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# High Rates of Unprotected Sex occurring among HIV-Positive Individuals in a Daily Diary Study in South Africa: The Role of Alcohol Use

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**Title:** High Rates of Unprotected Sex occurring among HIV-Positive Individuals in a Daily Diary Study in South Africa: The Role of Alcohol Use

**Running Head:** Alcohol Use and Unprotected Sex

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Social Issues, and by the Clarence J. Rosecrans Research Scholarship from the American Psychological Foundation.

### Abstract

**Objective:** To assess the prevalence of unprotected sex and examine the association between alcohol consumption before sex and unprotected sex among HIV+ individuals in Cape Town, South Africa.

**Methods:** For 42-days daily phone interviews assessed daily sexual behaviour and alcohol consumption. Logistic and Poisson GEE models were used to examine associations between alcohol consumption before sex and subsequent unprotected sex.

**Results:** During the study which yielded 3,035 data points, the 58 HIV+ women and 24 HIV+ men drank an average of 6.13 drinks when they drank, and reported 4,927 sex events, of which 80.17% were unprotected. Over half (58%) of unprotected sex events were with HIV-negative or HIV-status-unknown partners. Extrapolating from the data using likelihood of infection per act estimates we calculated that an estimated 2.95 incident HIV-infections occurred during the study. Drinking alcohol before sex by the female, the male, or by both partners, increased the proportion and number of subsequent unprotected sex events. However, these associations held only when the quantity of alcohol consumed corresponded to moderate or higher risk drinking.

**Conclusions:** Among HIV-positives engaging in moderate or higher risk drinking prior to sex increases the likelihood and rate of unprotected sex. Prevention efforts need to address reducing alcohol-involved unprotected sex among HIV-positive persons.

**Keywords:** HIV seropositivity; alcohol drinking; prevention; condoms; sexual partners; prospective cohort study; South Africa

## Introduction

South Africa is currently facing one of the world's worst HIV-epidemics with nearly 5 million people or over 16% of the adult population being HIV-infected.<sup>1</sup> Understanding the factors that influence unprotected sex among HIV-positive individuals in South Africa is an important precursor to developing effective HIV-prevention interventions specifically designed to help HIV-positive individuals reduce sexual risk behavior and thus help stop the spread of HIV.<sup>2,3</sup>

It is commonly believed that alcohol contributes to the occurrence of unprotected sexual behavior. Qualitative and quantitative data from around the world support an association between alcohol consumption and unprotected sexual behavior among a wide variety of populations.<sup>4-10</sup> The majority of these studies have been conducted in the U.S. among presumed HIV-negative populations. However, there is a growing literature on the association between alcohol use before sex and unprotected sexual behavior in Africa, as well as between alcohol use before sex and risk of HIV-acquisition.<sup>11,12</sup> However, few have studied the role of drinking before sex in unprotected sexual behavior among HIV-positive populations in Africa.<sup>6,13,14</sup>

Worldwide, the association between alcohol and unprotected sex has been studied using different methodologies which answer different questions regarding the nature of the ostensible relationship between alcohol consumption and unprotected sex. Two types of descriptive cross-sectional studies are commonly employed; those which correlate global self-reports of overall frequency of alcohol consumption or the situational frequency of drinking prior to sexual intercourse with self-reported frequency of unprotected sex. These types of studies answer questions such as: "Do individuals who drink more frequently also engage in unprotected sex more frequently?" and "Do individuals who frequently drink before they have sex have more

unprotected sex?” These cross-sectional methodologies do not permit the researcher to determine if drinking before sex increases the likelihood of unprotected sex or if an individual drinks equally frequently prior to protected and unprotected sex acts.

Often the question of greatest interest regarding the relationship between alcohol and unprotected sex is: “Does drinking alcohol before sexual intercourse make people more likely to have unprotected sex?” This question implies a causal relationship between consuming alcohol before sex and subsequent unprotected sex. Although it is not ethical to conduct a controlled experimental study of the causal effects of alcohol consumption on sexual behavior, a viable alternative is to employ a prospective cohort study using daily diary methods to collect event-level data that temporally sequences discrete instances of alcohol consumption as occurring before discrete events of unprotected sex.<sup>15</sup> However, there have been no such studies among HIV-positive individuals in Africa. The present prospective cohort study collected event-level data using daily diary methods among a sample of HIV-positive individuals in South Africa to document the levels of unprotected sexual behavior in this population and test the hypothesis that consuming alcohol before sex increases the likelihood and number of subsequent unprotected sex acts.

## Methods

### *Participants and Procedure*

Eighty-two HIV-positive individuals (58 female, 24 male) participated in an intensive longitudinal (42-day) structured daily phone interview which yielded a possible 3,396 data points (one wave of data collection with 12 participants was shortened to 38-days in duration due to overlap with religious holidays). Using purposeful sampling we recruited participants from five HIV service organizations in Cape Town, South Africa between May and November 2006.

Eligibility required being (a) >18 years of age, (b) HIV+, (c) having vaginal or anal sex, (d) consuming alcohol in the prior 30-days, and (e) having access to a phone where they could receive calls every afternoon. Only one member of a couple was allowed to participate. Of those screened, five did not meet the eligibility criteria (4 for sexual inactivity, and 1 for no alcohol in prior 30-days). Two eligible individuals declined participation. The study was approved by institutional review boards in the U.S. and in South Africa.

Interviewers called participants each day between 1pm and 6pm and conducted a structured interview in Xhosa. Participants were compensated with up to 660 Rand (about \$95 USD, including transportation reimbursement), the amount of which depended upon the number of interview days completed.

Based upon our pilot work with this population and a conservative estimate of the magnitude of effects, we estimated the effect size for a difference between when alcohol is and is not consumed before sex as Cohen  $d = 0.3$  for the proportion of sex events that would be unprotected and the number of unprotected sex events that occurred each day. With this expected difference in these two outcomes, an  $\alpha$ -level of 0.05, a sample size of 80 participants and 3,500 unprotected sexual events would provide 0.80 power to detect a difference in our two outcomes that is attributable to alcohol consumption.

### *Measures*

Each day participants reported on their drinking and sexual behavior for *last night* (after yesterday's interview, approximately 5 pm yesterday until going to sleep) and for *today* (since waking up until now). For these two time periods participants reported: (a) how many drinks (drink sizes standardized to equate alcohol content across types of alcoholic drinks, 1 drink = 12g of alcohol) they consumed, (b) how many times they had vaginal and anal sex, (c) how many times a

condom was used during each type of sex, (d) the perceived HIV-serostatus of their partner (positive, negative, unknown), (e) the type of partner (main/steady, secondary/casual), (f) if the alcohol consumption occurred before/during or after the sexual event(s), and (g) if their partner consumed alcohol before the sexual event (yes, no). The measures were adapted from measures verified to be valid in South Africa and in daily diary studies.<sup>14, 16-18</sup> Oral sex was not assessed due to the low frequency of this behavior among HIV-positive samples in South Africa.<sup>14</sup> The number of unprotected sex events during each time period (daytime and evening) was calculated by taking the sum of the number of vaginal and anal sex events minus the sum of the number of times a condom was used during vaginal and anal sex. The proportion of sex events that were unprotected during each time period was also calculated.

#### *Data Analysis Approach*

Generalized estimating equation (GEE) analyses using SPSS 15.0 software<sup>19</sup> were conducted to examine the event-level association between alcohol consumption prior to sex and unprotected sex. Also of interest were the effects of the time-varying event-level variable of partner type (main/steady, casual/secondary) and its interaction with alcohol consumption prior to sex. Time-invariant sociodemographic variables of age, education (primary or less vs. high school or more), marital status (unmarried vs. married), socioeconomic status (self-rated on a 4-point continuum ranging from: *I do not have enough money to buy food to I have most of the important things, but not enough money to pay for things like my children's education*),<sup>1</sup> months known HIV-positive, disclosed HIV-status to current partner(s) (yes vs. no), HIV-stigma,<sup>20, 21</sup> STI in prior 6-months (yes vs. no), and currently taking ARVs (yes vs. no), time-varying event-level variables of partner's perceived HIV-serostatus (positive, negative, or unknown) and day in study (1 through 42) were also included in each model. Gender was included as a potential

moderator of each event-level association. Alcohol before sex was operationalized as a predictor of unprotected sex both as a categorical time-varying variable representing 4 categories: neither partner, only the female partner, only the male partner, or both partners drank any before sex, and as a categorical time-varying variable representing the risk level of the alcohol consumption based on the amount of alcohol the individual consumed prior to sex. We adopted WHO categories for level of risk from specific quantities of alcohol (five categories ranging from no risk to very high risk) with gender adjusted correspondence between alcohol quantity and risk level (see Table 3 for definitions of risk levels).<sup>22</sup>

In our event-level models the outcome of unprotected sex events can be represented as a proportion and as a count of events that occurred each evening. GEE models, using robust standard errors, which account for clustering due to repeated measurement of participants over time, were used for all analyses. These models also account for differences in the number of data points between participants by weighing data from participants with more data points more heavily. To examine predictors of the log odds of unprotected sex given the total number of sex acts that occurred per evening over time we used logistic GEE models with a binomial distribution and logit link, which provide odds ratios (OR). To examine predictors of the number of unprotected sex acts that occurred per day over time we used GEE models with a Poisson distribution and log link, which provide a ratio of the estimated mean number of unprotected sex acts compared to overall mean number of unprotected sex acts.

Both unadjusted and adjusted (including all variables) models were estimated. Results did not differ between these models and therefore we report only the adjusted models. In Tables 2 and 3 using the model-generated coefficients for each factor included in the model and plugging these into the model regression equation, we calculated the adjusted estimated proportion and

number of unprotected sex acts based upon the levels of the factor of interest controlling for all other factors in the model. Sociodemographic and situational time-varying variables were retained in the final models if they were statistically significant ( $p < .05$ ). Our results focus on the data from drinking and sexual behavior that occurred during the evening, because results from the evening and daytime data were nearly identical.

### Results

All participants were of Xhosa ethnicity, average age was 32.23 (SD 7.20, range 21-55), 46.7% had completed primary school or less and 53.4% had completed high school, 32% were married or in the process of getting married, 22.7% were living with a partner but were not married, 25.3% were single, and 20% were widowed. Nearly half (43.8%) reported not having enough money for food. On average participants had known they were HIV-positive for 36.45 months (SD 30.81, range 1-144), 41.3% reported having an STI in the last 6-months. Over half (59.2%) were eligible for and were currently taking antiretrovirals (ARVs) indicating that at ARV initiation their CD4<sup>+</sup> count was  $<200/\text{mm}^3$ .<sup>3,23</sup>

Of the possible 3,396 data points during the study, participants completed 89.37% of the possible days yielding 3,035 data points. The mean number of days completed was 37.04 (SD 7.56, range 8-42).

### *Descriptive Statistics*

There were 4,848 vaginal and 79 anal sex events reported, 80.36% of which occurred during evening hours. Of the total events, 3,904 vaginal and 46 anal events were unprotected. On evenings when participants had sex they reported an average of 2.30 sex events (SD 1.23, range 1-11) and 2.01 unprotected sex events (SD 1.10, range 1-11). On evenings when participants drank

alcohol women drank an average of 5.91 drinks (70.92g of alcohol), SD 3.59 and men drank an average of 6.74 drinks (80.88g of alcohol), SD 3.99, (range 1-11 for both men and women).

Overall, 80.1% of sexual events when the participant did not drink alcohol before sex were unprotected compared to 83.0% when the participant drank alcohol. In Table 1, we present the total number of protected and unprotected sex events over the duration of the study by partner type and partner HIV-serostatus and the proportion of sex events that were unprotected when the participant did not and did consume alcohol before sex. From this aggregated data, which does not control for within-subject correlation resulting from repeated observations over time, for women a greater proportion of the total sex acts were unprotected when alcohol was consumed before sex (0.82), than when it was not (0.79),  $\chi^2$  3.95,  $p=.05$ . We also saw that among men and women respectively, for sex events with casual partners, a greater proportion of the total sex acts were unprotected when alcohol was consumed before sex (0.86; 0.77) than when it was not (0.73; 0.71),  $\chi^2$  8.76  $p=.01$ ;  $\chi^2$  6.18  $p=.01$ . When women drank before sex a greater proportion of sex acts with HIV-status unknown partners were unprotected than when they did not drink before sex (0.60 vs. 0.79),  $\chi^2$  29.85  $p<.001$ . No other statistically significant differences were observed in the aggregated data.

#### *Effects of Time-Invariant and Time-varying factors*

No gender differences were observed in the proportion or number of unprotected sex acts that occurred per day. The proportion and number of unprotected sex acts per day, or the number of drinks consumed per day did not decrease over time in response to completing the daily interview for 42-days.

As presented in Table 2, individuals who had completed high school engaged in more unprotected sex events per day over time than did individuals who had less education (adj ratio

of means 1.25, CI 1.09-1.43). Age, marital status, socioeconomic status, length of time knowing HIV-positive status, disclosure, HIV stigma, STI history, or currently taking ARVs did not predict the proportion or of the number of unprotected sex acts that occurred per day over time. Regarding time-varying variables, when the sex event was with a main/steady partner it was more likely to be unprotected compared to sex events with a casual/secondary partner (adjOR 1.46, CI 1.08-1.96). Compared to HIV-positive partners, sex was less likely to be unprotected if it was with a partner of unknown HIV-serostatus (adjOR 0.70, CI .53-.93).

#### *Alcohol before Sex—Unprotected Sex Association*

Controlling for all other factors, consumption of one or more drinks of alcohol before sex by only the female partner, only the male partner, or both partners increased the proportion of sex events that were unprotected per day and also increased the number of unprotected sex events that occurred per day (see Table 2). The proportion and number of sex acts that were unprotected was largest when only the male partner drank before sex (adjOR 3.81, CI 1.08-9.38; adj ratio of means 1.52, CI 1.27-1.82), followed by when both partners drank before sex (adjOR 3.04, CI 1.59-5.81; adj ratio of means 1.43, CI 1.19-1.72). However, the effect of drinking prior to sex varied based upon partner type. As illustrated in Figure 1, for women when they had sex with both casual and steady partners when only their male partner drank before sex the sex event was more likely to be unprotected than when only they themselves drank before sex or when neither partner drank before sex. In addition, when women had sex with casual/secondary partners unprotected sex was most likely to occur when both they and their partner drank. The same pattern of results was found for men (see Figure 1), suggesting that for both men and women, partner drinking before sex influences the likelihood that sex will be unprotected more

than does their own drinking. Furthermore, when having sex with casual partners the likelihood of sex being unprotected is even greater when both partners drank before sex.

#### *Effect of the Amount of Alcohol Consumed*

Controlling for all other factors, the amount of alcohol, corresponding to a gender adjusted risk level, consumed before sex affected the proportion and the number of unprotected sex events that occurred. As shown in Table 3, compared to not drinking before sex, low risk drinking did not increase the proportion or number of subsequent sex acts that were unprotected. For moderate risk drinking and above (men >40g, women >20g of alcohol) consuming an increasing number of drinks before sex led to incremental increases in the proportion and number of sex acts that were unprotected, however, the trajectory varied based upon partner type. As illustrated in Figure 2, the effect of the number of drinks on the likelihood of unprotected sex was stronger when sex was with casual/secondary partners than when it was with main/steady partners. These findings suggest that the effect of alcohol before sex on unprotected sex may be limited to instances in which moderate or higher risk drinking occurs.

#### Discussion

Unprotected sex with HIV-negative, HIV-status unknown, and HIV-positive partners was reported with high frequency in our sample of HIV-positive individuals in Cape Town, South Africa. Over 42-days the 82 HIV-positive participants in our study engaged in nearly 4,000 unprotected sex acts, over half of which were with 87 partners who were perceived to be HIV-negative and 110 HIV-status unknown partners resulting in possible incident HIV-infections as discussed below. All but two of the participants reported sex with HIV-negative or HIV-status unknown partners and all but one participant reported sex with both regular/steady and casual/secondary partners. Our findings of high levels of unprotected sex among HIV-positive

individuals are consistent with those reported in two recent studies which were carried out in the same city.<sup>24, 25</sup>

Using the present data we calculated an estimate of how many incident HIV-infections may have occurred during our 42 day study. Taking the number of unprotected sex acts that occurred with each of the 87 HIV-negative and 113 HIV-status unknown partners (assuming that, based on South Africa's HIV prevalence rate of 16%,<sup>1</sup> 84% of unknown-status partners were HIV-negative) of study participants and multiplying the number of sex acts with each partner thought to be HIV-negative by the average 0.0012 per act probability of HIV-infection estimate from the Rakai, Uganda data<sup>26, 27</sup> we estimated that 2.95 incident HIV-infections occurred among partners of study participants during the 42-day study. We also ran this calculation by including only the unprotected sex acts that involved alcohol and we calculated that 0.98 of the 2.95 estimated incident HIV-infections were attributable to alcohol consumption before sex. Assuming the same rate of unprotected sex with a participant's current partners over time we calculated that these estimates correspond to an incidence rate of 30.34 per 100 person-years with 10.11 attributable to drinking prior to sex.

Alcohol was frequently consumed before sexual events and consumed in large quantities; an average of more than five drinks per sitting for both men and women, which meets the WHO definition of high risk drinking for men and very high risk drinking for women.<sup>22</sup> Our analyses for the effect of the number of drinks consumed revealed that an individual's drinking affected behavior only in instances where at least moderate risk (>3 drinks for men, >1.8 drinks for women) drinking behavior occurred. Our findings regarding a general positive association between alcohol consumption before sex and sexual risk behavior are contrary to one study<sup>13</sup> but consistent with two other studies in Africa,<sup>11, 12</sup> and elsewhere.<sup>7, 8, 28-30</sup> Notably our study is the

first to examine the association at an event-level over time in an HIV-positive population in Africa. Using daily diary methods reduced recall bias and afforded us greater confidence in ruling out alternative explanations for the effect of drinking before sex on increasing the likelihood and amount of subsequent unprotected sexual behavior.

Finding that engaging in moderate risk drinking before discrete sex events almost doubled the likelihood that those sex events were unprotected compared to instances in which drinking did not occur before sex allows us to rule out the competing explanation for an association between alcohol and unprotected sex—that individuals drink equally frequently before protected and unprotected sex. Interestingly, when the data were aggregated (Table 1) and clustering due to repeated measurement of subjects over time was not accounted for, only a slightly greater proportion of sex events were unprotected when preceded by alcohol use than when not. However, this aggregated data does not permit a comparison between sexual events that did and did not involve alcohol within-individuals, nor does it permit us to rule out a competing hypothesis that the effect of drinking before sex on increasing the likelihood of unprotected sex is actually caused by individual differences such as personality characteristics.

The daily diary methodology also allowed us to examine the effect of situational variables including partner type and partner drinking before sex at the event-level over time. Drinking before sex by either partner increased the proportion and number of unprotected sex events, except for with steady partners among men when only the individual himself drank before sex. In all cases, except for women in sex events with main/steady partners, compared to when only the individual drank before sex, if both partners drank this further slightly increased the likelihood (Figure 1) and number of unprotected sex events. In a recent review of the literature on the alcohol—unprotected sex association in sub-Saharan Africa, Kalichman et al.

concluded that women's unprotected sexual behavior is often the result of their partner's drinking.<sup>11</sup> In contrast, our data suggest that women's unprotected sexual behavior can be attributed to their own as well as their partner's drinking. Furthermore, women and men consumed alcohol before sex at similar rates. Consistent with prior event-level research,<sup>7, 18, 31</sup> we found that drinking before sex influenced subsequent sexual behavior with casual/secondary partners more than it did with main/steady partners.

### *Limitations*

Gender-related power differentials in sexual behavior decision making, especially in the context of alcohol consumption, are believed to be an important factor in understanding unprotected sexual behavior in South Africa.<sup>32-34</sup> Our null findings regarding gender differences may be due in part to a lack of power to detect gender differences because the sample was composed of more women than men. While every effort was made to recruit equal numbers of men and women into the study it is more difficult to recruit HIV-positive men for participation in research studies due to the fact that fewer men than women generally attend HIV services in South Africa. This is because women frequently receive voluntary HIV-testing as part of antenatal care and thus more women than men are aware of their HIV-positive status.

A limitation of the present study is that the sample consisted of individuals who were seeking HIV services. Therefore, it is unknown to what extent the findings would generalize to HIV-positive individuals who have not sought treatment and care services and may experience greater fear of being stigmatized. Our sample consisted of HIV-positive individuals in an urban area who were both sexually active and had recently consumed alcohol. This limits the generalizability of our findings beyond HIV-positive individuals with these characteristics. However, a recent study that sampled over 1,000 HIV-positive individuals in Cape Town found

that for the prior 3 months 90% of men and 81% of women reported having sex and 64% of men and 43% of women reported consuming alcohol.<sup>24</sup> This suggests that our findings are generalizable to a significant proportion of HIV-positive individuals in urban areas of South Africa.

As with all studies with multiple assessment points, participant burden and reactivity are a possible limitation. Analyses for the effect of time indicated that the participants did not change their sexual or alcohol use behavior during the study which suggests that measurement reactivity was not a problem. The accuracy of self-reports of sensitive behaviors such as sexual behaviors is still to some extent unknown but methodologies such as those used in the present study increase the likelihood of veridical responses.<sup>35-37</sup> Finally, while our methodology allowed us to rule out competing explanations for our findings such as that individuals who drink alcohol may be more likely to have unprotected sex and that those who have unprotected sex may be more likely to drink alcohol, explain the observed effects, we cannot infer causality per se since it was a descriptive not a randomized study.

### *Conclusion*

Despite these limitations, the present prospective cohort study using daily diary methods provided the first evidence that at the event-level engaging in moderate or higher risk drinking before sex increases the likelihood and rate of unprotected sex among HIV-positive individuals in South Africa. As the first study we are aware of in South Africa to collect daily diary data and to do so using phone interviews, we demonstrated that this data collection method is both a feasible and valuable methodology for studying unprotected sexual behavior among HIV-positive individuals in Africa.

Most surprising were the sheer numbers of unprotected sex events that occurred during the brief course of this study and especially the large percentage of these events that were with presumed HIV-negative and HIV-serostatus unknown partners which likely led to incident HIV infections. From a public health perspective, these data indicate a critical need for the rapid and widespread implementation of HIV-prevention efforts for HIV-positive individuals that consider the role of alcohol use in precipitating unprotected sexual behavior. Such interventions could help individuals who are living with HIV reduce their unprotected sexual behavior to protect their own health and to avoid transmitting the virus to others. Speaking to the importance of reducing alcohol-involved unprotected sex, extrapolating further from our calculations of incident HIV-infections attributable to alcohol consumption among our sample, our data suggest that an intervention that reduced alcohol-involved unprotected sex by 50% among urban HIV-positive individuals in South Africa who drink alcohol would result in five less incident infections per 100 person years. Such prevention efforts would help avoid a ballooning of the already devastating HIV-epidemic in South Africa.

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## Figure Legends

**Figure 2.** Note: Risk level defined by WHO: no risk=0 drinks, Men: low risk=1-2 drinks (1-40g alcohol), moderate risk=3-5 drinks (41-60g alcohol), high risk=6-10 drinks (61-100g alcohol), very high risk=more than 10 drinks (>101g alcohol); Women: low risk=1-1.7 drinks (1-20g alcohol), moderate risk=1.8-3.3 drinks (21-40g alcohol), high risk=3.4-5 drinks (41-60g alcohol), very high risk=more than 5 drinks (>61g alcohol).<sup>20</sup>

**Table 1. Aggregated number of unprotected sexual events and proportion involving alcohol across individuals and time**

	Men					$\chi^2$	$P$	Women					$\chi^2$	$P$
	n	Number of protected sex events	Number of unprotected sex events	Prop. unprotected no alcohol <sup>a</sup>	Prop. unprotected alcohol <sup>b</sup>			n	Number of protected sex events	Number of unprotected sex events	Prop. unprotected no alcohol <sup>a</sup>	Prop. unprotected alcohol <sup>b</sup>		
Overall	24	237	1062	0.82	0.84	$\chi^2=0.62$		58	740	2888	0.79	0.82	$\chi^2=3.95$	
						$P=0.43$								$P=0.05$
Partner Type														
Steady	24	120	694	0.83	0.86	$\chi^2=0.97$		58	380	1873	0.81	0.83	$\chi^2=1.14$	
						$P=0.32$							$P=0.29$	
Casual	24	117	368	0.73	0.86	$\chi^2=8.76$		57	360	1015	0.71	0.77	$\chi^2=6.18$	
						$P=0.003$							$P=0.01$	
Partner HIV serostatus														
HIV+	24	67	363	0.85	0.86	$\chi^2=0.02$		58	230	1049	0.83	0.82	$\chi^2=0.12$	
						$P=0.90$							$P=0.73$	
HIV-	15	106	522	0.83	0.84	$\chi^2=0.04$		38	220	1117	0.84	0.84	$\chi^2=0.01$	
						$P=0.85$							$P=0.93$	
unknown	17	64	177	0.73	0.75	$\chi^2=0.02$		49	290	722	0.60	0.79	$\chi^2=29.85$	
						$P=0.90$							$P<0.001$	

Note: These aggregate analyses do not account for clustering due to repeated measurement of subjects over time.

<sup>a</sup>Proportion of times that sex was unprotected when sex was not preceded by alcohol consumption not controlling for repeated observations from individuals over time.

<sup>b</sup>Proportion of times that sex was unprotected when sex was preceded by alcohol consumption not controlling for repeated observations of subjects over time.

**Table 2. Time-invariant and time-varying variables predicting the proportion and number of unprotected sex acts per person per day over time.**

	% of sample by gender		Proportion of sex acts unprotected model			Number of unprotected sex acts model		
			OR (95% CI)	Adj estim. prop. of unprotected sex acts <sup>a</sup>		Ratio of Means <sup>b</sup> (95% CI)	Adj estim. no. of unprotected sex acts per person per day <sup>c</sup>	
				Men	Women		Men	Women
Time-invariant factors	Men n = 24	Women n = 58						
Education								
Primary or <	48.1%	41.2%	1	0.77	0.73	1	1.49	1.45
High school or >	51.9%	58.8%	1.36 (.97-1.90)	0.81	0.77	1.25 (1.09-1.43)	1.86	1.82
Time-varying factors								
	% of data points by gender							
Time-varying factors	Men n = 798	Women n = 2,237						
Partner Type								
Casual/Secondary	38.2%	36.6%	1	0.76	0.71	1	1.74	1.71
Main/Steady	61.8%	63.4%	1.46 (1.08-1.96)	0.82	0.78	.97 (.70-1.17)	1.73	1.65

**Table 2 continued.**

	% of data points by gender		Proportion of sex acts unprotected model			Number of unprotected sex acts model		
			OR (95% CI)	Adj estim. prop. of unprotected sex acts <sup>a</sup>		Ratio of Means <sup>b</sup> (95% CI)	Adj estim. no. of unprotected sex acts per person per day <sup>c</sup>	
				Men	Women		Men	Women
Time-varying factors	Men n = 798	Women n = 2,237						
Partner's HIV-serostatus								
Positive	33.5%	36.6%	1	0.77	0.73	1	1.73	1.68
Negative	46.4%	35.8%	1.08 (.82-1.43)	0.77	0.72	0.94 (.85-1.07)	1.62	1.58
Unknown	20.1%	27.5%	.70 (.53-.93)	0.77	0.52	.96 (.87-1.01)	1.65	1.61
Alcohol before sexual event								
Neither partner	17.9%	19.7%	1	0.77	0.73	1	1.56	1.50
Only Female partner	6.7%	29.6%	2.92 (1.55-5.52)	0.88	0.85	1.26 (1.04-1.53)	1.92	1.84
Only Male partner	32.0%	9.5%	3.81 (1.08-9.38)	0.91	0.88	1.52 (1.27-1.82)	1.78	1.71
Both partners	43.4%	41.3%	3.04 (1.59-5.81)	0.89	0.86	1.43 (1.19-1.72)	1.84	1.76

AdjOR. Adjusted odds ratios; CI, confidence interval

<sup>a</sup> Proportion of sex acts that were unprotected per day over time calculated from model estimates accounting for other variables in the model

<sup>b</sup> Adjusted ratio of means comparing estimated mean number of unprotected sex acts by levels of the factor compared to overall mean number of unprotected sex acts.

<sup>c</sup> Number of unprotected per day over time calculated from model estimates accounting for other variables in the model.

**Table 3. Effect of the number of drinks consumed before sex on the proportion and number of subsequent unprotected sex acts per person per day over time**

	% of data points		Proportion of sex acts unprotected model			Number of unprotected sex acts model		
	Men n = 798	Women n = 2,237	OR (95% CI)	Adj estim. prop. of unprotected sex acts <sup>b</sup>		Ratio of Means <sup>c</sup> (95% CI)	Adj estim. no. of unprotected sex acts per person per day <sup>d</sup>	
				Men	Women		Men	Women
Risky alcohol use before sexual event <sup>a</sup>								
no risk	24.8%	28.5%	1	0.81	0.79	1	1.57	1.50
low risk	7.1%	9.7%	1.39 (.93-2.08)	0.84	0.83	1.02 (.92-1.13)	1.60	1.53
moderate risk	27.3%	18.5%	1.91 (1.22-2.96)	0.87	0.87	1.10 (1.01-1.19)	1.74	1.66
high risk	29.4%	18.3%	1.78 (1.18-2.70)	0.89	0.87	1.14 (1.05-1.24)	1.82	1.74
very high risk	11.4%	25.0%	1.65 (1.14-2.41)	0.88	0.86	1.21 (1.10-1.33)	1.97	1.84

AdjOR. Adjusted odds ratios; CI, confidence interval

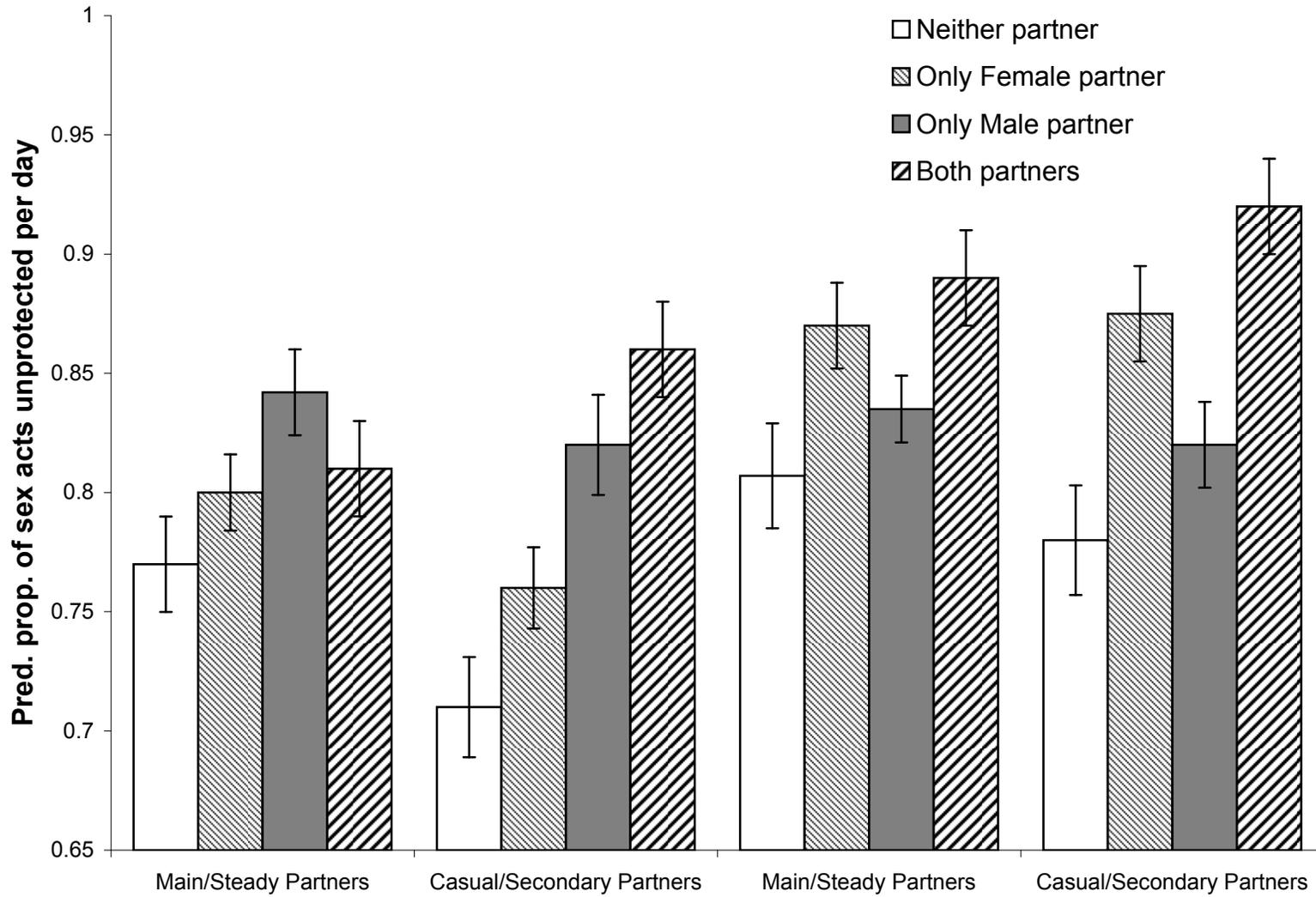
<sup>a</sup> Risk level defined by WHO: no risk=0 drinks, Men: low risk=1-2 drinks (1-40g alcohol), moderate risk=3-5 drinks (41-60g alcohol), high risk=6-10 drinks (61-100g alcohol), very high risk=more than 10 drinks (>101g alcohol); Women: low risk = 1-1.7 drinks (1-20g alcohol), moderate risk=1.8-3.3 drinks (21-40g alcohol), high risk=3.4-5 drinks (41-60g alcohol), very high risk=more than 5 drinks (>61g alcohol).<sup>20</sup>

<sup>b</sup> Proportion of sex acts that were unprotected per day over time calculated from model estimates controlling for gender, education, partner type, and partner HIV-serostatus.

<sup>c</sup> Adjusted ratio of means comparing estimated mean number of unprotected sex acts by levels of the factor compared to overall mean number of unprotected sex acts.

<sup>d</sup> Number of unprotected per day over time calculated from model estimates controlling for gender, education, partner type, and partner HIV-serostatus.

Figure 1. Effect of drinking prior to sex on the proportion of unprotected sex acts by gender and partner type



**Figure 2. Effect of alcohol consumption risk level corresponding to the amount of alcohol consumed before sex on the proportion of unprotected sex acts by partner type**

