Alcohol use before sex and HIV acquisition: a longitudinal study in Rakai, Uganda

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Objective: To examine the association between alcohol use and HIV acquisition.

Design and methods: We examined alcohol use before sex and incident HIV in a population-based cohort in Rakai, Uganda, between 1994 and 2002. Adjusted incidence rate ratios (adjIRR) of HIV acquisition and 95% confidence intervals (CI) were estimated by Poisson multivariate regression. We also estimated adjusted prevalence rate ratios to assess the association between alcohol use and the number of sex partners and consistency of condom use.

Results: In 6791 men and 8084 women HIV incidence was 1.4 per 100 person-years and 1.5 per 100 person-years, respectively. After adjustment for sociodemographic and behavioral factors, the risks of HIV when one partner consumed alcohol before sex were: adjIRR 1.67, 95% CI 1.17–2.40 among men, and adjIRR 1.40, 95% CI 1.02–1.92 among women, and when both partners consumed alcohol the risks were adjIRR 1.58, 95% CI 1.13–2.21 among men, and adjIRR 1.81, 95% CI 1.34–2.45 among women. Alcohol use was significantly associated with inconsistent condom use and multiple sexual partners in both sexes.

Conclusion: The use of alcohol before sex increases HIV acquisition. A reduction of alcohol use should be incorporated into HIV prevention programmes.

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Introduction

Alcohol abuse is a major public health problem [1], and is associated with sexually transmitted infections, but the association with HIV is unclear [2]. Alcohol use is common, and disinhibition as a result of alcohol may precipitate and reinforce sexual risk-taking [2–13]. Two cross-sectional studies in Uganda have suggested

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associations between alcohol use, risk behaviors and prevalent HIV infection [12,14]. However, there are no prospective studies of alcohol use in conjunction with sex and HIV acquisition. We used data from a population-based cohort in Rakai, Uganda, to determine whether alcohol use before sex was associated with the risk of HIV acquisition, and risk behaviors.

Methods

The data are derived from an open community cohort in Rakai, Uganda, which enrolled adults aged 15–49 years who where followed at 10–12-month intervals between 1994 and 2002 [15]. Consenting adults were interviewed and asked to provide a venous blood sample for HIV testing. Participants provided written informed consent for enrollment and follow-up, and the study was reviewed and approved by three institutional review boards in Uganda and the United States.

Sociodemographic characteristics, sexual behaviors and health/family planning history were collected at each interview, and sexual network information was obtained on up to four partners in the previous year. The behavioral information included condom use, vaginal/genital practices, the number and characteristics of sexual partners, sex for money/gifts, alcohol use, and non-consensual sex [15]. Data on alcohol use included alcohol consumption during the past month, the past 7 days, and the frequency of alcohol consumption in the past week. Additional information was collected about alcohol use before sex reported by the respondents about themselves and their sexual partners. Patterns of alcohol consumption were relatively stable over successive visits; 81% of respondents who reported no alcohol use before sex at one survey reported the same behavior at the subsequent visit. Similarly, among those who initially reported alcohol consumption before sex, 76% reported this behavior at subsequent visits.

Venous blood was tested by two enzyme immunoassays: Vironostika HIV-1 (Organon Teknika, Charlotte, North Carolina, USA) and Cambridge Biotech (Worcester, Massachusetts, USA). Discordant enzyme immunoassay results or new seroconversions were confirmed by Western blot (Bio-Merieux-Vitek, St Louis, Mississippi, USA) [15].

The eligibility criteria for this analysis included enrollment into the cohort between 1994 and 2002, HIV-negative serostatus at enrollment, and follow-up information allowing the detection of HIV seroconversion. The study population consisted of 6791 men and 8084 women aged 15–49 years with complete information about alcohol use before sex and sexual behaviors (92 and 94% of the eligible population). Individuals with incomplete information were not different from those with complete information with respect to sociodemographic factors.

A total of 6791 men and 8084 women contributed 16 385 and 20 393 intervals of personal observation. For seroconverting individuals, we assumed that infection occurred at the midpoint between the last negative and the first positive HIV result. HIV incidence was calculated as the number of events per 100 person-years (PY). There were 287 HIV seroconversions over 20 878 PY among men (HIV incidence 1.4/100 PY), and 354 seroconversions over 24 486 PY among women (HIV incidence 1.5/100 PY).

The main exposure of interest was alcohol use before sex by one partner only or by both partners, compared with no alcohol use by either partner as the referent group. We assessed HIV incidence by sociodemographic characteristics: age (in 5-year age groups, compared with the age group over 40 years); education (none or primary versus secondary and higher); occupation (shop keeper/laborer/driver, professional, student or brewing/selling alcohol/otherwise not employed, compared with farming/housekeeping); religion (non-Muslims versus Muslims); marital status (currently or previously married compared with never married); and household possession of transportation, including bicycle, motorcycle, car or lorry, as a proxy for mobility (yes versus no). We examined two sexual risk behaviors: the number of sex partners in the past year (two or more compared with one partner), and condom use in the past 6 months (inconsistent or always compared with non-use). With the exception of religion (a time-fixed variable at enrollment), all other variables were treated as time-varying covariates specific for each follow-up interval.

We used multivariate Poisson regression to assess the association between time-dependent alcohol consumption before sex and HIV incidence, and estimated sex-specific incidence rate ratios (IRR) with 95% confidence intervals (CI). Robust standard errors were estimated using general estimating equation methods to account for within-individual correlation of behaviors over time. Sociodemographic and behavioral variables were included in the final multivariate models based on their statistically significant association with incident HIV in univariate analyses ($P < 0.05$). Variables not statistically significant in univariate analysis were assessed individually and did not have any substantial effect on IRR for the primary association.

Behavioral risk factors, such as the number of sex partners and condom use, could be in the pathway between alcohol use and incident HIV. Therefore, we constructed two final models, with and without these behavioral factors, to determine their possible mediating effects on the alcohol-associated risk of HIV acquisition. Both

models were adjusted for sociodemographic characteristics such as age, education, religion, marital status and the possession of transport.

We also assessed the association between alcohol use before sex and the number of sex partners (two or more partners versus one), having extramarital sex in the past year (yes versus no), and inconsistent condom use in the past 6 months compared with consistent use. We used a log-binomial regression model to estimate the adjusted prevalence rate ratios (PRR) and 95% confidence intervals. These models were adjusted for age, education, religion, marital status and the possession of transport, and take into account the within-individual correlation of behaviors over time.

All data analysis used the STATA 8.1 statistical package (STATA Corp., College Station, Texas, USA).

Results

Alcohol use by only one partner in conjunction with sex was reported during 23.1% of follow-up intervals by men (3786/16 385), and 28.2% of intervals by women (5754/20 393). A similar proportion of men (32.9%, 5396/16 385) and women (32.7%, 6666/20 393) reported that both partners consumed alcohol before sex. Table 1 shows the study population and HIV incidence. Among individuals who did not drink alcohol, HIV incidence was 0.9 per 100 PY among men, and 1.0 per 100 PY among women. HIV incidence was higher when one partner consumed alcohol before sex (1.7 per 100 PY in men and 1.5 per 100 PY in women), and was further increased when both partners drank alcohol before sex (1.8 per 100 PY in men and 1.9 per 100 PY in women). HIV incidence was highest among men aged 25–39 years and women aged 20–29 years, and non-Muslims had a higher HIV incidence than Muslims. HIV incidence was also higher in previously married individuals, and in those who lacked transport. HIV incidence increased with the reported number of sex partners, and in married individuals who reported at least one extramarital relationship in the past year. In both sexes, HIV incidence was highest in individuals reporting inconsistent condom use.

As shown in Table 2, the unadjusted HIV IRR were significantly increased with alcohol use before sex compared with no use. When adjusted for sociodemographic factors alone, the HIV IRR were significantly higher if one partner consumed alcohol before sex (adjIRR 1.84, 95% CI 1.28–2.64 among men, and adjIRR 1.51, 95% CI 1.11–2.07 among women), and when both partners used alcohol before sex (adjIRR 1.92, 95% CI 1.37–2.69 among men, and adjIRR 1.89, 95% CI 1.40–2.56 among women) compared with neither partner. After adjustment for risk behaviors, the magnitude of the association between alcohol use before sex and HIV acquisition decreased, but remained significant when only one partner consumed alcohol before sex (adjIRR 1.67, 95% CI 1.17–2.40 among men, and adjIRR 1.40, 95% CI 1.02–1.92 among women), and when both partners did (adjIRR 1.58, 95% CI 1.13–2.21 among men, and adjIRR 1.81, 95% CI: 1.34–2.45 among women) compared with either partner. If either one or both partners used alcohol, the IRR adjusted for sociodemographic and behavioral factors was 1.62 (95% CI 1.15–2.29) among men and 1.62 (95% CI 1.19–2.20) among women.

Individuals consuming alcohol were more likely to report inconsistent condom use in the past 6 months (adjPRR 1.38, 95% CI 1.28–1.49 among men, and adjPRR 1.28, 95% CI 1.15–1.44 among women), a greater number of sex partners in the past year (adjPRR 1.42, 95% CI 1.35–1.50 among men, and adjRR 1.27, 95% CI 1.15–1.40 among women), and more extramarital sex in the past year (adjPRR 1.32, 95% CI 1.23–1.40 among married men, and adjPRR 1.30, 95% CI 1.21–1.40 among married women).

Discussion

Alcohol use with sex was common in Uganda, and was associated with an increased risk of HIV acquisition in both sexes (Table 1 and Table 2). Adjustment for sexual risk behaviors only modestly reduced the strength of this association (Table 2). The use of alcohol was associated with increased risk behaviors, suggesting that alcohol may affect HIV risk by behavioral disinhibition. Our findings are consistent with two earlier cross-sectional studies [13,15], and with the literature on the disinhibiting effects of alcohol [3–14]. It is also possible that alcohol may affect HIV risk by impaired immune system regulation as suggested by in-vitro and simian studies [16–20].

This observational study has limitations. Self-reported information on alcohol and risk behaviors may be subject to recall error or misreporting. However, we observed consistency between male and female reports that both partners used alcohol before sex, and there was reasonable intra-individual stability in self-reported alcohol use over successive surveys, which suggests relatively consistent reporting. Condom use and the number of sexual partners may also be misreported, which could explain why adjustment for these proximal behaviors had modest effects on the association between alcohol use and HIV acquisition. Moreover, because alcohol use was associated with risk behaviors, incomplete control for these variables or other unmeasured confounders may partly account for the observed associations. Nevertheless, because of the disinhibiting effects of alcohol, such risk behaviors are

Table 1. HIV incidence by sex, sociodemographic and behavioral factors.

	Men				Women			
	No. persons[a]	PY	No. events	Incidence per 100 PY	No. persons	PY	No. events	Incidence per 100 PY
Total	6791	20 878	287	1.4	8084	24 486	354	1.5
Drinking alcohol before sex by								
Neither partner	2985	9030	77	0.9	3161	9646	100	1.0
One of the partners	1569	4698	81	1.7	2281	6749	103	1.5
Both partners	2236	7150	129	1.8	2642	8091	151	1.9
Sociodemographic characteristics								
Age (years)								
15–19	861	2396	9	0.4	1077	3046	38	1.2
20–24	1357	4353	61	1.4	1835	5710	99	1.7
25–29	1328	4248	70	1.6	1447	4558	86	1.9
30–34	989	3104	60	1.9	997	3085	46	1.5
35–39	676	2094	35	1.7	920	2729	38	1.4
40+	1580	4675	52	1.1	1804	5347	47	0.9
Education								
No formal	388	1229	26	2.1	953	2898	40	1.4
Primary	4395	13 473	183	1.3	5380	16 162	234	1.4
Secondary +	2007	6176	78	1.4	1751	5426	80	1.5
Occupation								
Farmer/housekeeper	3492	10 642	145	1.4	6641	22 373	281	1.4
Shop/labor/driver	1110	3411	53	1.6	397	1320	23	1.9
Professional	573	1787	26	1.5	318	1072	14	1.5
Student	632	2033	13	0.6	274	1032	5	0.5
Brewing/selling alcohol/not employed	984	3005	50	1.7	454	1487	31	2.3
Religion								
Muslim	933	2854	24	0.8	1217	3721	36	1.0
Non-Muslim	5858	18 025	263	1.5	6867	20 765	318	1.5
Marital status								
Currently married	4579	14 216	193	1.4	5637	17 035	208	1.2
Previously married	142	505	17	3.4	417	1510	44	2.9
Never married	2069	6158	77	1.3	2030	5940	102	1.7
Possession of transport								
No	2169	6839	112	1.6	2978	9174	177	1.9
Yes	4439	13 537	169	1.2	4869	14 671	168	1.1
Behavioral characteristics								
No. sex partners in past year								
0–1	4208	12 708	132	1.0	7523	23 120	311	1.3
2+	2583	8169	155	1.9	561	1366	43	3.1
Extramarital relationship								
No	5184	15 563	197	1.3	6985	21 004	262	1.2
Yes	1599	5292	89	1.7	1093	3469	91	2.6
Condom use in past 6 months								
None	4839	14 096	173	1.2	7041	20 623	272	1.3
Inconsistent	1392	4440	91	2.0	621	1815	44	2.4
Always	545	1748	16	0.9	322	1002	21	2.1

PY, Person-years.
[a]Some variables may not add up to total because of a few missing observations.

Table 2. Univariate and adjusted incidence rate ratios for HIV acquisition and alcohol drinking before sex.[a]

	Men			Women		
	UnadjIRR (95% CI)	AdjIRR[b,c] (95% CI)	AdjIRR (95% CI) model inc. potential mediating variables[d]	UnadjIRR (95% CI)	AdjIRR[c] (95% CI)	AdjIRR (95% CI) model inc. potential mediating variables[d]
Drinking alcohol before sex by						
Neither partner	1.00	1.00	1.00	1.00	1.00	1.00
One partner	2.02 (1.48–2.76)	1.84 (1.28–2.64)	1.67 (1.17–2.40)	1.47 (1.12–1.94)	1.51 (1.11–2.07)	1.40 (1.02–1.92)
Both partners	2.12 (1.60–2.81)	1.92 (1.37–2.69)	1.58 (1.13–2.21)	1.80 (1.40–2.32)	1.89 (1.40–2.56)	1.81 (1.34–2.45)
Sociodemographic characteristics						
Age (years)						
15–19	0.34 (0.17–0.69)	0.38 (0.17–0.83)	0.31 (0.14–0.68)	1.42 (0.93–2.18)	2.14 (1.34–3.42)	2.05 (1.27–3.30)
20–24	1.26 (0.87–1.83)	1.27 (0.85–1.90)	1.04 (0.68–1.58)	1.97 (1.39–2.79)	2.86 (1.97–4.15)	2.68 (1.83–3.93)
25–29	1.48 (1.03–2.12)	1.58 (1.09–2.29)	1.30 (0.88–1.92)	2.15 (1.50–3.06)	2.86 (1.97–4.15)	2.77 (1.90–4.04)
30–34	1.74 (1.20–2.52)	1.84 (1.26–2.68)	1.58 (1.07–2.34)	1.70 (1.13–2.55)	2.11 (1.38–3.20)	2.00 (1.30–3.07)
35–39	1.50 (0.98–2.31)	1.57 (1.02–2.42)	1.44 (0.94–2.22)	1.58 (1.03–2.43)	1.92 (1.24–2.97)	1.93 (1.24–2.99)
40+	1.00	1.00	1.00	1.00	1.00	1.00
Education						
No formal	1.67 (1.08–2.61)	1.55 (0.97–2.46)	1.67 (1.05–2.67)	0.94 (0.64–1.37)	1.12 (0.75–1.68)	1.17 (0.78–1.77)
Primary	1.08 (0.82–1.40)	1.11 (0.84–1.47)	1.14 (0.86–1.51)	0.98 (0.76–1.27)	1.09 (0.83–1.42)	1.09 (0.83–1.42)
Secondary +	1.00	1.00	1.00	1.00	1.00	1.00
Religion						
Muslim	1.00	1.00	1.00	1.00	1.00	1.00
Non-Muslim	1.74 (1.14–2.63)	1.16 (0.74–1.82)	1.34 (0.84–2.11)	1.58 (1.12–2.23)	1.08 (0.73–1.60)	1.13 (0.76–1.67)
Married						
Currently	1.09 (0.83–1.41)	0.68 (0.49–0.94)	0.61 (0.43–0.85)	0.71 (0.56–0.90)	0.67 (0.51–0.88)	0.77 (0.58–1.03)
Previously	2.69 (1.59–4.55)	1.57 (0.88–2.80)	1.58 (0.89–2.82)	1.70 (1.19–2.41)	1.86 (1.27–2.72)	1.93 (1.31–2.84)
Never	1.00	1.00	1.00	1.00	1.00	1.00
Possession of transport						
No	1.00	1.00	1.00	1.00	1.00	1.00
Yes	0.76 (0.60–0.97)	0.89 (0.69–1.14)	0.89 (0.70–1.15)	0.59 (0.48–0.73)	0.71 (0.56–0.89)	0.71 (0.56–0.90)
Behavioral characteristics						
No. sex partners in past year						
0–1	1.00		1.00	1.00		1.00
2+	1.83 (1.45–2.30)		1.64 (1.27–2.16)	2.34 (1.70–3.22)		1.73 (1.21–2.46)
Condom use in past 6 months						
None	1.00		1.00	1.00		1.00
Inconsistent	1.67 (1.30–2.15)		1.25 (0.93–1.69)	1.84 (1.34–2.53)		1.38 (1.00–1.94)
Always	0.75 (0.45–1.25)		0.63 (0.36–1.10)	1.59 (1.02–2.48)		1.22 (0.75–1.98)

AdjIRR, Adjusted incidence rate ratios; CI, confidence interval; unadjIRR, unadjusted incidence rate ratios.
[a]Some variables may not add up to total due to a few missing observations.
[b]In the columns with AdjIRR, all adjusting variables included in the model have corresponding IRR.
[c]Adjustment for sociodemographic factors only.
[d]The full model is adjusted for sociodemographic and behavioural characteristics.

likely to be in the causal pathway linking alcohol consumption to HIV acquisition.

This study suggests that alcohol use before sex is an important risk factor for HIV acquisition. In many developing countries, and in the countries of the former Soviet Union and eastern Europe, alcohol use is common and HIV incidence rates are high or increasing [21–23]. Therefore, designing and providing interventions to identify those at risk and to promote the reduction of alcohol use in conjunction with sex may provide a means of HIV prevention.

Contributors

Iryna B. Zablotska contributed to formulating the research issue and design of this analysis, and assumed principal responsibility for data analysis and preparation of the paper. Ronald.H. Gray (co-principal investigator of the Rakai Project) contributed to data collection and assisted with the analysis design, interpretation of results and preparation of the paper. David Serwadda, Fred Nalugoda, Godfrey Kigozi, Nelson Sewankambo, Tom Lutalo, Fred Wabwire Mangen, and Maria Wawer contributed to the design and conduct of the data collection and preparation of this report. All authors have seen and approved the final version of this paper.

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