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Alcohol use and associations with biological markers and self-reported indicators of unprotected sex in HIV-positive female sex workers in Mombasa, Kenya

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Abstract

Background—Studies of alcohol use and sexual behavior in African populations have primarily been cross-sectional, used non-validated measures of alcohol use, or relied on self-reported sexual risk endpoints. Few have focused on HIV-positive women.

Methods—Longitudinal data were collected from a cohort of HIV-positive Kenyan female sex workers. At enrollment and annual visits, participants were asked about past-year alcohol use using the Alcohol Use Disorders Identification Test (AUDIT). The primary endpoint was detection of prostate-specific antigen (PSA) in vaginal secretions at quarterly examinations. Associations between hazardous/harmful alcohol use (AUDIT score ≥ 7), PSA detection, and secondary

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measures of sexual risk were evaluated using generalized estimating equations with a log binomial regression model.

Results—A total of 405 women contributed 2,750 vaginal samples over 606 person-years of follow-up. Hazardous/harmful alcohol use was reported at 16.6% of AUDIT assessments, and was associated with higher risk of PSA detection (relative risk [RR] 1.50; 95% confidence interval [CI] 1.11–2.01) relative to no alcohol use. This association was attenuated, and no longer statistically significant, after adjusting for age, work venue, intimate partner violence, depression, and partnership status (adjusted RR [aRR] 1.13; 95% CI 0.82–1.56). In exploratory analyses, alcohol use was associated with self-report of unprotected sex and with STI acquisition.

Conclusions—Although hazardous/harmful alcohol use was not associated with detection of PSA in adjusted analysis, associations with secondary outcomes suggest that alcohol use is at least a marker of sexual risk behavior.

SUMMARY

In HIV-positive Kenyan female sex workers, alcohol use was associated with self-reported unprotected sex and STI acquisition, but not with increased risk of prostate-specific antigen detection in vaginal secretions.

Keywords

Alcohol; unprotected sex; HIV transmission; female sex workers; Africa

INTRODUCTION

Excessive drinking, which encompasses hazardous, harmful, and dependent alcohol use, has been observed at high prevalence among people living with HIV in sub-Saharan Africa.^{1,2} In addition to adverse health effects, alcohol use in this population could facilitate secondary HIV transmission if it increases engagement in unprotected sex. Research in African populations has reported associations between alcohol use and having more sex partners, unprotected sex, and sexually transmitted infections (STIs).³ However, evidence for an association between alcohol use and unprotected sex is limited among African women, who comprise 58% of people living with HIV in the region.⁴ Analyses focused on women have generally been cross-sectional,^{5–8} and most have used inconsistent and primarily self-reported sexual risk endpoints^{5,7,8} or non-validated measures of alcohol use.⁶ Few have examined associations separately in HIV-positive women.^{5,7,8}

Among women, excessive drinking is associated with transactional sex,³ in which context alcohol may serve as a means to cope with stress or facilitate interactions with clients.⁹ Although not all women who engage in transactional sex identify as sex workers, the prevalence of HIV among African women who exchange sex for money is estimated at 36.9%.¹⁰ Consequently, the potential impact of alcohol use on secondary HIV transmission in this population is especially high.

To address these gaps in the literature, this analysis was conducted using data from a longitudinal study of HIV-positive female sex workers (FSWs) in Mombasa, Kenya. Alcohol

use was measured with the Alcohol Use Disorders Identification Test (AUDIT),^{11,12} and unprotected sex was measured as detection of prostate-specific antigen (PSA) in vaginal swabs, as well as by self-report and sexually transmitted infection (STI) diagnosis. With prospective data on these robust indicators, we tested the hypothesis that HIV-positive FSWs would be more likely to engage in unprotected sex during periods of hazardous or harmful alcohol use.

MATERIALS AND METHODS

Study Design, Setting, and Procedures

Data were collected from HIV-positive FSWs participating in a cohort study that examined the influence of key reproductive life course events on HIV transmission risk (the Lifecourse Study). Enrollment began in October of 2012. Participants were recruited from the Mombasa Cohort, a long-term study of FSWs established in 1993.¹³ Women were eligible for participation in the Lifecourse Study if they were aged 16 years or older, HIV-positive, anticipated remaining in Mombasa for at least 2 years, and reported exchanging sex for cash, goods, or services at the time of screening into the Mombasa Cohort. Ethical approval was obtained from the Kenyatta National Hospital Ethics and Research Committee and the University of Washington Human Subjects Research Committee.

After providing written informed consent, participants completed a standardized face-to-face interview and received a physical examination. Follow-up visits were scheduled every 28 days, and women were compensated 250 Kenyan shillings (valued at approximately 2.45 USD) at enrollment and follow-up visits.

Measures

For the primary analysis, unprotected sex was measured through detection of PSA in vaginal swabs. Specimens were collected from the posterior fornix at enrollment and quarterly visits, and analyzed using ABACard p30 (Abacus Diagnostics, West Hills, CA). A positive test provides evidence of exposure to semen in the past 48 hours,¹⁴ with a test positivity threshold of >1 ng PSA/mL.¹⁵ Four self-reported secondary outcomes regarding behavior in the past week were evaluated at enrollment and monthly follow-up visits: (1) unprotected vaginal sex, (2) sexual abstinence, (3) three or more sex partners, and (4) three or more vaginal sex acts. The latter two outcomes were restricted to visits where women were sexually active in the preceding week. The cut-offs of 3 or more partners and 3 or more sex acts were selected to identify visits where women had higher than the median values reported at enrollment. A fifth secondary outcome was diagnosis of an STI at quarterly visits. Nucleic acid amplification tests (NAATs) were used for diagnosis of vaginal trichomoniasis, gonorrhea, and chlamydia using the Hologic/Gen-Probe Aptima detection system (Hologic, San Diego, CA).

Alcohol use was measured annually using the AUDIT,¹¹ an internationally validated^{11,16} 10-item tool designed to screen for alcohol use disorders and early manifestations of risky alcohol use. These include hazardous (a pattern of drinking that increases the risk of future harm), and harmful alcohol use (drinking that impairs physical, mental, or social health).¹²

Possible scores on the AUDIT range from 0 to 40. For this study, a cut-point of 7 was used to identify hazardous or harmful drinking in the past year, aligning with WHO recommendations for use with women.¹² Primary analyses compared visits corresponding to an AUDIT score ≥ 7 (hazardous/harmful drinking) to those with a score of 0 (no drinking in the past year). We also compared visits with AUDIT scores between 1 and 6 (low-risk drinking) to those with a score of 0.

Demographic, social, and clinical variables were measured using a combination of self-report and laboratory methods. Age was reported in years at enrollment and updated for subsequent visits based on elapsed time in the study. Age groups of ≤ 29 , 30–39, 40–49, and ≥ 50 were created. Educational attainment was categorized as primary education or lower (0–8 years), some secondary (9–12 years), or post-secondary (13 or more years). Women's workplace was reported at enrollment as: 1) bar, restaurant, or guesthouse; 2) nightclub; or 3) other, including home-based.

Partnership status was measured at enrollment and quarterly visits as report of a regular male sex partner (defined as “a husband or a partner with whom you have (or had) a committed relationship”) in the past 3 months. At enrollment and annual visits, women who reported a current or most recent regular male sex partner were asked if they had experienced intimate partner violence (IPV) by that partner ever and in the past 12 months.¹⁷ Intimate partner violence was defined as report of 1 or more of 13 items corresponding to acts of psychological, physical, and sexual violence.¹⁸ An additional set of questions assessed whether women had experienced physical or sexual violence from anyone other than a current or most recent regular sex partner since the age of 15.

Depressive symptoms were measured using the PHQ-9,¹⁹ administered via face-to-face interview every 6 months. Responses were categorized as minimal (scores 0 to 4), mild (scores 5 to 9) or moderate-to-severe depressive symptoms (scores 10 or higher).¹⁹ Due to a small number of participants who reported moderate-to-severe depressive symptoms, these categories were collapsed to contrast minimal with mild-to-severe depressive symptoms.

At enrollment and quarterly examination visits, pregnancy status was assessed using urine β -hCG tests, and CD4+ T-cell count was measured by FACScount (BD Biosciences, San Jose, CA). Women's antiretroviral (ART) status was assessed monthly and categorized as ineligible (WHO clinical stage below 3, CD4+ T-lymphocyte count above 350, no active tuberculosis, and not pregnant or breastfeeding), eligible but not on ART, or on ART. To account for the influence of counseling and care provided as part of the study, time since enrollment was included in analyses as a continuous variable.

Analyses

Outcomes were measured at quarterly (PSA and STI screening) or monthly visits (self-reported sexual behavior). Alcohol use and some covariates were measured less frequently to reduce the response burden on participants and avoid overlapping reporting periods for standardized measures like the AUDIT, which ask about behavior during the past year. Values for variables that were measured less frequently were carried forward from the most recent measurement and applied to intervening monthly or quarterly visits.

To account for repeated measures from individual participants, associations between hazardous/harmful alcohol use and PSA detection were evaluated using generalized estimating equations (GEE) with a log link, binomial family distribution, independence working correlation structure,²⁰ and robust standard errors. After estimating unadjusted associations, a multivariable model was built using a modified forward selection process. First, a base model was fitted, adjusting for 4 factors that were specified *a priori* as potential predictors of both alcohol use and unprotected sex: age,^{1,5} venue of work,²¹ depression,¹ and lifetime history of IPV^{6,22} (see Figure, Supplemental Digital Content 1, for causal model). In light of possible bidirectional associations between alcohol use and depression, we present models with and without adjustment for depression. Additional covariates associated with PSA detection ($p < 0.10$) were added sequentially, starting with the variable with the largest risk estimate. Variables were retained in the model if they shifted the effect estimate for hazardous/harmful alcohol use relative to no alcohol use by approximately 10% or more. Standard errors were examined after the addition of each variable to assess multicollinearity. In the final model, an alpha of 0.05 was used to assess statistical significance of the adjusted association between hazardous/harmful alcohol use and detectable PSA.

Analyses exploring the association between hazardous/harmful alcohol use and the 5 secondary outcomes used the same GEE model developed for the primary analysis. Exploratory analyses also examined associations with low-risk alcohol use (AUDIT score 1–6). To assess the sensitivity of results to the use of different AUDIT cut-points, the primary analysis was repeated using the standard cut-point of 8¹² and a lower cut-point of 5.¹⁶ Lastly, a model was constructed using only enrollment values for all covariates to assess the influence of potential reverse causality between covariates and alcohol use.

RESULTS

Between October 11, 2012 and March 31, 2015, 405 HIV-positive FSWs completed 6,134 study visits. A total of 2,750 quarterly PSA samples were collected, with a median of 8 PSA measures per participant (interquartile range [IQR] 3–11) over an average follow-up period of 2.0 years (IQR: 0.7–2.3). Participants completed a median of 3 AUDIT questionnaires (IQR: 1–3) for a total of 907 AUDIT measures from enrollment and annual visits.

Characteristics of the sample at enrollment are presented in Table 1. The modal age group was 40 to 49 years ($n=156$; 38.5%), and most women worked in a bar, restaurant, or guesthouse ($n=236$; 58.3%). Twenty-two percent ($n=88$) of participants reported hazardous/harmful alcohol use in the 12 months preceding their enrollment visit, and 49.6% ($n=201$) reported no alcohol use. Prostate-specific antigen was detected in vaginal samples of 14.6% of participants ($n=59$), yet only 8.1% ($n=33$) reported unprotected vaginal sex in the past week. Among 245 women who reported that they were sexually active during the week prior to enrollment, the median number of sex partners and the median number of sex acts in the past week were both 2 (IQR: 1, 3). Forty-six (11.6%) participants screened positive for gonorrhea, chlamydia, or trichomoniasis.

Alcohol Use and PSA Detection

In the primary univariate analysis, the risk of PSA detection was 50% higher at visits corresponding to periods of harmful/hazardous alcohol use, relative to periods of no drinking (RR 1.50; 95% confidence interval [CI] 1.11–2.01; Table 2). However, in the final multivariable model, the association was attenuated, and no longer statistically significant (adjusted RR [aRR] 1.13; 95% CI 0.82–1.56). This association was nearly identical when depression was removed from the model (aRR 1.12; 95% CI: 0.81–1.53). The shift in the effect estimate with adjustment for potential confounding factors was mostly due to age; younger women were far more likely to report hazardous/harmful alcohol use and to have detectable PSA in vaginal specimens (Table 3). In a model adjusting for age group alone, the relative risk of PSA detection associated with hazardous/harmful alcohol use was 1.28 (95% CI 0.93–1.76).

Sensitivity analyses using AUDIT cut-points of 5 and 8, as well as an analysis holding time-varying covariates at their enrollment values, produced results that were not meaningfully different from the primary analysis (see Tables, Supplemental Digital Content 2, for the results of sensitivity analyses).

Alcohol Use, Self-Reported Risk Behaviors, and STI Diagnosis

In unadjusted analyses, periods of hazardous/harmful alcohol use were associated with a lower likelihood of self-reported sexual abstinence in the past week (RR 0.37; 95% CI 0.29–0.49), and a higher likelihood of self-reported unprotected vaginal sex (RR: 2.59 95% CI 1.71–3.94; Table 2). At the subset of visits where women were sexually active, hazardous/harmful alcohol use was associated with a higher risk of reporting three or more sex partners (RR 1.81; 95% CI 1.20–2.73) and three or more sex acts (RR 1.73; 95% CI 1.29–2.31). After adjusting for covariates, hazardous/harmful alcohol use remained significantly associated with a lower likelihood of self-reported sexual abstinence (aRR 0.58; 95% CI 0.45–0.74) and a higher risk of self-reported unprotected vaginal sex (aRR 1.62; 95% CI 1.04–2.52).

Both low-risk and hazardous/harmful alcohol use were associated with higher risk of STI diagnosis in unadjusted analysis (Table 2). These associations remained after adjustment for potential confounding factors, although the association with hazardous/harmful alcohol use was no longer statistically significant at $\alpha=0.05$ (low-risk aRR 2.16; 95% CI 1.45–3.23; hazardous/harmful aRR 1.57; 95% CI 0.95–2.59).

DISCUSSION

In this longitudinal study of HIV-positive FSWs in Kenya, alcohol use was common, with over one-fifth of the sample reporting hazardous/harmful drinking at enrollment. During periods corresponding to reported hazardous/harmful alcohol use, women were more likely to engage in higher risk sexual behaviors, as indicated by detection of PSA in vaginal specimens, self-reported sexual risk behaviors, and acquisition of STIs. While the adjusted association between hazardous/harmful drinking and PSA detection was not significant, associations with self-reported risk behaviors remained significant even in adjusted analyses.

The relationship between hazardous/harmful alcohol use and self-reported indicators of sexual risk in this population is consistent with findings from prior studies of African women.^{6,22,23} The strength of associations between alcohol use and self-reported behaviors relative to the associations between alcohol use and PSA detection likely reflects the influence of recall and social-desirability biases. Both alcohol use and sexual behaviors are sensitive topics, particularly for HIV-positive women.²⁴ One possible explanation for the difference in the results with self-report versus PSA in our study is that women who are more likely to report one stigmatized behavior, such as alcohol use, may also be more likely to report another stigmatized behavior like unprotected sex. An additional explanation is that women may perceive higher acceptability of reporting unprotected sex in the context of reported alcohol use.

Diagnosis with an STI provides an alternative indicator of sexual behavior that does not rely on self-report. In this study, STI diagnosis was associated with reporting alcohol use in the past year. It is possible that alcohol use, even at low levels, is a marker for STI risk. Women who drink may be more likely to have male partners who drink, and men's alcohol consumption has been linked with non-use of condoms.^{5,25} Additionally, drinking alcohol may be associated with engagement in high-risk sexual networks. A recent randomized trial of an alcohol intervention in Kenyan FSWs did not observe a change in STI incidence despite reductions in alcohol use, but the authors highlight the need for additional investigation to better understand these relationships.²⁶

This analysis indicated that younger FSWs are a particularly high-risk group for both alcohol use and unprotected sex. Although this study was not designed to examine the association between alcohol use and unprotected sex separately by age group, these overlapping risk factors suggest that interventions to address hazardous/harmful alcohol use in younger FSWs could be especially beneficial and should be explored.

A strength of this study was the use of PSA detection and laboratory-based STI testing as objective indicators of recent unprotected sex. Most studies have relied on self-reported indicators of sexual behavior,^{5,7,8} which underestimate unprotected sex due to recall and social-desirability biases.²⁷ Additionally, the AUDIT provides a reliable and standard measure of alcohol use, capturing social and psychological aspects of drinking in addition to the quantity and frequency of consumption. With data on alcohol use measured annually and PSA specimens collected every 3 months over 2,750 visits, this is one of the first and largest longitudinal studies to examine alcohol use and sexual risk among HIV-positive women in Africa.

These results should be interpreted in light of a number of limitations. First, the study was not designed to measure alcohol use and sexual risk at the event-level. Although event-level data allow for evaluation of a direct link between alcohol use and sexual behaviors, data that capture more habitual patterns of alcohol use and possible dependence are also informative. To clarify the mechanisms driving these associations, however, future studies in this population should collect event-level data using biological measures of sexual behavior. A second limitation is that few validation studies have been conducted with the AUDIT in African women or HIV-positive individuals,^{28,29} and these have recommended variable cut-

points for identification of hazardous/harmful alcohol use. Although the findings from this study were similar using a range of cut-points, optimal context-specific cut-points should be verified for more precise measurement.

A third limitation is that the biological and self-reported measures of unprotected sex in this study capture behaviors over different time periods. Women were asked about sexual behavior in the past week. In contrast, the sensitivity of the PSA assay begins to decline one hour following exposure to semen and approaches zero by 48 hours.¹⁴ Nonetheless, the finding that detectable PSA was 80% more common than self-reported unprotected sex at enrollment, and 60% more common across all quarterly visits, suggests under-reporting of unprotected sex in this population. Importantly, neither measure is designed to capture all unprotected sex in the one-year period assessed by the AUDIT. Fourth, this study did not collect data on partnership-specific sexual behaviors, such that we were unable to examine associations separately for regular partners and clients, with whom the effects of alcohol use may differ. Lastly, participants in this study were HIV-positive FSWs enrolled in a prospective study of HIV transmission risk. Thus, the findings may be most generalizable to other populations of HIV-positive African FSWs receiving risk reduction education and services.

Conclusions

This study adds to the limited body of literature on alcohol use and sexual risk behavior among HIV-positive women in Africa, demonstrating associations between AUDIT-measured alcohol use, self-reported unprotected sex, and STI diagnosis. Although the association with PSA detection was not significant after adjusting for age and other characteristics, the high prevalence of hazardous/harmful alcohol use in this sample of high-risk HIV-positive women suggests that integration of alcohol screening and counseling into HIV testing and treatment services could contribute to efforts to prevent HIV transmission and improve individual and population-level health.

Supplementary Material

Refer to Web version on PubMed Central for supplementary material.

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Conflicts of Interest and Sources of Funding

R.S.M. currently receives research funding from Hologic Corporation, paid to the University of Washington, for a validation study of collection methods for cervical cancer screening. J.M.S. has received payment for lectures, travel, accommodations, and meeting expenses from the University of Wisconsin. B.A.R. holds consultancies as a Data Safety and Monitoring Board member with Theratechnologies, Inc. and Tobira Therapeutics, Inc. B.A.R. also provides expert testimony for Pepper Hamilton, LLC. D.W. held shares of stock in Bristol-Myers Squibb. For the remaining authors, no conflicts of interest were declared.

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Table 1

Baseline characteristics of 405 HIV-positive female sex workers in Mombasa, Kenya

<i>Demographic and social characteristics</i>	Percent	(n/N)		
Age				
20 to 29	16.5%	(67/405)		
30 to 39	36.5%	(148/405)		
40 to 49	38.5%	(156/405)		
50 and older	8.4%	(34/405)		
Education				
Some primary (0 to 8 years)	58.3%	(236/405)		
Some secondary (9 to 12 years)	36.8%	(149/405)		
Some post-secondary (13+ years)	4.9%	(20/405)		
Venue of work				
Bar, restaurant or guesthouse	58.3%	(236/405)		
Nightclub	24.9%	(101/405)		
Home-based or other	16.8%	(68/405)		
Regular partner, past 3 months	46.3%	(187/404)		
<i>Reproductive health indicators</i>	Percent	(n/N)	Percent	(n/N)
Post-menopausal	15.9%	(64/402)		
Using a modern contraceptive method ^a	32.6%	(111/341)		
Desires more children	24.3%	(98/403)		
Trying to become pregnant	8.9%	(36/403)		
Currently pregnant	0.5%	(2/404)		
Currently postpartum	2.0%	(8/405)		
Intimate partner violence ^b			<i>Ever</i>	<i>Past 12 months</i>
Psychological	45.4%	(147/324)	15.4%	(50/324)
Physical	41.4%	(134/324)	14.8%	(48/324)
Sexual	18.2%	(59/324)	5.0%	(16/323)
Any	51.2%	(166/324)	20.7%	(67/323)
Non-partner violence ^c	39.4%	(159/404)	12.9%	(52/403)
<i>Clinical and health behavior indicators</i>	Percent	(n/N) or median		(IQR)
CD4 cell count	455	(328, 629)		
ART status				
Ineligible	31.6%	(128/405)		
Eligible, not on ART	9.1%	(37/405)		
Eligible, on ART	59.3%	(240/405)		
Disclosed HIV status outside of clinic	63.6%	(257/404)		
Depressive symptoms				
None or minimal (PHQ-9 score 0 to 4)	70.9%	(287/405)		

<i>Demographic and social characteristics</i>	Percent	(n/N)
Mild (PHQ-9 score 5 to 9)	22.0%	(89/405)
Moderate to severe (PHQ-9 score 10+)	7.2%	(29/405)
Alcohol use in the past 12 months		
None (AUDIT score 0)	49.6%	(201/405)
Low risk (AUDIT score 1 to 6)	28.6%	(116/405)
Hazardous or harmful (AUDIT score 7 to 40)	21.7%	(88/405)
<i>Sexual behavior indicators</i>	Percent median	(n/N) or (IQR)
PSA detected	14.6%	(59/405)
Abstinent in the past week ^d	39.5%	(160/405)
Unprotected vaginal sex in the past week ^d	8.1%	(33/405)
Number of sex partners in the past week ^{d,e}	2	(1, 3)
Number of sex acts in the past week ^{d,e}	2	(1, 3)
STI detected ^f	11.6%	(46/398)
Gonorrhea	3.8%	(15/398)
Chlamydia	2.3%	(9/398)
Trichomoniasis	6.8%	(27/398)

^a Among pre-menopausal women. Modern contraceptive method defined to include hormonal methods of contraception (e.g. oral pills, Depo-Provera, Norplant), IUDs, sterilization, and hysterectomy

^b Among women who reported having a current or most recent regular male sex partner

^c Physical or sexual violence from a partner other than the current or most recent regular male partner, either between age 15 and enrollment (ever) or in the past 12 months

^d Based on self-reported behaviors in the past week

^e Among women who reported sexual activity in the past week

^f Positive NAAT test for gonorrhea, chlamydia, or trichomoniasis

Table 2

Univariate and multivariable GEE regression estimates for associations between alcohol use, prostate-specific antigen (PSA) detection, and secondary measures of sexual risk

	Univariate regression estimates		Multivariable regression estimates ^a	
	Risk ratio (95% CI)	p-value	Risk ratio (95% CI)	p-value
Outcome: PSA detection				
No alcohol use	REFERENCE		REFERENCE	
Low risk alcohol use	1.21 (0.92, 1.59)	0.2	1.08 (0.83, 1.41)	0.6
Hazardous or harmful alcohol use	1.50 (1.11, 2.01)	0.008	1.13 (0.82, 1.56)	0.5
Outcome: Unprotected sex				
No alcohol use	REFERENCE		REFERENCE	
Low risk alcohol use	1.66 (1.08, 2.57)	0.02	1.45 (0.94, 2.24)	0.09
Hazardous or harmful alcohol use	2.59 (1.71, 3.94)	<0.001	1.62 (1.04, 2.52)	0.03
Outcome: Abstinence				
No alcohol use	REFERENCE		REFERENCE	
Low risk alcohol use	0.61 (0.51, 0.72)	<0.001	0.73 (0.63, 0.85)	<0.001
Hazardous or harmful alcohol use	0.37 (0.29, 0.49)	<0.001	0.58 (0.45, 0.74)	<0.001
Outcome: 3 or more sex partners^b				
No alcohol use	REFERENCE		REFERENCE	
Low risk alcohol use	1.30 (0.90, 1.89)	0.2	0.98 (0.70, 1.38)	0.9
Hazardous or harmful alcohol use	1.81 (1.20, 2.73)	0.005	1.19 (0.83, 1.71)	0.4
Outcome: 3 or more sex acts^b				
No alcohol use	REFERENCE		REFERENCE	
Low risk alcohol use	1.15 (0.86, 1.54)	0.3	0.96 (0.73, 1.25)	0.7
Hazardous or harmful alcohol use	1.73 (1.29, 2.31)	<0.001	1.21 (0.93, 1.58)	0.1
Outcome: STI diagnosis^c				
No alcohol use	REFERENCE		REFERENCE	
Low risk alcohol use	2.45 (1.69, 3.55)	<0.001	2.16 (1.45, 3.23)	<0.001
Hazardous or harmful alcohol use	2.03 (1.34, 3.08)	0.001	1.57 (0.95, 2.59)	0.08

^aAdjusted for a priori confounders (age, venue of work, ever experience of IPV, and depression) and whether women reported having a regular partner in the past 3 months

^bAt visits where women reported sexual activity in the past week

^cDiagnosis of vaginal trichomoniasis, gonorrhea, or chlamydia at quarterly exams

Table 3

Prevalence of alcohol use and PSA detection by age group^a

	Hazardous or harmful alcohol use		PSA detected		p-value ^b
	percent	(n/N)	percent	(n/N)	
Age					0.006
20 to 29	36.2%	(38/105)	22.9%	(58/253)	
30 to 39	23.6%	(77/326)	19.4%	(182/936)	
40 to 49	8.5%	(33/388)	14.3%	(179/1,248)	
50 and older	3.4%	(3/88)	10.5%	(33/313)	

^aWomen may contribute to more than one age group across visits – data are presented for all 907 visits at which AUDIT was measured and 2,750 visits at which PSA was measured from the 405 participants.

^b p-value for joint significance of the age effect, from GEE models to account for repeated measures on participants