High Rates of Biomarker-Confirmed Alcohol Use among Pregnant Women Living with HIV in South Africa and Uganda

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Abstract

Background—Alcohol use is common among people living with HIV and particularly harmful during pregnancy. However, objective data on alcohol use in pregnant women living with HIV (WLWH) are lacking. In areas with high levels of alcohol use generally, such as South Africa and Uganda, these data are needed to inform interventions.

Methods—Pregnant and non-pregnant, ART-naïve WLWH were recruited from outpatient clinics in South Africa and Uganda. Women provided self-report data on prior three-month alcohol use and potential mental health correlates of alcohol use (depression and stigma). Blood samples were used to measure phosphatidylethanol (PEth), an objective biomarker of recent alcohol intake. We analyzed any alcohol use (i.e., any self-reported use or PEth-positive [8 ng/ml]) and under-reporting of alcohol use (i.e., no self-reported use with concurrent PEth-positive).

Results—Among pregnant WLWH (n=163, median age was 26 [IQR: 23–29], median gestational age was 20 weeks [IQR: 16–26]), 40% were using alcohol and 16% under-reported alcohol use. Neither any alcohol use nor under-reporting of alcohol use differed significantly between pregnant and non-pregnant women or by country (*p*>0.05). Greater depression (but not greater stigma) was significantly associated with any alcohol use (aOR=1.41, 95% CI [1.01, 1.99]; *p*=0.045).

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Conclusions—Alcohol use was prevalent and under-reported among pregnant WLWH in South Africa and Uganda, similar to non-pregnant participants, and associated with depression. General healthcare and antenatal clinic settings present opportunities to provide integrated alcohol-based counseling and depression treatment.

Keywords

Alcohol; HIV; Pregnancy; South Africa; Uganda; Phosphatidylethanol; women living with HIV

Introduction

Hazardous alcohol use is an ongoing problem among individuals living with HIV worldwide. In South Africa and Uganda, where HIV prevalence is among the highest in the world,[1] the prevalence of hazardous alcohol use (ranging from heavy drinking to alcohol use disorders) is 7–31% among persons living with HIV.[2–5] Alcohol consumption among persons living with HIV is linked to lower adherence to antiretroviral therapy (ART) and, in some studies, compromised immunologic function and higher mortality.[7]

The harms of alcohol use are even greater among pregnant women living with HIV (WLWH), in part due to the adverse health impact on the developing fetus. Alcohol use during pregnancy is associated with low birth weight, pre-term delivery, and fetal alcohol syndrome, the latter of which affects as many as 21% of children in the Western Cape of South Africa.[8–10] Maternal HIV infection itself [11,12] and exposure to some forms of ART[13] may further increase risk for some of these poor outcomes.

Studies of perinatal alcohol use in South Africa and Uganda describe self-reported intake ranging from 18–43% during pregnancy.[14–17] While many WLWH may reduce or cease alcohol intake after learning of their pregnancy,[17,18] women who drink during pregnancy often do so at hazardous levels. Desmond and colleagues[17] found that, among pregnant WLWH in KwaZulu-Natal, South Africa, two-thirds of drinkers (12% of the full sample) reported typically consuming three or more drinks on each drinking occasion. Another analysis found that 9% of pregnant WLWH recruited in Cape Town, South Africa reported hazardous drinking while aware of their pregnancy[19]; these mothers' infants were more likely to be small for gestational age than those born to women reporting low levels of alcohol intake during pregnancy.

Perinatal alcohol use in South Africa and Uganda has not been evaluated using objective biomarkers measured during pregnancy, representing a significant gap in the literature for several reasons. For one, non-standard portion sizing[20] and varied ethanol content of alcoholic beverages[21] across sub-Saharan Africa makes self-report data in aggregate inherently unreliable. Moreover, persons living with HIV may under-report alcohol consumption due to social desirability bias, or fear of being denied ART by medical providers.[22] Indeed, studies comparing self-reported to objectively measured alcohol use among non-pregnant persons living with HIV in Uganda reveal under-estimates of both frequency and amount of alcohol use,[23,24] and a 50% under-reporting rate among patients initiating ART and testing positive for objective alcohol use.[25] Pregnant WLWH may be especially motivated to conceal unhealthy or risky behaviors, such as alcohol consumption.

A comparison of self-reported and objectively measured alcohol intake among pregnant WLWH, therefore, represents a critical next step in the literature. Moreover, gathering these objective data is particularly important in areas with known high per capita alcohol consumption, such as South Africa and Uganda.[26]

Understanding the drivers of alcohol use among pregnant WLWH is also important, and a necessary precursor to developing interventions aimed at reducing perinatal alcohol intake. Pregnancy is often a stressful time for women; one qualitative study among pregnant women surveyed at South African drinking establishments noted participants "drink[ing] [their] problems away," suggesting the use of alcohol to deal with complex life challenges.[27] This stress may be magnified among pregnant WLWH, who experience the added burdens of managing HIV, potential for HIV transmission to the newborn, and concerns about future child-rearing capacity.[18,28] Depression is twice as common among pregnant WLWH compared to HIV-seronegative pregnant women in sub-Saharan Africa,[29,30] and has been linked to increased self-reported alcohol use among pregnant WLWH in South Africa.[17] Relatedly, overt discrimination by healthcare workers due to HIV stigma has been reported by pregnant WLWH in Uganda and identified as a driver of maladaptive health behaviors, such as suboptimal engagement in HIV care.[31] It remains unknown whether HIV-related stigma is associated with alcohol use among pregnant WLWH in South Africa or Uganda.

The aims of this paper are to: (1) quantify alcohol consumption and under-reporting of alcohol consumption using self-report and objective biomarker data among pregnant WLWH starting ART in South Africa and Uganda; (2) compare any alcohol consumption and under-reporting of alcohol consumption between pregnant and non-pregnant WLWH; and (3) evaluate HIV-related depression and HIV-related stigma as correlates of alcohol consumption among pregnant and non-pregnant WLWH, with pregnancy status as a potential effect modifier.

Methods

Recruitment and Participants

The results presented in this paper represent cross-sectional, secondary analyses from a longitudinal study of adherence to ART among individuals with HIV initiating treatment (Measuring Early Treatment Adherence [META]; ClinicalTrials.gov, [32]). Participants were recruited from outpatient clinics offering HIV care in Cape Town, South Africa, and southwestern Uganda between March 2015 and September 2016. Patients were approached by study staff upon presenting for care. To be eligible for the parent study, participants were required to meet the following criteria: (1) diagnosed with HIV; (2) ART-naïve; (3) initiating ART within one month of enrollment; (4) at least 18 years of age; (5) live within 60 km of the clinic; (6) intending to stay in the area for the next year; (7) if pregnant, no more than 34 weeks gestation; (8) able to provide informed consent; and (9) able to communicate in English or local languages (Runyankole or Xhosa). Participants were excluded if they had either: (1) intermediate stage disease at enrollment (CD4: 200–349); or (2) among pregnant women only, late stage disease (CD4 < 200). For the analyses reported here, the sample was restricted to baseline visits only, and to individuals who provided both PEth and self-report data (see Figure 1). All women received care according to national guidelines for ART

treatment. The threshold for ART initiation was a CD4 count <500 cells/mm^3 during the recruitment period in both sites.

Measures

Participants completed a structured interview (measures detailed below) and blood draw at enrollment. Urine samples were collected from all women under age 50 to confirm pregnancy status.

Demographics—Participants were asked to provide basic demographic information including but not limited to age, income, marital status, and educational achievement.

HIV and pregnancy characteristics—Participants were asked to provide time since HIV diagnosis and gestational age. Past three-month CD4 cell count was extracted from participant medical charts, if available, and otherwise assessed by study blood draw at enrollment.

Alcohol consumption—Self-reported and objective alcohol consumption were measured using the three-item Alcohol Use Disorders Identification Test – Consumption (AUDIT-C)[33] and a blood biomarker (phosphatidylethanol [PEth]), respectively. For the present study, we modified the AUDIT-C to account for only the past three months of alcohol intake (versus past year). The AUDIT-C is scored on a scale of 0–12, with higher scores representing greater self-reported alcohol intake.

To measure objective alcohol use, PEth results were obtained by testing dried blood spots prepared from venous blood draws. PEth levels reflect alcohol intake up to three weeks prior to blood draw.[34] All samples were tested at the U.S. Drug Testing Laboratories in Des Plaines, IL using previously published methods.[35] PEth testing has demonstrated good sensitivity and specificity (88.0% and 88.5%, respectively) in detecting any alcohol consumption among people living with HIV.[36] PEth results have also effectively differentiated between true abstention and light, moderate, and heavy drinking among pregnant women.[37]

For the primary analyses in this paper, we defined alcohol use based on a combination of AUDIT-C and PEth values; a participant was positive for *any* alcohol use with an AUDIT-C > 0 (i.e., some self-reported alcohol use) and/or PEth ≥ 8 ng/ml (i.e., the lower limit of quantification). *Under-report* of alcohol use was defined as indication of no alcohol intake via self-report (AUDIT-C = 0) paired with a quantifiable PEth result (≥ 8 ng/ml). *Heavy/hazardous* alcohol use was defined as an AUDIT-C ≥ 3 (i.e., self-report cutoff for hazardous drinking, among women specifically) and/or PEth ≥ 50 ng/ml, consistent with cutoffs for heavy drinking used in previous studies.[38]

Depression—Depressive symptoms were measured using the Depression Scale of the Hopkins Symptom Checklist (DHSCL).[39] The scale used in the present study consisted of 12 items, each representing a distinct depressive symptom. This version of the DHSCL specifically omitted somatic symptoms of depression, as they may overestimate depression among individuals living with HIV.[40–42] Participants were asked to rate each symptom on a

four-point scale based on the extent to which they experienced it over the previous week (1 = Not at all, 4 = Extremely). The DHSCL has successfully been used to assess depression prevalence among residents of rural Uganda[43] and pregnant women across Africa.[44] We used a cutoff of 1.75, which has demonstrated good sensitivity for detecting depression in studies among African populations.[45,46]

In addition to the DHSCL, pregnant participants completed the Edinburgh Postnatal Depression Scale (EPDS).[47] The EPDS is a frequently utilized measure of perinatal depression severity and probable postnatal depression in African countries, including Uganda.[48] Meta-analytic analyses have revealed a pooled sensitivity of 0.94 (95% confidence interval [CI]: 0.68–0.99) and a pooled specificity of 0.77 (95% CI: 0.59–0.88) at the cutoff score of 9.[44] We used a cutoff score of 10, consistent with previous studies.[49,50]

Stigma—Perceived HIV-related stigma was measured using 20 items adapted from the Berger HIV Stigma Scale.[51] Items are scored on a four-point Likert scale (1 = Strongly disagree, 4 = Strongly agree) and summed across two domains: perceived negative attitudes, and disclosure concerns. Higher scores indicate greater perceived HIV-related stigma.

Statistical Analyses—For descriptive analyses, we calculated proportions for categorical variables, and means, standard deviations (SD), medians, and interquartile ranges (IQR) for continuous variables. We examined bivariate associations between participant characteristics by pregnancy status and by country (separately) using Chi-square tests (categorical variables) and Mann-Whitney tests (continuous variables). We conducted logistic regression to test bivariate associations between each independent variable of interest (pregnancy status; depression; perceived negative attitudes stigma; disclosure concerns stigma), sociodemographics, and any alcohol use (yes/no; primary outcome variable). Multivariable logistic regression models were used to test the associations of these variables with any alcohol use, while controlling for the following demographic covariates selected *a priori*: age, marital status, education, and study site. We additionally examined pregnancy as a potential effect modifier of these associations using interaction terms in separate multivariable models, with $p < 0.10$ on the likelihood ratio test considered statistically significant.

Results

Participant Characteristics

Descriptive statistics for demographic and clinical characteristics are presented in Table 1. Female study participants randomly selected for PEth testing ($n = 435$) were similar to those who were not selected for PEth testing ($n = 180$; 32 pregnant, 148 not pregnant); no significant differences were observed in age, marital status, education, household assets, months since HIV diagnosis, depression, or the disclosure concerns stigma scale. CD4 count was significantly higher among participants who had PEth results compared to those without (median = 428 [inter-quartile range [IQR]: 193–516], versus 384 [IQR: 144–451]; $p < 0.01$). Finally, scores on the perceived negative attitudes stigma scale were significantly lower

among those with PEth results compared to those without (median = 1 [IQR: 0–2], versus 2 ([IQR: 0–3]; $p = 0.02$).

Alcohol Use Prevalence

Table 2 presents descriptive statistics for alcohol use, and comparisons of alcohol use across participant groups based on pregnancy status and country. Among the 418 participants, 28.5% self-reported any alcohol use in the prior three months (AUDIT-C > 0). In comparison, 37.8% met criteria for any objective alcohol intake based on biomarker results (PEth 8 ng/ml). Combining self-report and objective alcohol use data, 42.6% ($n = 178$) of all participants met criteria for any alcohol use (AUDIT-C > 0 and/or PEth 8 ng/ml), with 14.1% of women under-reporting alcohol use. Further, 27.0% ($n = 113$) met criteria for heavy/hazardous alcohol use based on self-report and PEth results.

Comparing participants based on pregnancy status, 39.9% of pregnant participants were positive for any alcohol use (vs. 44.3% non-pregnant), and 23.3% were positive for heavy/hazardous alcohol use (vs. 29.4% non-pregnant). A greater proportion of pregnant women under-reported current alcohol use (16.0% pregnant vs. 12.9% non-pregnant). None of these differences were statistically significant ($p > 0.05$). Compared by study site, significantly more participants in South Africa met criteria for heavy/hazardous drinking (35.2%) compared to those in Uganda (20.0%; $p < 0.01$).

Correlates of Alcohol Use

Tables 3 and 4 present results of multivariable analyses examining pregnancy and depression, respectively, as correlates of any alcohol use. Pregnancy status was not significantly associated with alcohol use in bivariate or multivariable analyses, (adjusted Odds Ratio [aOR] = 0.80, 95% CI [0.51, 1.24], $p = 0.32$ [Table 3]); the association remained nonsignificant in bivariate analyses stratified for age, marital status, and study site (data not shown). Higher depression scores (on the DHSCL) were, however, significantly associated with any alcohol use after adjusting for pregnancy status and demographic covariates (age, marital status, education, and study site; aOR = 1.41, 95% CI [1.01, 1.99], $p = 0.045$ [Table 4]). Pregnancy status was not a statistically significant effect modifier of this relationship in the full sample (interaction $p > 0.10$); however, when we stratified these analyses by study site, pregnancy was a significant effect modifier among Ugandan participants only (depression + pregnant, aOR = 2.25, 95% CI [1.02, 4.94], $p = 0.04$ [Supplementary Table]). Neither stigma type (disclosure concerns stigma, negative attitudes stigma) was significantly associated with alcohol use in multivariable analyses (disclosure concerns, OR = 0.98, 95% CI [0.87, 1.11], $p = 0.78$; negative attitudes, OR = 0.97, 95% CI [0.82, 1.15], $p = 0.72$), and pregnancy status was not a statistically significant effect modifier in these relationships (disclosure concerns + not pregnant, aOR = 1.04, 95% CI [0.89, 1.21]; disclosure concerns + pregnant, aOR = 0.90, 95% CI [0.74, 1.10]; negative attitudes + not pregnant, aOR = 1.07, 95% CI [0.87, 1.33]; negative attitudes + pregnant, aOR = 0.81, 95% CI [0.60, 1.08]; all interactions, $p > 0.10$).

Discussion

We used a sensitive alcohol biomarker, phosphatidylethanol (PEth), to demonstrate a 43% prevalence of alcohol consumption among women living with HIV (WLWH) initiating ART in South Africa and Uganda. The inclusion of both pregnant and non-pregnant WLWH is unique in this study and allowed for direct comparisons of alcohol use and under-reporting of alcohol use across groups.

The high rates of perinatal alcohol use (40% any use, 23% heavy/hazardous use) among pregnant WLWH in our study are alarming, and exceed most previously reported figures, [17,19] including biological measures of ethanol use drawn from newborn meconium.[52] Our use of objective and sensitive biomarker data to quantify alcohol intake likely accounts for some of the observed discrepancy, and provided a more accurate assessment of alcohol use compared to self-report. Further, close to one in four pregnant WLWH engaged in heavy/ hazardous perinatal drinking, suggesting high risk for adverse infant outcomes in our sample. Heavy episodic drinking during pregnancy is associated with poor pregnancy outcomes (e.g., low birth weight) and risk for long-term neurodevelopmental deficits in children (e.g., attention problems), some of which persist into adulthood.[8–10,53] Knowledge of the risk of poor pregnancy outcomes associated with alcohol consumption should be reinforced among all pregnant women, and support provided to avoid any amount of alcohol intake. Indeed, data on the impact of light-to-moderate perinatal drinking on fetal neurodevelopment are inconclusive, and no level of alcohol use during pregnancy is considered reliably safe.[54,55] In addition, given emerging data on poorer birth outcomes among women living with HIV and exposed to ART,[13,56] our findings highlight the importance of objectively measuring other exposures known to impact birth outcomes.

Notably, alcohol use among pregnant WLWH in our study was not statistically different from non-pregnant women (40% vs. 44%, respectively). This finding raises questions about women's motivation and/or ability to cease alcohol intake following pregnancy recognition, and the role of cultural factors such as social drinking norms. While we did not collect data on alcohol use preceding conception, prior research has identified pre-pregnancy alcohol consumption as a strong predictor of perinatal consumption among women in South Africa[57]; this suggests that alcohol use counseling and reduction interventions could best support women of child-bearing age if offered *prior* to conception in addition to during pregnancy. For example, alcohol-based counseling could be integrated in women's healthcare, HIV care, and antenatal care settings, and may be performed by healthcare providers during clinic visits or off-site through community-based support groups.[58–60]

A significant minority of participants under-reported their alcohol intake, with similar rates demonstrated by pregnant and non-pregnant women (16% versus 13%, respectively). Our findings are consistent with a Ugandan study showing a 13% rate of alcohol use under-reporting among non-pregnant WLWH.[25] Some under-report of alcohol use is unsurprising given social desirability bias,[61] and that individuals initiating ART may be motivated to underplay their drinking behaviors for fear of being denied treatment.[22] In fact, the rate of alcohol use under-reporting among pregnant WLWH in our study is surprisingly low. This finding may suggest a pre-established atmosphere of open communication among patients

and providers in surveyed clinics or, conversely, patients' willingness to disclose alcohol use to study research assistants specifically (but *not* necessarily to medical providers), as observed in prior research.[24] The former explanation may be supported by the low levels of HIV-related stigma reported by our participants. As a third and final explanation, many WLWH in our study may have been unaware of the dangers posed by alcohol use during pregnancy, giving them little reason to conceal their true alcohol intake. Future research in this area should evaluate the association, if any, between women's knowledge of the impact of alcohol consumption on birth outcomes and objective alcohol intake.

A significantly greater proportion of our study participants (pregnant and non-pregnant) recruited from the South African clinic were heavy/hazardous drinkers (35%) compared to women in Uganda (20%). This discrepancy is consistent with population-based data showing more prevalent heavy episodic drinking in South Africa (10.4%) compared to Uganda (3.4%).[62] We did not explore the underpinnings of this finding; however, multifaceted cultural differences between countries, including social drinking norms, likely play a part.[27,63] Future research should identify key factors associated with alcohol consumption in each country and, based on those data, develop alcohol reduction interventions tailored to local WLWH.

Depression was common and found in approximately 40% of all WLWH in the study. Depression was also significantly associated with alcohol use, such that WLWH with greater depressive symptoms were more likely to consume alcohol. These depression rates are consistent with the extant literature[30,64] and suggestive of a pervasive problem among WLWH with potentially serious consequences. Indeed, a systematic review of the literature among persons living with HIV in sub-Saharan Africa showed that depressed patients were 55% less likely to demonstrate good adherence to ART compared to their non-depressed peers.[6] Interventions that integrate depression treatment with alcohol-based counseling are needed. Further, while pregnancy status was not a statistically significant effect modifier of the relationship between depression and alcohol use in our complete participant sample, we did find a significant association between incremental increases in depression and alcohol use among pregnant women only; it is possible that our relatively small sample size may have limited statistical power to detect a significant result in the full participant pool. Further research should attempt to confirm these findings in a larger sample.

Some methodological limitations to our study should be noted. First, PEth biomarker data reflect only sustained alcohol intake up to three *weeks* prior to blood draws,[65] whereas the self-report measure captures alcohol use from the preceding three *months*. This mismatch may have impacted the accuracy of our findings by *under*estimating the rate of under-reporting. Thus, our estimate of under-reporting in this sample of WLWH is likely a conservative one. Second, our findings may have differed had we prospectively measured alcohol intake in the months following ART initiation (i.e., after study enrollment). Research suggests that individuals starting HIV treatment are often driven to reduce alcohol intake in the short-term; however, alcohol reduction efforts may wane over time, possibly in the absence of HIV- or ART-related physical symptoms.[38] Indeed, an analysis of data from men and women living with HIV recruited for our parent study showed heavier alcohol use among individuals with higher CD4 levels in Uganda.[66] Third, it is possible that PEth results

among pregnant WLWH in our study were skewed due to intake of traditional fermented food and beverages with low, but detectable, alcohol content, and that are believed to render health benefits during pregnancy.[15] Fourth, our participant sample had significantly higher (i.e., better) CD4 levels and lower reported stigma compared to individuals from the parent study not included in these analyses. It is possible, therefore, that our data would not generalize to all persons living with HIV in the geographic regions sampled. Fifth, it is worth noting that some pregnant participants meeting criteria for perinatal alcohol consumption may have done so only *prior* to learning of their pregnancy. In other words, women who drank during pregnancy may not have been aware of their pregnancy. Those who have stopped drinking since learning they are pregnant may need counseling to avoid pregnancy during times of heavy alcohol use in the future, but may not need counseling during the current pregnancy. To maximize the efficacy of alcohol use interventions for pregnant WLWH, women should be asked about the timing of their drinking behaviors in relation to pregnancy recognition. Finally, the generalizability of our findings may be limited by the exclusion of individuals with intermediate stage disease, and the short average duration of time since HIV diagnosis (1.2 months) in our sample. The latter may have altered our results in a number of ways, namely inflating depression scores, and potentially decreasing alcohol use.[38]

Conclusions and Future Directions

This study is the first to provide biomarker-corroborated data on alcohol consumption among pregnant WLWH in sub-Saharan Africa, and to examine differences by pregnancy status across two African countries. We show very high proportions of WLWH using alcohol, with no difference by pregnancy. Depression was also common among both pregnant and non-pregnant participants, and positively associated with alcohol intake.

Offering integrated alcohol-based counseling and mental health services in women's HIV care and antenatal care settings may improve HIV health status and promote healthier pregnancies. The potential utility of integrating these services may be understood through a syndemics framework, wherein depression and alcohol use among WLWH represent intersecting epidemics with shared social and behavioral drivers.[10,67–69] Services could be performed by healthcare providers and held during clinic visits or off-site. Community-based support and task shifting (i.e., recruiting unspecialized or untrained health workers to conserve resources) show promise for large-scale delivery of supportive services. The Mentor Mother Programme, which trains community health workers to deliver home-visiting support and education to pregnant women in African countries, exemplifies this model.[70]

To minimize alcohol use under-reporting, providers should be encouraged to employ a patient-centered, non-judgmental approach in conversations about alcohol use with WLWH to encourage open dialogue and increase the likelihood of positive change. Future studies should also utilize biomarker data to corroborate alcohol use during pregnancy, and collect data on adverse pregnancy outcomes (e.g., neurodevelopmental problems) to assess the health impact of objective alcohol intake among pregnant WLWH, particularly in settings with high alcohol use.

Finally, while some data support the use of PEth to distinguish levels of drinking (e.g., none versus heavy) among pregnant women,[37,71] more studies are needed to confirm the validity of this method in the context of pregnancy (and the physiological changes associated with pregnancy, such as increased blood volume, which could impact test results).

Supplementary Material

Refer to Web version on PubMed Central for supplementary material.

Acknowledgments

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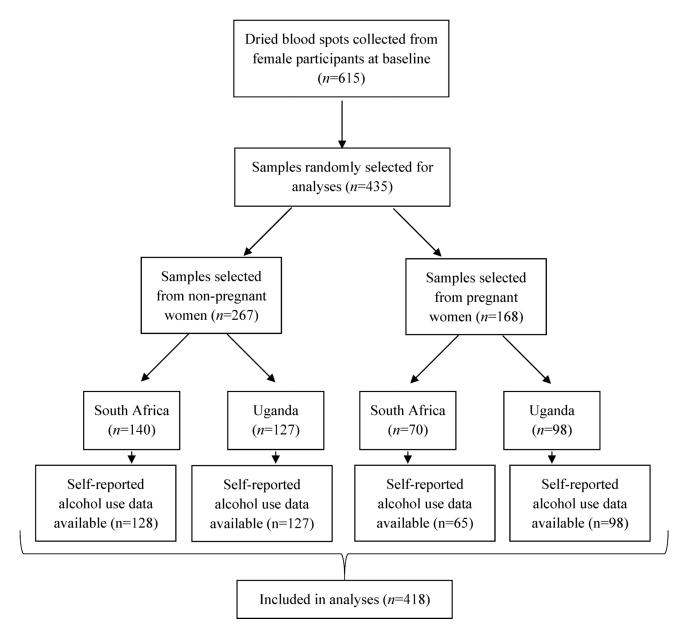
Figure 1.
Testing flow for study of women living with HIV in South Africa and Uganda

Table 1.

Participant demographic and clinical characteristics: overall, by group, and by study site ($N = 418$)[*]

	Total (N = 418)	Non-pregnant (n = 255)	Pregnant (n = 163)	Uganda (n = 225)	South Africa (n = 193)
	N (%)	N (%)	N (%)	N (%)	N (%)
Pregnant				98 (43.6)	65 (33.7)
Age (median (IQR))	29 (24–35)	**31 (25–39)**	**26 (23–29)**	**27 (23–32)**	**30 (26–37)**
Education					
Less than primary school	95 (22.7)	62 (24.3)	33 (20.3)	**77 (34.2)**	**18 (9.3)**
Primary school or more	323 (77.3)	193 (75.7)	130 (79.8)	**148 (65.8)**	**175 (90.7)**
Married/cohabitating	182 (43.5)	**86 (33.7)**	**96 (58.9)**	**133 (59.1)**	**49 (25.4)**
Household asset index					
Low	176 (44.1)	102 (42.2)	74 (47.1)	**126 (58.3)**	**50 (27.3)**
Middle	146 (36.6)	88 (36.4)	58 (36.9)	**49 (22.7)**	**97 (53.0)**
High	77 (19.3)	52 (21.5)	25 (15.9)	**41 (19.0)**	**36 (19.7)**
Months since HIV+ diagnosis (median [IQR])	1.2 (0.1–21.7)	**1.4 (0.4–27.6)**	**0.3 (0.0–12.7)**	1.2 (0.1–17.9)	1.1 (0.2–24.3)
CD4 (median [IQR])	427 (193–517)	**375 (135–448)**	**555 (435–692)**	**458 (362–596)**	**396 (176–474)**
Number medical visits in past 6 months (median [IQR]) [**]	2 (1–2)	**2 (2–3)**	**1 (1–2)**	2 (1–2)	2 (1–3)
Weeks gestation (median [IQR])	20 (16–26)	-	20 (16–26)	**19 (12–24)**	**24 (19–28)**
History of sexual violence (yes)	63 (15.1)	39 (15.4)	24 (14.7)	**53 (23.7)**	**10 (5.2)**
Hopkins depression scale (mean [SD])	1.7 (0.6)	**1.7 (0.6)**	**1.6 (0.6)**	**1.5 (0.6)**	**1.9 (0.6)**
Met clinical cutoff (yes; score 1.75)	164 (39.2)	**111 (43.5)**	**53 (32.5)**	**60 (26.7)**	**104 (53.4)**
Edinburgh Postnatal Depression Scale score (mean [SD])	9.2 (5.2)	--	9.2 (5.2)	8.7 (5.1)	9.9 (5.2)
Met clinical cutoff (yes; score 10)	59 (41.0)	--	59 (41.0)	**26 (32.9)**	**33 (50.8)**
Stigma: perceived negative attitudes score (mean [SD])	1.3 (1.2)	1.4 (1.2)	1.2 (1.1)	**1.1 (1.1)**	**1.5 (1.2)**
Stigma: disclosure concerns score (mean [SD])	1.9 (1.6)	**1.7 (1.6)**	**2.1 (1.6)**	2.0 (1.6)	1.8 (1.6)

[*] Values in bold indicate p-values <0.05 (comparing non-pregnant versus pregnant women, or Uganda versus South Africa).

[**] Number of medical visits includes all visits, scheduled or unscheduled, to a medical facility for any reason in the previous 6 months.

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Table 2.

Participant substance use: overall, by group, and by study site (*N* = 418)[*]

	Total (*N* = 418)	Non-pregnant (*n* = 255)	Pregnant (*n* = 163)	Uganda (*n* = 225)	South Africa (*n* = 193)
	N (%)	N (%)	N (%)	N (%)	N (%)
AUDIT-C (median [IQR])	0 (0–1)	0 (0–1)	0 (0–0)	**0 (0–1)**	**0 (0–2)**
Any self-reported alcohol use (prior 3 months) (yes; AUDIT-C >0)	119 (28.5)	80 (31.4)	39 (23.9)	61 (27.1)	58 (30.1)
PEth (ng/ml; median [IQR])	<LLQ (<LLQ-33)	<LLQ (<LLQ-38)	<LLQ (<LLQ-27)	<LLQ (<LLQ-15)	<LLQ (<LLQ-45)
Any objectively measured alcohol use (yes; PEth 8 ng/ml)	158 (37.8)	99 (38.8)	59 (36.2)	77 (34.2)	81 (42.0)
Any alcohol use (yes; AUDIT-C >0 and/or PEth 8 ng/ml)	178 (42.6)	113 (44.3)	65 (39.9)	91 (40.4)	87 (45.1)
Under-report of any alcohol use (yes; AUDIT-C=0 and PEth 8 ng/ml)	59 (14.1)	33 (12.9)	26 (16.0)	30 (13.3)	29 (15.0)
Heavy / hazardous alcohol use (yes; AUDIT-C 3 and/or PEth 50 ng/ml)	113 (27.0)	75 (29.4)	38 (23.3)	**45 (20.0)**	**68 (35.2)**
Current cigarette use	15 (3.6)	12 (4.7)	3 (1.8)	**2 (0.9)**	**13 (6.7)**
Current recreational drug use	4 (1.0)	3 (1.2)	1 (0.6)	1 (0.4)	3 (1.6)

[*] Values in bold indicate *p*-values <0.05 (comparing non-pregnant versus pregnant women, or Uganda versus South Africa).

[x] Recreational drug use includes marijuana or "other" recreational drugs.

Definitions: AUDIT-C = Alcohol Use Disorders Identification Test – Consumption; PEth = phosphatidylethanol; LLQ = Lower limit of quantification

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Table 3.

Multivariable logistic regression model examining the association between pregnancy status and any alcohol use ($N = 418$)[*]

	Adjusted OR (95% CI)	*p*-value
Pregnancy status		0.32
Not pregnant	1.00	
Pregnant	0.80 (0.51, 1.24)	
Age (per year)	0.98 (0.95, 1.00)	0.07
Marital status		0.39
Married/cohabitating	1.00	
Not married	1.21 (0.78, 1.86)	
Education		**0.03**
Less than primary school	1.00	
Primary school or more	**0.58 (0.35, 0.96)**	
Study site		0.17
Uganda	1.00	
South Africa	1.37 (0.87, 2.15)	

[*] Any alcohol use defined as AUDIT-C (prior 3 months) >0 and/or PEth 8 ng/ml.

Definitions: AUDIT-C = Alcohol Use Disorders Identification Test – Consumption; PEth = phosphatidylethanol

Table 4.

Multivariate analyses testing depression as a correlate of any alcohol use and pregnancy as a moderator of this relationship ($N = 418$)[*]

	Main Effects Model		Interaction Model	
	Adjusted OR (95% CI)	*p*-value	Adjusted OR[X] (95% CI)	*p*-value
Depression (Hopkins)[X]	**1.41 (1.01, 1.99)**	**0.045**	-	
Pregnancy status		0.38		
Not pregnant women	1.00		-	
Pregnant women	0.82 (0.52, 1.28)		-	
Pregnancy + depression[X]				Interaction *p*=0.25
Depression (+1 point), not pregnant	-		1.22 (0.81, 1.86)	0.34
Depression (+1 point), pregnant	-		1.83 (1.05, 3.19)	0.03
Age (per year)	0.98 (0.95, 1.00)	0.07	0.98 (0.95, 1.00)	0.09
Marital status		0.43		0.46
Married/cohabiting	1.00		1.00	
Not married	1.19 (0.77, 1.84)		1.18 (0.76, 1.82)	
Education		**0.04**		**0.04**
Less than primary school	1.00		1.00	
Primary school or more	**0.58 (0.35, 0.96)**		**0.59 (0.36, 0.97)**	
Study site		0.40		0.42
Uganda	1.00		1.00	
South Africa	1.22 (0.77, 1.95)		1.21 (0.76, 1.93)	

[*] Any alcohol use defined as AUDIT-C >0 and/or PEth 8 ng/ml

[X] Hopkins depression measure was used as continuous variable

Definitions: AUDIT-C = Alcohol Use Disorders Identification Test – Consumption; PEth = phosphatidylethanol