Title

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ORIGINAL PAPER

Sexual Risk among Pregnant Women at Risk of HIV Infection in Cape Town, South Africa: What Does Alcohol Have to Do with It?

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Abstract

This study examines baseline associations between alcohol use and HIV sexual risk among a cohort of HIV-uninfected pregnant women (n = 1201) residing in a high HIV burdened community in Cape Town, South Africa. Alcohol use was measured using a modified version of the Alcohol Use Disorder Identification Test (AUDIT). HIV sexual risk was measured through a composite variable of four risk factors: diagnosis with a STI, self-report of > 1 recent sex partners, partner HIV serostatus (unknown or HIV+) and condomless sex at last sex. Any past year alcohol use prior to pregnancy was reported by half of participants (50%); 6.0% reported alcohol use during pregnancy. Alcohol use prior to pregnancy was associated with increased odds of being at high risk of HIV (aOR = 1.33, 95% CI 1.05–1.68, for 2 risks and aOR = 1.47, 95% CI 0.95–2.27 for 3 risks). In addition to reducing alcohol use, several other strategies to address HIV sexual risk were identified. Evidence-based interventions to address alcohol use and other HIV sexual risk behaviors during pregnancy in South Africa are desperately needed. Qualitative work exploring individual and community level drivers of alcohol use among pregnant and breastfeeding women in this setting could support development of a culturally tailored intervention to address these issues in this population.

Keywords Alcohol use · Pregnancy · HIV · South Africa · Sub-Saharan Africa

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Introduction

Heavy alcohol use and HIV are prevalent interrelated public health issues that are associated with a substantial burden of disease in South Africa [1]. With a national HIV prevalence of 19%, South Africa is home to the highest number of persons living with HIV globally (7.8 million) [2]. The prevalence of HIV among pregnant women (29%) [3] in this setting is even higher and pregnant and post-partum women experience a high rate of incident HIV infection [4]. Although only 31% of South Africa's population reports alcohol use in the past 12 months, consumption levels are high among those who drink, with 59% engaging in heavy episodic drinking (HED), which is defined as the consumption of 60 g or more of pure alcohol (the equivalent of six standard drinks) in one sitting [5]. Estimates for total per capita consumption among drinkers (29.9 L of pure alcohol), prevalence of alcohol use disorders (AUD) (7%) and prevalence of alcohol dependence (2%) in South Africa exceed regional averages [5]. There are gender differences in patterns of use and quantity of alcohol consumption in South Africa, with men being both more likely to drink and to consume hazardous levels of alcohol [5]. However, HED is prevalent among women who consume alcohol. A recent report by World Health Organization (WHO) found that roughly one-third (34%) of women reported having engaged in this behavior in the month preceding the survey [5] while another study found that a similar proportion of women (32%) reportedly engage in binge drinking on a weekly basis [6]. Alcohol use is also common among pregnant women in Cape Town [7–10]. Prior work among pregnant women in this setting found that 29% reported alcohol use during pregnancy [11], an estimate that is likely biased due to underreporting/social desirability bias [12]. Biomarker measures of hazardous alcohol use (23%) have also confirmed use among pregnant women who are living with HIV in South Africa [13].

Both incident HIV infection and alcohol use during pregnancy are associated with adverse health outcomes for the mother and fetus. Incident HIV during pregnancy is associated with increased risk of HIV transmission from mother-to-child (across the placental barrier or during delivery) due to high maternal viral load in the acute infection phase [14, 15]. Fetal alcohol spectrum disorder (FASD) describes a continuum of cognitive and physical impairments a fetus may experience due to prenatal alcohol exposure, the most severe form being fetal alcohol syndrome (FAS) [16]. As a result of heavy alcohol use in pregnancy, South Africa has the highest rate of FAS in the world [17]. FAS is a lifelong diagnosis and its deleterious effects on the central nervous system can result in neurocognitive developmental delays and behavioral problems that can persist into adolescence and young adulthood [18, 19]. There is also evidence of socioeconomic disparities in the "harm per liter" of alcohol use, with poor South Africans experiencing worse outcomes associated with their alcohol use. Sixty percent of deaths attributable to alcohol use occur among persons in the bottom third of the socioeconomic spectrum [20]. These socioeconomic disparities also extend to alcohol attributable HIV mortality [21].

In addition to directly threatening the health of both mother and baby, alcohol use is a widely recognized driver of the HIV epidemic through its association with sexual risk behavior. Alcohol use can impact decision making around sexual practices including having multiple sex partners [22, 23] and condomless sex [22, 24], resulting in increased risk of HIV acquisition [25–28]. Alcohol use is also associated with increased risk of intimate partner violence (IPV) [29, 30], which itself is a risk factor for HIV, through forced sex and reduced ability to safely negotiate condom use [31]. While the evidence base supporting alcohol use as a risk factor for engaging in sexual risk behavior is well established [25], data examining this relationship among pregnant women in South Africa is more limited. Prior work with pregnant women in South Africa found that alcohol use prior to (Cape Town [32]) or during (Mpumalanga [33]) pregnancy was associated with having multiple sexual partners but not condomless sex [33]. In another Cape Town study, one in four pregnant women (27%) indicated that alcohol and drug use leads to greater sexual risk taking [34]. These intertwined public health issues of alcohol use, risky sexual practices, IPV and HIV can result in excess disease burden and exacerbate health disparities.

Addressing alcohol use among pregnant women is critical to HIV prevention efforts and public health efforts to promote healthy pregnancies and births. The present study fills important gaps in the literature by providing a comprehensive picture of the burden of alcohol use among pregnant women in South Africa using multiple validated measures and cutoffs and exploring sociodemographic and behavioral factors associated with alcohol use in this population. As a modifiable behavior that can be incorporated into prevention programming, identifying associations between alcohol use and other HIV risk factors among pregnant women who experience a high burden of HIV incidence cannot be overlooked. While a small number of previous studies have reported on associations between alcohol use and specific HIV risk behaviors, to better characterize this relationship, the present study explores associations between alcohol use and a composite sexual risk index among a large cohort of pregnant women residing in an underserved community experiencing a heavy burden of HIV in Cape Town, South Africa. We measure HIV sexual risk using a composite proxy risk measure to identify modifiable sexual risk factors and hypothesize that alcohol use will be associated with greater odds of being in the high-risk category. This knowledge can inform the development of an alcohol

reduction and HIV prevention intervention to interrupt and potentially prevent alcohol use during pregnancy in this setting and address other associated modifiable HIV risk behaviors.

Materials and Methods

Participants and Procedures

Pre-exposure Prophylaxis in Pregnancy and Post-partum (PrEP-PP) is an ongoing observational prospective closed-cohort study of pregnant and postpartum women attending antenatal care (ANC) in Gugulethu, Cape Town, South Africa (clinical trial no. NCT03902418). This community was selected because of the high incidence and prevalence of HIV among pregnant and breastfeeding women [35]. Consecutive eligible, consenting study participants were enrolled at the study site until the target sample size of 1201 pregnant women was met. Women 16 years or older attending their first ANC visit and pregnant at time of enrollment were eligible for study participation. Additional inclusion criteria included confirmed HIV negative serostatus (confirmed with 4th generation ab/ag Abbott rapid test), intention to give birth in Cape Town, no medical or psychiatric conditions contraindicated for PrEP and consent to participate in the study. Consented, enrolled participants are invited to return every 3 months for study visits that correspond with their ANC visits. Participants are followed until 12 months' postpartum or until censorship (pregnancy loss, infant death, seroconversion, moving away, transfer out of care, loss to follow-up). All study staff are trained, salaried staff working for the University of Cape Town (UCT).

The present analysis utilizes baseline data (n = 1201) from study enrollment visits, collected between August 2019 and September 2021. Trained research staff conducted eligibility screening, HIV counseling and testing, counseling around HIV prevention and PrEP use, offered to initiate PrEP, provided diagnostic testing for other STIs and administered a survey which took approximately 30–45 min to complete. For STI testing and management, participants were instructed on how to do a self-collected vaginal swab which was tested for Chlamydia trachomatis (CT), Neisseria gonorrhoeae (NG), and Trichomonas vaginalis (TV) using point of care testing (Cephid, Inc., Sunnyvale, CA, US). Treatment was provided as needed during the same visit following South Africa National STI Guidelines [36]. The study interviewers collected data on participant sociodemographics, sexual practices, depression, alcohol use, and attitudes and knowledge towards PrEP.

Written informed consent was obtained from all study participants; unassisted self-consent was obtained from adolescents (participants 16 and 17 years of age). This study was approved by the UCT Faculty of Health Sciences Human Research Ethics Committee (UCT-HREC) and the University of California Los Angeles (UCLA). The study received approval from UCT Human Research Ethics Committee (HREC) to waive parental consent. Participants were given the informed consent form to take home if they wanted to discuss with partners or parents and could return within 24 h if they wanted to participate in the study. Participants viewed a video describing the study and the consent process in isiXhosa, the primary language spoken in this setting, to ensure that they understood the study design and consent form fully before signing. Light refreshments, compensation for their time (R100, ~ USD$7) as well as reimbursement for transportation were provided at each study visit [37].

Measures

Our primary interest was any alcohol use in the past year prior to pregnancy. We selected this exposure for a number of reasons including, (1) the potential for underreporting of alcohol use while pregnant, (2) the adverse consequences of any amount of alcohol use while pregnant on neonatal outcomes, (3) prior work which suggests that alcohol use prior to pregnancy is a good predictor of alcohol use during pregnancy [38], (4) the late median gestational age at baseline (first ANC visit) of 21 weeks (the 5th month of pregnancy) and (5) high prevalence of unplanned pregnancies in our study sample [39]. If women in our study were not aware of their pregnancy until well into the second trimester, "prior to pregnancy" may encompass the entire first trimester, a critical time in fetal development. Any alcohol use prior to pregnancy was measured using a modified version of the Alcohol Used Disorders Identification Test-Consumption (AUDIT-C [40]) with a reference period, "in the past year prior to finding out you were pregnant". The AUDIT-C is scored by summing responses to the three items (score range of 0–12 with high scores indicative of greater alcohol use). A cut-off of zero was used to identify no alcohol use.

We also explored patterns of risky alcohol use prior to and during pregnancy as secondary exposures of interest. This was done using the AUDIT-C with two reference periods "in the past year prior to finding out you were pregnant" and "since finding out you were pregnant". To further understand patterns of alcohol use during pregnancy, we also used a modified versions of the 10 item Alcohol Use Disorders Identification Test (AUDIT) [41, 42], a validated measure that has been used globally, including among pregnant women in Cape Town [43, 44]. Questions were modified to the reference period "since finding out you were pregnant". The AUDIT is scored by summing responses to the 10 items (score range of 0–40 with high scores indicative of greater alcohol use) and cut-offs are used to differentiate between lower risk use, hazardous or harmful use and persons with probable alcohol dependence.

We report several alcohol thresholds. We report any alcohol use during pregnancy using an AUDIT-C cut-off of zero to identify no alcohol use. Using an AUDIT-C cut-off of ≥ 3 (which has previously been used with pregnant women in South Africa [13]), we report hazardous drinking prior to and during pregnancy. We consider all alcohol use during pregnancy to be "risky"; therefore, we adopted a conservative AUDIT cut-off of ≥ 5 to capture even light to moderate patterns alcohol use which we would consider "higher risk" during pregnancy [43]. This "higher risk" cut-off captures the categories of risky, harmful, and severe alcohol use in women and has previously been used among pregnant women in South Africa [43]. To identify women with probable alcohol dependence, we used a cut-off of ≥ 20.

HIV risk, our primary dependent variable of interest, was measured through a proxy composite variable of four risk factors that have previously been associated with increased risk of HIV acquisition: (1) diagnosis with a STI infection (measured at baseline), (2) self-report of multiple sexual partners (reporting more than one partner in the past 3 months), (3) self-report of partner HIV serostatus (dichotomized into two categories: HIV-negative/no partner and HIV-positive/unknown serostatus), and (4) self-report of condomless sex at last sex. These risk behaviors were chosen for their known associations with increased risk of HIV acquisition [45–47] and alcohol use [22–24] and their modifiable nature (i.e., ability to be targeted through an intervention). An ordinal count variable was created for individuals experiencing these risk factors. A sensitivity analysis was performed to identity an optimal cut-off and a binary composite HIV sexual risk variable was created for those at high-risk versus not high-risk. Results are presented for two cut-offs: we explore classifying women who experience two or more HIV risk factors as high-risk as well as classifying women who experience three or more HIV risk factors as high-risk.

Other measures analyzed in descriptive and multivariable analysis included sociodemographic variables such as age, educational attainment (did not complete secondary school/completed secondary school), employment status (a six category variable collapsed into a three category variable: any form of employment/unemployed/student), residence type (a five category variable collapsed into a binary variable: formal/informal housing) and beliefs that may impact alcohol use during pregnancy such as participants' pregnancy intentions, which were measured using items adapted from prior studies of fertility intentions in this setting [48, 49], including feelings about the timing of the pregnancy (did this pregnancy happen at the right/wrong time?) and having a baby (I wanted to have a baby/I have mixed feelings about having a baby/I did not want to have a baby). HIV risk factors were also considered, including current sexual partner (no/yes, the father of my unborn baby/yes someone else), relationship status (cohabitating/not cohabitating), likelihood their partner has other sexual partners (not likely at all/somewhat likely/very likely/I don't know), and frequency of condom use in past 3 months (never/rarely/sometimes/almost always/always). Other risk factors included depression, using the Edinburgh Postnatal Depression Scale (EPDS) [50] (cut-off of ≥ 11 for depression [51]) and experiences of past year verbal, physical and sexual IPV using 13 items adapted from the WHO IPV Scale (collapsed into a binary variable: any/no recent experiences of IPV) [52, 53].

Data Analysis

Analyses were conducted using SAS studio [54]. The data were first inspected for errors, omissions, and values lying outside of the limit ranges. To identify the most appropriate alcohol use measure to utilize in the main analysis of the present study, a sensitivity analysis was performed to explore the distribution of participants using various alcohol use measures and cut-offs. The analytic sample was restricted to participants who provided responses to our primary exposure of interest, alcohol use, resulting in an analytic sample of 1201. The distribution, mean and median, for each of our alcohol measures were explored as well as the internal reliability (Cronbach's alpha coefficient) and cut-off points were informed by the existing literature. Based on this sensitivity analysis and our prior work it was determined that past year alcohol use prior to pregnancy would be the alcohol measure used in bivariate and multivariable analyses. Next, sociodemographic and HIV risk related behavioral variables of interest were analyzed, using descriptive statistics, to characterize the analytic sample, overall, and by alcohol use. Stratified bivariate analysis of covariates by any past year alcohol use prior to pregnancy was performed using χ^2 analysis, fisher's exact test and the two sample t-test. Statistical significance was determined using an alpha of 0.05.

To test our two hypotheses, multivariable logistic regression models were built using the proc logistic function and the logit link to explore associations between past year alcohol use prior to pregnancy and our HIV risk outcome. Directed acyclic graphs were used a priori to determine the minimally sufficient set of covariates to adjust for to reduce bias from measured confounders (see supplemental file). A variable was considered a confounder if it was predictive of both the exposure and outcome and was not on the causal pathway between exposure and outcome. Multicollinearity was assessed by examining the intercorrelations between the exposure variables in the model as well as the tolerance and variance inflation factor (VIF). All VIF approximated 1, no tolerance values were < 0.1 and no correlations exceeded 0.7.

Results

Description of the Study Sample

Table 1 provides relevant sociodemographic and behavioral characteristics from baseline visits (i.e., first ANC appointment) for the 1201 study participants. Characteristics are provided for the overall sample and stratified by past year alcohol use prior to pregnancy. Mean age of participants was 26.6 years (SD 5.9); median gestational age was 21 weeks (interquartile range (IQR) 15–31). Roughly half (51%, n = 617) had completed secondary schooling and roughly half resided in an informal dwelling (54%, n = 644). Past year IPV was reported by 12% (n = 147) of participants and 7% (n = 89) of participants had EPDS scores indicative of current depression. Half (50%, n = 598) felt the timing of the pregnancy was wrong and nearly half (49%, n = 585) reported they did not want to have the baby. Most participants currently had a sexual partner (92%, n = 1105) and this partner was almost always the baby's father. More than one in five participants (22%, n = 268) were unaware of their partners HIV serostatus while 2% (n = 18) reporting having a partner living with HIV. Most participants (69%, n = 804) reported never using a condom in the prior 3 months and not using a condom at last sex (88%, n = 1057). Nearly one third of participants (29%, n = 345) were diagnosed with a STI infection. Mean age, residence type, past year IPV, pregnancy timing, feelings about the pregnancy, cohabitation, primary partner's HIV status and having multiple sexual partners, significantly differed by alcohol use status. Persons reporting alcohol use (versus no alcohol use) were more likely to be younger (mean age 25.9 years vs 27.3 years, $t = 4$, $p < 0.0001$), less likely to live in an informal dwelling (48% vs 59%, $\chi^2 = 16.1$, $p < 0.0001$), more likely to report IPV (17% vs 8%, $\chi^2 = 25.7$, $p < 0.0001$), less likely to feel the pregnancy timing was good (45% vs 55%, $\chi^2 = 12.2$, $p = 0.0005$), less likely to report wanting to have the baby (30% vs 42%, $\chi^2 = 17$, $p = 0.0002$), less likely to live with their primary partner (32% vs 48%, $\chi^2 = 27.7$, $p < 0.0001$), more likely to have a partner of unknown HIV serostatus (25% vs 19%, $\chi^2 = 8.1$, $p = 0.0434$) and more likely to have multiple partners (5% vs 1%, $\chi^2 = 14$, $p = 0.0002$).

Sensitivity Analysis of Alcohol Use Measures in the Study Sample

Results from the sensitivity analysis of our alcohol use measures before and during pregnancy can be found in Fig. 1. Any alcohol use in the past year prior to pregnancy was reported by half of participants (50%, n = 603) while 6% (n = 72) of participants reported any alcohol use during pregnancy. Prior to pregnancy, one-third (33%, n = 396) of the sample engaged in heavy alcohol use (see footnote on Fig. 1) while 2% (n = 23) engaged in heavy alcohol use during pregnancy. When looking exclusively among those reporting any alcohol use prior to pregnancy, the majority (66%, n = 396) engaged in heavy alcohol use. When looking exclusively among those reporting any alcohol use during pregnancy, one-third (32%, n = 23) engaged in heavy alcohol use. Three percent of all women (n = 33) had AUDIT scores indictive of risky drinking during pregnancy. Of those reporting any alcohol use during pregnancy, 46% (n = 33) had AUDIT scores indictive of risky drinking during pregnancy. Three percent (n = 2) of women reporting any alcohol use during pregnancy had an AUDIT score indictive of probable alcohol dependence. The AUDIT and AUDIT-C (for both reference periods: during and before pregnancy) had Cronbach's alpha coefficients suggestive of good internal consistency (> 0.8) in our study sample.

Descriptive Characteristics of Women by HIV Risk Profile

Table 2 presents sociodemographic characteristics of women stratified by HIV risk score. Across risk levels, women were similar in age. Women in the lowest risk group (0 risk factors) had the latest median gestational age at first visit 25 [IQR 19–35], More women in the higher HIV risk groups had not completed secondary school (61.7%, 53.8% and 40.5% in the 3+, 1–2 and 0 risk categories, respectively). Employment was comparable across groups while more women in the higher risk groups resided in informal housing (61.7%, 53.8% and 40.5% in the 3+, 1–2 and 0 risk categories, respectively). IPV was more prevalent among women with higher HIV risk scores (13.8%, 12.5% and 6.8% in the 3+, 1–2 and 0 risk categories, respectively) and so was alcohol use before and during pregnancy. Women in the lower HIV risk categories experienced a higher prevalence of depression (9.5% in the 0-risk category compared to 7.5% and 5.3% in the 1–2 and 3+ risk categories). Fewer women in the highest risk group lived with their partner (22.6% vs 41.7% and 41.4% for the 1–2 risk category and 0 risk category, respectively). Feelings around wanting to have a baby were similar across groups. The proportion of women reporting condomless sex and other HIV risk factors included in the HIV index increased as risk profile increased. Three percent of women (n = 3) in the highest risk category had all four HIV risk factors.

Bivariate and Multivariable Regression Analysis of Alcohol Use on HIV Risk

Figure 2 presents the results from bivariate and multivariable analysis of the association between past year alcohol use prior to pregnancy and HIV risk. In multivariable analysis,

Table 1 Sociodemographic and behavioral characteristics associated with alcohol use in 12 months prior to pregnancy among pregnant women at risk of HIV in Cape Town, South Africa (n = 1201 women)

	Overall (n = 1201)	No alcohol use (n = 603, 50.2%)	Any alcohol use (n = 598, 49.8%)	Statistical test	P value
Age					
Mean (SD)	26.6 (5.9)	27.3 (6.1)	25.9 (5.6)	$t = 4$	< 0.0001
Gestational age at first ANC visit					
Median [IQR]	21 [15–31]	22 [15–32]	21 [14–30]	$z = -0.6$	0.5370
Educational attainment				$x^2 = 3.76$	0.0526
Did not complete secondary	584 (48.6%)	310 (51.4%)	274 (45.8%)		
Completed secondary	617 (51.4%)	293 (48.6%)	324 (54.2%)		
Employment status				$x^2 = 0.8$	0.6621
Employed (full/part-time, formal/informal)	431 (35.9%)	220 (36.5%)	211 (35.3%)		
Student	131 (10.9%)	61 (10.1%)	70 (11.7%)		
Unemployed	639 (53.2%)	322 (53.4%)	317 (53.0%)		
Residence type				$x^2 = 16.1$	< 0.0001
Informal dwelling	644 (53.6%)	358 (59.4%)	286 (47.8%)		
Formal dwelling	557 (46.4%)	245 (40.6%)	312 (52.2%)		
Past year IPV				$x^2 = 25.7$	< 0.0001
Yes	147 (12.2%)	45 (7.5%)	102 (17.1%)		
No	1054 (87.8%)	558 (92.5%)	496 (82.9%)		
Depression				$x^2 = 3.7$	0.0557
Depression (EPDS ≥ 11)	89 (7.4%)	36 (6.0%)	53 (8.9%)		
No depression	1112 (92.6%)	567 (94.0%)	545 (91.1%)		
Pregnancy timing				$x^2 = 12.2$	0.0005
Pregnancy happened at the right time	603 (50.2%)	333 (55.2%)	270 (45.2%)		
Pregnancy happened at the wrong time	598 (49.8%)	270 (44.8%)	328 (54.8%)		
Feelings about pregnancy				$x^2 = 17$	0.0002
I wanted to have a baby	432 (36.0%)	251 (41.6%)	181 (30.3%)		
I have mixed feelings about having a baby	184 (15.3%)	87 (14.4%)	97 (16.2%)		
I did not want to have a baby	585 (48.7%)	265 (44.0%)	320 (53.5%)		
Current partner				$x^2 = 3.1$	0.2136
No partner	96 (8.0%)	54 (9.0%)	42 (7.0%)		
Yes, the partner is my unborn baby's father	1095 (91.2%)	546 (90.5%)	549 (91.8%)		
Yes, the partner is not my unborn baby's father	10 (0.8%)	3 (0.5%)	7 (1.2%)		
Relationship status (n = 1105)				$x^2 = 27.7$	< 0.0001
Cohabitating	443 (40.1%)	263 (47.9%)	180 (32.4%)		
Not cohabitating	662 (59.9%)	286 (52.1%)	376 (67.6%)		
Partner has other sexual partners (n = 1095)				$x^2 = 2.3$	0.5052
Not likely	219 (20.0%)	110 (20.1%)	109 (19.8%)		
Somewhat likely	423 (38.6%)	210 (38.5%)	213 (38.8%)		
Very likely	166 (15.2%)	75 (13.7%)	91 (16.6%)		
Don't know	287 (26.2%)	151 (27.7%)	136 (24.8%)		
Frequency of condom use in past 3 months (n = 1167)				$x^2 = 4.4$	0.10916
Never	804 (68.9%)	387 (66.4%)	417 (71.4%)		
Rarely/Sometimes	317 (27.2%)	168 (28.8%)	149 (25.5%)		
Almost always/always	46 (3.9%)	28 (4.8%)	18 (3.1%)		
Primary partner's HIV status				$x^2 = 8.1$	0.0434
Positive	20 (1.7%)	9 (1.5%)	11 (1.8%)		
Negative	852 (70.9%)	450 (74.6%)	402 (67.2%)		
Don't know	268 (22.3%)	116 (19.2%)	152 (25.4%)		
No recent partner	61 (5.1%)	28 (4.7%)	33 (5.5%)		

Table 1 (continued)

	Overall (n = 1201)	No alcohol use (n = 603, 50.2%)	Any alcohol use (n = 598, 49.8%)	Statistical test	P value
Multiple partners in past 3 months				$x^2 = 14.0$	0.0002
Yes	36 (3.0%)	7 (1.2%)	29 (4.9%)		
No	1165 (97.0%)	596 (98.8%)	569 (95.2%)		
Condom use at last sex				$x^2 = 1.9$	0.1713
Yes	144 (12.0%)	80 (13.3%)	64 (10.7%)		
No	1057 (88.0%)	523 (86.7%)	534 (89.3%)		
Current STI diagnosis				$x^2 = 0.6$	0.4277
Yes	345 (28.7%)	167 (27.7%)	178 (29.8%)		
No	856 (71.3%)	436 (72.3%)	420 (70.2%)		
Composite HIV sexual risk measure				$x^2 = 14.6$	0.0022
0 risk factor	74 (6.2%)	50 (8.3%)	24 (4.0%)		
1 risk factor	625 (52.0%)	324 (53.7%)	301 (50.3%)		
2 risk factors	408 (34.0%)	190 (31.5%)	218 (36.5%)		
3+ risk factors	94 (7.8%)	39 (6.5%)	55 (9.2%)		

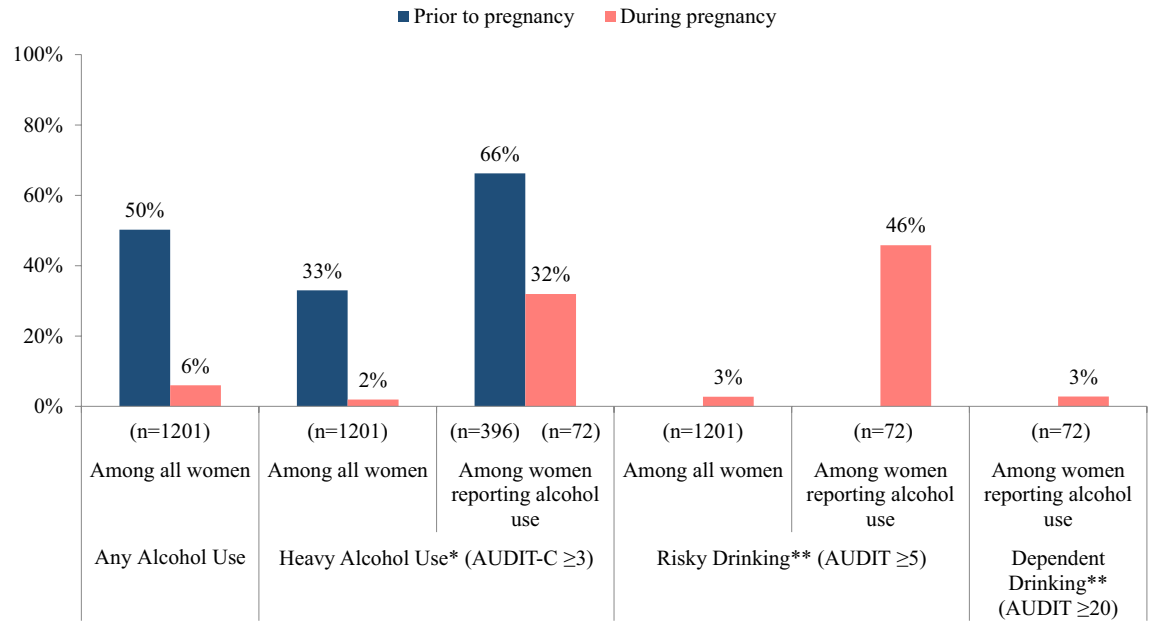

Fig. 1 Alcohol use severity prior to and during pregnancy among pregnant women in Cape Town, South Africa (n = 1201). *The term "hazardous drinking" is frequently used to describe the consumption patterns of women with scores ≥ 3; however, given that all alcohol use during pregnancy presents hazards and any alcohol use during pregnancy can lead to adverse health outcomes, we have relabeled this category as "heavy alcohol use" to remove implication that alcohol use under this threshold is non-hazardous. **The 10 item AUDIT was only asked for the reference period "during pregnancy", precluding our ability to report prevalence estimates for risky and dependent drinking "prior to pregnancy"

the model was adjusted for the following potential confounders: age, education level, employment status, residence type and current partner. Using the cut-off of two or more risk factors to denote "high risk" for HIV acquisition, after adjusting for covariates, persons reporting past year alcohol use prior to pregnancy had 1.33 times greater odds of being in the high HIV risk category than persons reporting no alcohol use prior to pregnancy (adjusted OR 1.33, 95% CI 1.05–1.68). Using the cut-off of three or more risk factors to denote "high risk" after adjusting for these covariates, persons reporting past year alcohol use prior to pregnancy had 1.47 times greater odds of being in the high HIV risk

Table 2 Sociodemographic and behavioral characteristics of women by HIV risk profile

	0 risk factors (n = 74)	1–2 risk factors (n = 1033)	3+ risk factors (n = 94)
	n (%)	n (%)	n (%)
Age			
Mean (SD)	26.4 (5.7)	26.7 (5.9)	25.8 (6.3)
Gestational age			
Median [IQR]	25 [19–35]	21 [14–31]	20 [13–29]
Educational attainment			
Did not complete secondary	34 (46.0%)	492 (47.6%)	58 (61.7%)
Completed secondary	40 (54.1%)	541 (52.4%)	36 (38.3%)
Employment status			
Employed (full/part-time, formal/informal)	27 (36.5%)	376 (36.4%)	28 (29.8%)
Student	7 (9.5%)	111 (10.7%)	13 (13.8%)
Unemployed	40 (54.0%)	546 (52.9%)	53 (56.4%)
Residence type			
Informal dwelling	30 (40.5%)	556 (53.8%)	58 (61.7%)
Formal dwelling	44 (59.5%)	477 (46.2%)	36 (38.3%)
Past year IPV			
Yes	5 (6.8%)	129 (12.5%)	13 (13.8%)
No	69 (93.2%)	904 (87.5%)	81 (86.2%)
Any alcohol use before pregnancy			
Yes	24 (32.4%)	519 (50.2%)	55 (58.5%)
No	50 (67.6%)	514 (49.8%)	39 (41.5%)
Any alcohol use during pregnancy			
Yes	2 (2.7%)	62 (6.0%)	8 (8.5%)
No	72 (97.3%)	971 (94.0%)	86 (91.5%)
Depression			
Depression (EPDS ≥ 11)	7 (9.5%)	77 (7.5%)	5 (5.3%)
No depression	67 (90.5%)	956 (92.6%)	89 (94.7%)
Pregnancy timing			
Pregnancy happened at the right time	29 (39.2%)	534 (51.77%)	40 (42.6%)
Pregnancy happened at the wrong time	45 (60.8%)	499 (48.3%)	54 (57.5%)
Feelings about pregnancy			
I wanted to have a baby	24 (32.4%)	378 (36.6%)	30 (31.9%)
I have mixed feelings about having a baby	8 (10.8%)	165 (16.0%)	11 (11.7%)
I did not want to have a baby	42 (56.8%)	490 (47.4%)	53 (56.4%)
Current partner			
No partner	16 (21.6%)	79 (7.6%)	1 (1.1%)
Yes, the partner is my unborn baby's father	58 (78.4%	946 (91.6%)	91 (96.8%)
Yes, the partner is not my unborn baby's father	0 (0%)	8 (0.8%)	2 (2.1%)
Relationship status			
Cohabitating	24 (41.4%)	398 (41.7%)	21 (22.6%)
Not cohabitating	34 (58.6%)	556 (58.3%)	72 (77.4%)
Partner has other sexual partners (n = 91?? I get 1095)			
Not likely	14 (24.1%)	197 (20.8%)	8 (8.8%)
Somewhat likely	15 (25.9%)	375 (39.6%)	33 (36.2%)
Very likely	10 (17.2%)	133 (14.1%)	23 (25.3%)
Don't know	19 (32.8%)	241 (25.5%)	27 (29.7%)
Frequency of condom use in past 3 months			
Never	8 (15.1%)	723 (70.9%)	73 (77.7%)
Rarely/Sometimes	29 (54.7%)	267 (26.2%)	21 (22.3%)

Table 2 (continued)

	0 risk factors (n = 74)	1–2 risk factors (n = 1033)	3+ risk factors (n = 94)
	n (%)	n (%)	n (%)
Almost always/always	16 (30.2%)	30 (2.9%)	0 (0.0%)
Primary partner's HIV status			
Positive	0 (0%)	15 (1.5%)	5 (5.3%)
Negative	63 (85.1%)	787 (76.2%)	2 (2.1%)
Don't know	0 (0%)	182 (17.6%)	86 (91.5%)
No recent partner	11 (14.9%)	49 (4.7%)	1 (1.1%)
Multiple partners in past 3 months			
Yes	0 (0%)	56 (5.5%)	14 (14.9%)
No	74 (100%)	964 (94.5%)	80 (85.1%)
Condom use at last sex			
Yes	74 (100%)	69 (6.7%)	1 (1.1%)
No	0 (0%)	964 (93.3%)	93 (98.9%)
Current STI infection			
Yes	0 (0%)	258 (25%)	87 (92.6%)
No	74 (100%)	775 (75%)	7 (7.4%)

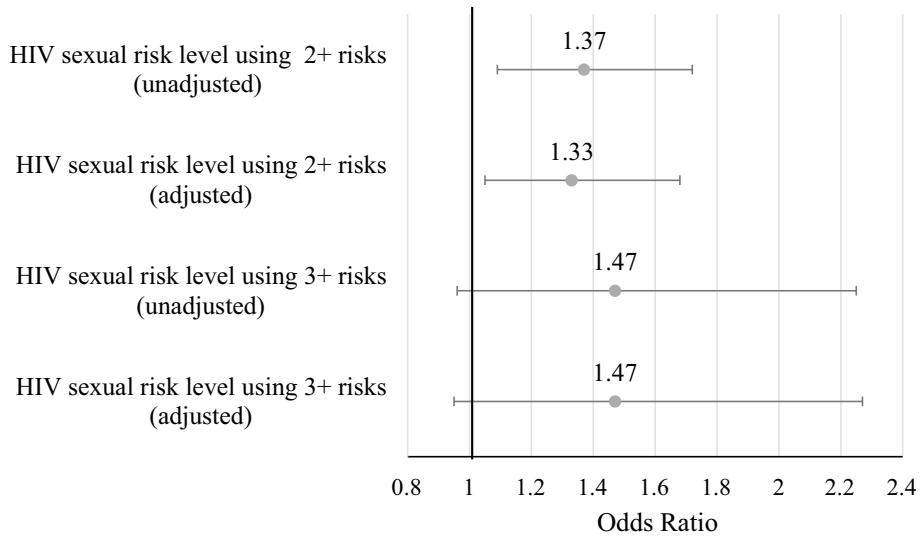

Fig. 2 Unadjusted and adjusted[1] analyses of associations between any alcohol use before pregnancy and HIV sexual risk[2]. [1]Model adjusted for age, education level, employment status, residence type and current partner. [2]HIV sexual risk measured by presence of an STI, multiple partners, condom use at last sex and partner HIV status. Individuals with three or more of these risks were considered "high risk"

category than persons reporting no alcohol use prior to pregnancy (adjusted OR 1.47, 95% CI 0.95–2.27).

Discussion

Using multiple validated measures of alcohol use and cut-offs consistent with the existing literature, the present study fills important gaps in the literature by characterizing alcohol use consumption and severity among pregnant women in South Africa. We also examined the potential role alcohol use may play as a risk factor for engaging in sexual risk behaviors in pregnancy by exploring associations between alcohol use prior to pregnancy and HIV sexual risk among HIV-uninfected pregnant women in South Africa. Obtaining accurate estimates of alcohol use during pregnancy presents challenges. Alcohol use during pregnancy is stigmatized and subject to underreporting due to social desirability bias [55]. In our study sample, as expected the prevalence of alcohol use was much lower during pregnancy relative to prior to pregnancy (6% vs 50%). Nevertheless, the prevalence of alcohol use prior to pregnancy in our sample was higher than that observed in another recent study of HIV-uninfected women in Cape Town (50% vs 40%), but the prevalence of heavy alcohol use (defined as an AUDIT-C score ≥ 3) among those

who reported any alcohol use, was similar in both samples at (66% vs 65%) [7]. Observing a reduction of alcohol use and increased abstinence among pregnant women was expected; a large global body of evidence suggests that many women reduce their alcohol use or stop drinking entirely once their pregnancy is recognized [56–59]. However, our estimate for alcohol use during pregnancy is lower than expected given estimates from prior studies. A recent systematic review and meta-analysis of alcohol use during pregnancy found a pooled alcohol use during pregnancy prevalence of 10.0% (95% CI 8.5–11.8%) in the WHO Africa region [60]. Underreporting of alcohol use during pregnancy in our sample may partially account for the low prevalence observed; timing of recognition of pregnancy may have also influenced this measure.

Women in our study who reported alcohol use prior to pregnancy differed in several ways from women who did not report this behavior. They had increased odds of reporting recent IPV, consistent with a prior study among women and men attending drinking establishments in Cape Town that found associations between IPV and both alcohol consumption and binge drinking among pregnant women [61]. Pregnant women who drank alcohol also had increased odds of being depressed and reporting an unplanned pregnancy, consistent with findings from a meta-analysis where depression and unplanned pregnancy were both predictors of alcohol use during pregnancy [62]. While it is known that pregnant women, including women in South Africa, experience stigma around alcohol use during pregnancy from healthcare providers [63–66], there is a dearth of literature exploring community norms and attitudes towards maternal drinking and how these may facilitate alcohol use in this population [64]. Some qualitative work has been undertaken to explore pregnant women's perceptions of these norms and attitudes [67], but there is a need for qualitative work with drinking partners, peers and family members to understand interpersonal and familial drivers of alcohol use during pregnancy and the post-partum period.

Two recent systematic reviews of psychosocial and structural interventions to address alcohol use in sub-Saharan Africa highlight the limited number of evidence-based interventions to address alcohol use in pregnancy in this setting [68, 69]. No structural interventions were identified. The reviews found a total of two psychosocial interventions [70–72] aimed at addressing alcohol use during pregnancy, both in South Africa. A brief intervention (BI) produced a significant reduction in mean AUDIT score immediately after intervention delivery but did not report outcomes in the post-partum period [72]. A peer-led mentor mother intervention providing a maternal care package (which included HIV prevention content and a single session on alcohol use) found increased abstinence 5 years postpartum but did not improve abstinence relative to the control group during the critical pregnancy and breastfeeding periods [71]. Neither intervention was designed to address alcohol use among persons experiencing alcohol dependence. Resources to address alcohol and other substance dependence in South Africa are limited and socioeconomic inequities in access to such services exist [73]. Given that alcohol withdrawal can be medically dangerous among persons experiencing alcohol dependence (for both mother and fetus) it is also important to identify women experiencing alcohol dependence in pregnancy to refer them to treatment centers that can facilitate supervised detoxification [74]. Although no structural interventions were identified in these reviews, evidence from other settings suggests they may help to reduce alcohol consumption [75]. Structural interventions seek to change the environment where risk behavior occurs (e.g., providing free water in drinking establishments) and could complement a roll out of targeted psychosocial interventions to address perinatal alcohol use, specifically. The disease burden associated with alcohol use and HIV during pregnancy and the paucity of available interventions to address these issues underscore the urgent need for culturally acceptable, evidence-based interventions to address alcohol use (including alcohol dependence) and HIV prevention among pregnant women in South Africa.

The women in our study are at high risk of HIV infection generally, due to the high prevalence of HIV in their community and increased risk of HIV acquisition during pregnancy [76]. Using both cut-offs (2+ risks and 3+ risks) we observed an effect in the expected direction with women reporting alcohol use having greater odds of being in the high HIV sexual risk category. The four risk factors: partner HIV serostatus, having > 1 recent sex partners, condomless sex at last sex and the presence of an STI, present opportunities for intervention, both directly as well as through reduced alcohol use. Alcohol use can reduce inhibitions and impair judgement around sexual decision making, including condomless sex [25], sex with non-primary partners [22, 23], and sex with partners of unknown HIV serostatus. Reduction in alcohol use may decrease engagement in these sexual risk behaviors. These results also highlight opportunity for integration of additional HIV prevention strategies into intervention programming. For example, among women in the highest risk group in our sample, 92% were unaware of their partner's HIV status. In the last decade, HIV self-testing (HIVST) [77] and couples HIV testing have emerged as promising interventions for reaching people that would otherwise be unlikely to access testing, such as male partners [78, 79] and inclusion of these testing strategies in interventions could have substantial added value among pregnant women in Cape Town.

The high prevalence of persons with partners of unknown HIV serostatus and high risk of HIV acquisition in pregnancy also underscore the importance of integrating

PrEP as a female controlled option for protection against HIV acquisition and onward transmission in this population. When taken correctly and consistently, daily oral PrEP (TDF/FTC) is a safe and highly effective method of HIV prevention [80–82]. Alcohol use is associated with barriers to optimum health outcomes in the pre-exposure prophylaxis (PrEP) care continuum, around initiation and adherence [83], reducing the utility of the most effective biomedical intervention available to reduce HIV acquisition in individuals at high risk of infection. A robust body of literature suggests that alcohol use is also a barrier to ART uptake and adherence among persons living with HIV [84], including pregnant women [85]. The effects of alcohol use on HIV risk, including non-adherence to PrEP, are especially problematic in pregnant women due to elevated risk for HIV acquisition during pregnancy [76]. Further understanding of the relationship between alcohol use and PrEP initiation and adherence is needed to determine if alcohol is a barrier to optimal uptake of this HIV prevention measure in this population.

The prevalence of other STIs was also high in our study sample (29%). While the prevalence of STIs was slightly higher among persons who use alcohol, this difference was not statistically significant. However, the high prevalence throughout the study sample makes addressing STIs in this population a public health priority. To avoid reinfection in these women, it is important that they disclose their status to their partner and encourage their partner to receive treatment. Qualitative work with HIV positive pregnant women in Pretoria highlights barriers and facilitators to partner disclosure of STI results that pregnant women experience; many participants indicated that fear of IPV was a barrier to disclosure [86]. To avoid re-infection, interventions that support partner disclosure, expedited partner therapy and offer support services for women experiencing IPV are needed in addition to STI testing services [87].

Finally, the late gestational age at first visit in our sample as well as the high prevalence of unplanned pregnancies underscore the risk of perinatal alcohol exposure in this setting and need to intervene on perinatal alcohol use prior to linkage to ANC care. Integration of screening, brief interventions, and referral to treatment (SBIRT) into other women's health services, such as family planning, STI treatment or well woman visits could offer opportunities for alcohol intervention prior to conception [88, 89]. Increasing affordability of home pregnancy tests (or offering them for free) could also promote earlier pregnancy awareness and reduce risk of an alcohol exposed pregnancy.

Our study had several limitations. Data were cross-sectional, precluding our ability to infer directionality or causality and all our alcohol use and HIV sexual risk variables (except for STI testing) were self-reported and subject to underreporting due to social desirability bias. The inclusions of objective measures (e.g. Phosphatidylethanol—i.e., PEth—detection) and prospective self-reported measures (e.g. ecological momentary assessment) of alcohol use, which are less subject to recall bias, could improve the accuracy of alcohol use estimates. Our study also had several strengths; we used globally validated alcohol measures in a large sample of HIV uninfected pregnant women to provide timely estimates of the prevalence of alcohol use and other HIV sexual risk factors in a population at high risk of HIV infection.

Conclusion

We found a high prevalence of alcohol use prior to pregnancy in our study sample which may reflect high levels of alcohol use in early pregnancy. Furthermore, alcohol use was associated with being at high risk of HIV acquisition in HIV-uninfected pregnant women. Evidence-based interventions to address alcohol use and other HIV risk behaviors during pregnancy in South Africa are desperately needed. We identified several modifiable behaviors that could be targeted in future interventions including, improved measures to increase partner HIV testing and disclosure, and, testing/counseling around STI results disclosure which could be integrated into ANC service delivery. Future studies should use objective measures of alcohol use as well as self-reported measures collected in real time to reduce bias from recall and social desirability. Finally, qualitative work is needed to understand individual and community level drivers of alcohol use among pregnant and breastfeeding women in this setting to develop a culturally tailored intervention to address these issues in this population.

Supplementary Information The online version contains supplementary material available at https://doi.org/10.1007/s10461-022-03742-1.

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Declarations

Conflict of interest The authors declare that there are no conflict of interest.

Informed Consent Written informed consent was obtained from all study participants; unassisted self-consent was obtained from adolescents (participants 16 and 17 years of age). Each woman received R100, (~USD$7) in compensation for her time.

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