in a trading village, being separated or widowed, not being a student, having 2 or more partners, experiencing STD symptoms, and using alcohol before sex were associated with their HIV acquisition. Examining the partner characteristics for the male respondents showed that having a partner who was younger (IRR1: 1.54 [1.09-2.16]) or older (IRR1: 2.24 [1.60-3.12]) than the respondent, a partner who was not current wife (IRR: 1.70 [1.31-2.18]), a partner who had sex within 1 month of knowing the respondent (IRR: 1.57 [1.01-2.43]), a partner who had sex more than 48 times (once a week in average) in the past 12 months (IRR: 1.74 [1.08-2.67]), a partner who used condom inconsistently (IRR: 1.52 [1.13-2.04]), a partner who had more than two sexual partners (IRR: 2.10 [1.28-3.46]), and a partner who was not absolutely free from being suspected to be HIV infected (IRR: 1.59 [1.03-2.46]) increased the risk of HIV acquisition.

The second column in Tables 3.1 and 3.2 provides the relative risk for partner characteristics adjusted for the type of partnership (Adjusted IRR). For a female youth respondent in Rakai (Table 3.1) and independent of the type of partnership, partner's occupation as a truck driver (Adj. IRR: 1.97 [1.12-3.47]), a partner who had drunk alcohol before having sex (Adj. IRR: 1.71 [1.24-2.36]) and a partner who used condom inconsistently (Adj. IRR: 2.15 [1.49-3.11]) increased the risk of HIV acquisition. After the adjustment, for a male youth respondent in Rakai (Table 3.2), having a partner who was not a student (Adj. IRR: 1.59 [1.15, 2.18]), who had increased coital frequency (Adj. IRR: 1.50 [1.01, 2.21]), and whose HIV risk is un-assessable (Adj. IRR: 3.13 [1.19-8.20]) significantly contributed to their HIV acquisition.

The third column in Tables 3.1 and 3.2 presents the results of the multivariate analyses (models 1 and 2). Model 1 presents all the significant respondent risk factors for HIV acquisition through multivariate analysis. Model 2 presents factors associated with HIV acquisition among all the partner-related risk factors. After adjusting for all the potential partner-related risk factors, a non-martial partner (Model 2 IRR: 2.10 [1.54-2.86]), a partner who drinks alcohol before having sex (Model 2 IRR: 1.76 [1.24-2.50]) and inconsistent condom use (Model 2 IRR: 2.30 [1.53-3.46]) were the most significant factors for HIV acquisition among female youth respondents in Rakai (Table 3.1). For male youth respondents (Table 3.2), after considering all the potential partner-related risk factors, the following partner related factors remain significantly associated with the HIV acquisition: whether the partner is a non-student (Model 2 IRR: 1.50 [1.10 – 2.30]), and if the partner's HIV risk is unknown to the respondent (Model 2 IRR: 2.35[0.98, 5.64]).

Finally, the fourth column in Tables 3.1 and 3.2 presents the results of the mixed-model multivariate analyses (model 3) that assesses HIV acquisition based on significant partner-related risk factors and adjusting for respondent's own risk factors. For young women, whether their partners was non-marital (Model 3 IRR: 1.60 [1.11-2.32]), drank alcohol before sex (Model 3 IRR: 1.57 [1.11-2.21]), and used condom inconsistently (Model 3 IRR: 1.99 [1.33-2.98]) were significantly associated with the HIV acquisition (Table 3.1). Whereas, for young men, whether the partner was non-marital (Model 3 IRR: 1.54[1.20 – 1.98]) was the only partner related factor that remained significant and contributed to their HIV acquisition (Table 3.2).

These IRRs reflect the risk of HIV acquisition per partner. For instance, if a young woman has two non-marital partners her relative risk of HIV incidence is 1.60^2 or 2.56 compared to a young woman who only has marital partners. Thus, the respondents who have partners with multiple high-risk characteristics or multiple high-risk partners have exponentially increased risk of HIV acquisition.

Discussion

We found that partner characteristics independently influence HIV risk among youth. Young men aged 15-24 years, were more likely to have non-marital partners, compared to young women. For both young men and young women, after controlling for individual-level risk factors, engaging in sexual activity with non-marital partners increased their likelihood of HIV acquisition. Additionally, for women the behaviors of their male partners – alcohol use and inconsistent condom use – enhanced their risk of HIV. Risk of HIV acquisition increased exponentially if respondents had a partner with multiple high risk characteristics or multiple partners with one or more high risk characteristics.

We add to the literature by examining the HIV-risk contributions of marital and non-marital partner characteristics. Further, in our analysis we examined a wide range of partner risk characteristics – ranging from partner age, residence, occupation, to sexual behaviors and

substance abuse – to identify factors associated with HIV incidence. Young men and young women respondents showed considerable difference in reported marital and non-martial partnership characteristics. For young men, non-martial partner characteristics were characterized by greater age disparities, partner from outside the household, partner 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 partner characteristics, characteristics of note included living outside the household, higher coital frequency, greater partner concurrency, and limited knowledge of partner HIV status compared to marital partner characteristics.

Using longitudinal data, our study confirms previous research that partner characteristics are an important determinant of HIV risk, especially for female youth. Our study confirms previous findings that for women, their partner's use of alcohol before engaging in sexual activity enhanced their risk of HIV acquisition. Similarly, inconsistent condom use significantly predicted HIV acquisition when we controlled for the type of partnership for female youth. We also confirm previous work in Rakai that showed that partner age was not associated with HIV incidence. Among our sample, age discrepant relationships did not increase the likelihood of HIV acquisition when controlling for other partner-related factors. Previous analysis has also demonstrated that partners with multiple sexual partners increase likelihood of STIs among index respondents. We find instead that non-marital partnerships add substantial risk to both young men and young women in Rakai. Greater exploration of couple-dynamics within marital and non-martial partnerships is needed.

Limitations

In this analysis partner risk characteristics were reported by the respondents, and hence subject to errors and biases. Future research linking respondent information with marital and non-marital partners' information could help assess bias, and in turn achieve a more accurate estimation in associations. Two additional data limitations restricted our analyses – partner's age, and the index respondents' alcohol use. In our analysis were unable to calculate the exact age difference between partner. Previous research has shown that larger age differentials between partners heighten HIV risk. However, it was extremely difficult to capture reliable information on partner age from the index respondents. Second, previous analysis in Rakai shows that use of alcohol before sex is associated with HIV incidence among youth.[16] However, these measures were not consistently measured across survey rounds and could not be included in this analysis.

Implications

Partner attributes contribute substantially to HIV risk among youth in rural Uganda. HIV prevention programs targeting youth need to address risk from marital and non-marital partners. HIV prevention programs should emphasize knowledge of partners and characteristics of

partners that increase HIV risk, in addition to current emphasis on abstinence, condom use, partner reduction, and HIV testing and disclosure.

Table1: Summary respondent characteristics of sexually experienced male and female youth in Rakai, Uganda 2005-2011

Risk factors	Male	Female
Number of respondents	2884	4196
Number of person rounds (n)	5315	7391
Number of HIV incident cases	45	96
Age of respondent		
15-19	856 (30)	951 (23)
20-24	2028 (70)	3245 (77)
Total number of person rounds	2884	4196
Community		
Rural	2473 (86)	3501 (83)
Trading village	411 (14)	694 (17)
Total number of person rounds	2884	4195
Marital status		
Never married	1931 (67)	1049 (25)
Divorced/Widowed	74 (3)	153 (4)
Current married	878 (30)	2994 (71)
Total number of person rounds	2883	4196
Current student		
No	2411 (84)	3796 (90)
Yes	473 (16)	400 (10)
Total number of person rounds	2884	4196
Number of sex partners		
1	1687 (59)	3991 (95)
2	781 (27)	189 (5)
3+	416 (14)	16 (<1)
Total number of person rounds	2884	4196
Painful urination		
No	2636 (91)	3733 (89)
Yes	248 (9)	461 (11)
Total number of person rounds	2884	4194
Genital warts		
No	2852 (99)	4096 (98)
Yes	32 (1)	98 (2)
Total number of person rounds	2884	4194
Genital ulcer		
No	2608 (90)	3578 (85)
Yes	276 (10)	616 (15)
Total number of person rounds	2884	4194
Drinking alcohol[1]		
No	748 (59)	1369 (66)
Yes	519 (41)	703 (34)
Total number of person rounds	1267	2072

[1] The alcohol use variable 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	Index Male respondent			Index Female respondent		
	Type of Partnerships			Type of Partnerships		
	Non-marital (N%)	Marital (N%)	P-value	Non-marital (N%)	Marital (N%)	P-value
N (number of partner characteristics, row %)	4226 (91)	420 (9)		2782 (63)	1634 (37)	
Age 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)	
Relationship duration before 1st sexual activity with partner						
< 1 month	1580 (37)	71 (17)	<0.0001	303 (11)	190 (12)	0.7287
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)	

Table2 (continued): characteristics/

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

Table 3.1: Unadjusted and Adjusted risk of HIV acquisition (Incidence Rate Ratios for new HIV infection) among female respondents [2]

Risk factors	Categories	Likelihood of HIV acquisition			
		Unadjusted IRR (95% CI)		Multivariate model 1 IRR (95% CI)	Multivariate model 3 IRR (95% CI)
Characteristics of Respondents					
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	No (ref)	--		--	--
	Yes	1.49 (0.84-2.64)		--	--
Characteristics of Partner					
		Unadjusted IRR (95% CI)	Adjusted IRR (95% CI)	Multivariate model 2 IRR (95% CI)	
Age of partner	Same age (ref)	--	--	--	--
	Younger	1.69 (0.23-12.48)	0.61 (0.08-4.76)	--	--
	Older	2.59 (1.62-4.14)	1.08 (0.65-1.78)	--	--
Partner Residence	In same household	--	--	--	--
	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)	--	--	--	--
	>1 hour walk or 3 miles	2.13 (1.47-3.08)	1.32 (0.88-1.99)	--	--
Relationship with Partner	Married (ref)	--	NA	--	--
	Not married	2.41 (1.81-3.20)	NA	2.10 (1.54-2.86)	1.60 (1.11-2.32)
Partner works as a trucker	Non-trucker (ref)	--	--	--	--
	Trucker	2.63 (1.45-4.78)	1.97 (1.12-3.47)	--	--
Partner is currently a student	Student (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)	--	--	--	--
	Bar worker	1.81 (0.26-12.71)	1.56 (0.21-11.83)	--	--
Duration before 1st sexual activity with partner	> 2 month (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	--	--	--	--
	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)	--	--	--	--
	> 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)	--	--	--	--
	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)
Number of other sexual partners that the partner had in past year	0 (ref)	--	--	--	--
	1	1.83 (1.22-2.77)	1.36 (0.90-2.04)	--	--
	>1	1.35 (0.65-2.83)	0.98 (0.47-2.06)	--	--
Partner's HIV risk assessed by the index respondent	Not at all (ref)	--	--	--	--
	Low risk	1.80 (0.99-3.27)	0.81 (0.47-1.41)	--	--
	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)	--	--
Partner informed respondent of	Inform HIV status (ref)	--	--	--	--

[2] Note: Unadjusted IRR: associations between risk factors and HIV acquisition for respondent and partner characteristics;
Adjusted IRR: association between partner characteristics and HIV acquisition adjusted for the relationship with partners; Multivariate models 1 & 2: separate regressions of the influence respondent's own risk factors and of partner characteristics on HIV acquisition; Multivariate 3: final mixed model incorporating significant respondent and partners characteristics to predict HIV acquisition

HIV status	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)	--	--

Table 3.2: Unadjusted and Adjusted risk of HIV acquisition (Incidence Rate Ratios for new HIV infection) among male respondents [3]

Risk factors	Categories	Likelihood of HIV acquisition			
		Unadjusted relationships IRR (95% CI)		Multivariate model 1 IRR (95% CI)	Multivariate model 3 IRR (95% CI)
Characteristics of Respondents					
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)
Marital status	Never married (ref)	--		--	--
	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	No (ref)	--		--	--
	Yes	3.12 (1.09-8.91)		--	--
Characteristics of Partner					
		Unadjusted IRR (95% CI)	Adjusted IRR2 (95% CI)	Multivariate model 2 IRR (95% CI)	
Age of partner	Same age (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	--	--	--	--
	Out of household	1.39 (1.09-1.79)	0.47 (0.30-0.74)	--	--
Proximity of residence	≤1 hour walk or 3 miles (ref)	--	--	--	--
	>1 hour walk or 3 miles	1.35 (0.94-1.96)	0.91 (0.60-1.39)	--	--
Relationship with Partner	Married (ref)	--	NA	--	--
	Not married	1.70 (1.34-2.17)	NA	1.13 (0.62-2.05)	1.54 (1.20-1.98)
Partner is currently a student	student (ref)	--	--	--	--
	Non-student	1.88 (1.52-2.32)	1.59 (1.15-2.18)	1.59 (1.10-2.30)	--
Partner works as a bar worker	Non-bar-worker (ref)	--	--	--	--
	Bar worker	1.39 (0.49-3.96)	0.88 (0.26-3.03)	--	--
Duration before 1st sexual activity with partner	> 2 month (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	--	--	--	--
	Yes	1.32 (0.80-2.18)	1.00 (0.60-1.66)	--	--
Coital frequency with the partner in the past year	≤ 48 (ref)	--	--	--	--
	> 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)	--	--	--	--
	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)	--	--
Number of other sexual partners that the partner has in past year	0 (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)	--	--	--	--
	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)	

[3] Note: Unadjusted IRR: associations between risk factors and HIV acquisition for respondent and partner characteristics;
Adjusted IRR: association between partner characteristics and HIV acquisition adjusted for the relationship with partners; Multivariate models 1 & 2: separate regressions of the influence respondent's own risk factors and of partner characteristics on HIV acquisition; Multivariate mixed model 3: final mixed model incorporating significant respondent and partners characteristics to predict HIV acquisition

	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 respondent of HIV status	Inform HIV status (ref)	--	--	--	--
	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)	--	--

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