Published in final edited form as:

J Acquir Immune Defic Syndr. 2015 March 1; 68(3): 322–328. doi:10.1097/QAI.0000000000000433.

Traumatic stress and the mediating role of alcohol use on HIV-related sexual risk behavior: Results from a longitudinal cohort of South African women who attend alcohol-serving venues

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Abstract

Background—In South Africa, alcohol contributes to the HIV epidemic, in part, by influencing sexual behaviors. For some, high levels of alcohol consumption may be driven by previous traumatic experiences that result in traumatic stress. The purpose of this study was to quantify the longitudinal association between traumatic stress and unprotected sex among women who attend drinking venues and to assess whether this association was explained by mediation through alcohol use.

Methods—Data were collected in four waves over a year from a prospective cohort of 560 women who regularly attended alcohol-serving venues in a Cape Town township. Longitudinal mixed models examined: 1) the relationship between traumatic stress and counts of unprotected sex, and 2) whether alcohol use mediated the association between traumatic stress and unprotected sex.

Results—Most women reported elevated traumatic stress (80%) and hazardous alcohol use (88%) at least once during the study period. In models adjusted for covariates, traumatic stress was associated with unprotected sex ($b=0.28$, $SE=0.06$, $t=4.82$, $p<.001$). In addition, traumatic stress was associated with alcohol use ($b=0.27$, $SE=0.02$, $t=14.25$, $p<.001$), and was also associated with unprotected sex ($b=0.20$, $SE=0.06$, $t=3.27$, $p<.01$) while controlling for alcohol use ($b=0.28$, $SE=0.07$, $t=4.25$, $p<.001$). The test for the mediated effect established that alcohol use was a significant mediator, accounting for 27% of the total effect of traumatic stress on unprotected sex.

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Conflicts of Interest: The authors have no conflicts of interest to disclose.

Conclusions—These results highlight the need to address traumatic stress among female venue patrons as an important precursor of HIV risk due to alcohol use.

Keywords

HIV risk behavior; mental health; alcohol use; unprotected sex; mediation analysis; prospective cohort

INTRODUCTION

South Africa is one of the countries most affected by HIV, with approximately 17.9% of the population living with HIV.¹ Like the HIV epidemic, alcohol use in South Africa is a health concern, characterized by problematic patterns of drinking.² About a third of the adult population in South Africa reports alcohol consumption,³ and among those who do consume alcohol, they typically to drink at hazardous levels.⁴ This drinking pattern is also reflected among South African women; 24% report alcohol consumption and of the women who use alcohol, they tend to drink hazadously.⁵ Levels of drinking among South African women have been consistently maintained over time with little evidence of a decrease.⁶ Alcohol use in South Africa has a robust association with sexual risk behavior,⁷ especially when drinking occurs in the context of sexual events.⁸ The risk of HIV infection is markedly higher for South Africans who use alcohol at hazardous levels.^{9,10}

While the association between alcohol use and HIV risk in South Africa is well-established, often overlooked in this relationship is the role of mental health. In particular, psychological distress, such as traumatic stress, can act as a determinant of both alcohol use and sexual risk behavior.¹¹ Traumatic stress has been directly linked to sexual risk behavior; higher levels of traumatic stress are associated with greater risk behavior,¹² as well as greater risk of HIV infection.¹³ To cope with traumatic stress, individuals may turn to alcohol use.^{14,15} However, alcohol use often acts as a maladaptive coping mechanism that does not necessarily ease traumatic stress over time.¹⁶ In addition, alcohol use may in turn increase traumatic stress, which is the predominant direction of this relationship described in the research literature.¹⁷ Nevertheless, those who use alcohol to cope with current stressors are more likely to experience worse mental health and alcohol use outcomes,¹⁸ which may have a longer-term impact on HIV risk.

Traumatic stress results from traumatic experiences to which many South African women in impoverished urban townships are exposed due to factors such as poverty, violence, and gender inequality.¹⁹ Traumas experienced in South Africa are numerous (e.g., partner violence, child abuse, violent crime, and human rights violations).²⁰ South African women experience traumatic events at alarming rates; a tenth report sexual assault from non-partners,²¹ over a third have a history of childhood sexual abuse,²² and nearly half experience in their lifetime physical or sexual abuse from male partners.²³ These traumatic experiences can cause traumatic stress at subthreshold levels or post-traumatic stress disorder (PTSD), both of which can lead to social impairment.²⁴ The impact of trauma can linger long after a traumatic event has passed, in which memories and reminders may trigger delayed-onset traumatic stress symptoms.²⁵ In South Africa, PTSD and traumatic stress are

often undertreated because of limited mental health resources.²⁶ In addition, traumatic experiences and stress symptoms are associated with increased alcohol use.²⁷ Therefore, women may try to cope with the traumatic stress by turning to alcohol as a form of self-medication.²⁸

The dynamic role that traumatic stress has on influencing alcohol use, and in turn, sexual behavior that can transmit HIV, warrants additional attention, especially among South Africa women who drink. The current study draws on data from a prospective cohort of women recruited from alcohol-serving venues and followed for one year to examine the longitudinal associations between traumatic stress, alcohol use, and sexual risk behaviors. The study aims to evaluate traumatic stress as a distal determinant of sexual behavior via its effect on alcohol use, by testing the total effect of traumatic stress on sexual behavior and assessing alcohol use as a mediator of the relationship between traumatic stress and sexual behavior.

METHODS

Procedures and Participants

This research was conducted in a Cape Town township between 2009 and 2011. The study sampling and recruitment procedures have been described in detail previously.^{9,27,29} In brief, 12 venues were selected for inclusion in the study, ranging in size (licensed taverns and unlicensed *shebeens*), geographic distribution in the township, and ethnic diversity with some venues predominantly attended by Coloured (a recognized South African ethnic group of mixed-race ancestry) or by Black African patrons. From the 12 venues, female patrons were eligible if they attended the venue regularly, were at least 18 years old and lived in the study township. Study staff approached 604 women who were regular patrons, and 92.7% (n=560) agreed to participate.

The participants comprised a prospective cohort of women who were followed for a year. Participants completed assessments once every four months (baseline, 4-, 8-, and 12-months). Study staff invited the participants to the local study office to complete assessments in a private setting. The women provided written informed consent immediately prior to the first assessment. The survey was administered using Audio Computer-assisted Self-Interviewing (ACASI) and offered in Afrikaans, Xhosa or English to accommodate language preferences. Over the one-year period, participants were retained at high rates (94.6% completed the final assessment). The Institutional Review Boards for all participating universities approved all data collection procedures.

Measures

Demographic characteristics included age, ethnicity, relationship status, education, employment, HIV testing, and HIV status.

Traumatic stress symptoms were measured using the PTSD Checklist-Civilian Version (PCL-C)³⁰ ($\alpha=0.96$). The 17 items asked about the frequency in the last month of experiencing PTSD symptoms from the DSM-IV (i.e., re-experiencing, avoidance, and hyper-arousal symptoms). Response options ranged from not at all (1) to very often (5) and

total scores ranged from 17 to 85. A score of 30 across the 17 items was considered as sensitive measure of the presence of a potential PTSD diagnosis³¹ and was categorized as elevated traumatic stress. A mean score (range 0–4) of the 17 items was used in the regression analyses.

Alcohol use, as the mediator, was assessed by the ten-item Alcohol Use Orders Identification Test (AUDIT)³² measure ($\alpha=0.80$). Items, asking about current alcohol consumption (e.g., “how often do you have six or more drinks on one occasion?”) and problems associated with alcohol use recalled in the past year (e.g., “how often during the last year have you had a feeling of guilt or shame after drinking?”), were rated on a 5-point scale (0=“never” to 4=“daily or almost daily”), and total scores ranged from 0–40. Participants who scored 8 across the ten items were categorized as hazardous drinkers.³³ A mean score (range 0–4) of the ten items was used in the regression analyses.

Frequency of unprotected sex was the primary outcome. Participants self-reported the total number of unprotected sexual events in the past four months (e.g., “in the past four months, how many times have you had vaginal/anal sex without condoms?”). The number of unprotected vaginal and anal intercourse occasions from the previous four months was summed to create the frequency of unprotected sex outcome measure.

Analysis

Summary statistics (means, standard deviations, frequencies) described the demographic characteristics, traumatic stress, alcohol use, and unprotected sex in the sample. Pearson’s correlations were calculated to assess the unadjusted relationship at baseline between the variables of interest. To address the study objectives assessing the longitudinal relationship between traumatic stress and HIV risk behavior mediated by alcohol use, mediation analyses were conducted using longitudinal mixed modeling with PROC MIXED and GLIMMIX (SAS v9.3, Cary, NC). This modeling uses all available data for a participant with maximum likelihood estimation to account for lost to follow-up.³⁴ Participants who did not report having sex or a partner throughout the study period ($n=23$) were excluded, because they had no sexual risk behavior to model and would have acted as excess zeroes in the count analysis.³⁵ The final sample size used in the analysis was 537.

In the longitudinal mixed models, variables were entered at two levels to account for the repeated measures collected from individuals over time.³⁶ Level two included time-invariant demographic covariates that were significantly related to unprotected sex at baseline ($p<0.05$), which included race, age, and education. Level one included the time-varying predictor variables (traumatic stress and alcohol use) and a time variable to indicate assessment wave (coded as 0, 1, 2, 3). Participants were treated as random effects, such that each participant in the model had a random intercept that permits individual difference in the baseline level of the outcome. A random slope for time was tested in the models but because it was not significant, only the fixed slope was retained. The covariance parameters for the random effects were estimated using an unstructured covariance matrix. For the alcohol use outcome, a linear mixed model tested its relationship with traumatic stress (model 1 to determine path a; Figure 1). For the unprotected sex outcome, generalized linear mixed models (GLMM) utilized a negative binomial distribution and log link. The GLMM

parameter estimates (β), when exponentiated ($1-e^{\beta}$), characterize the expected percentage change in unprotected sex for every one unit change in the predictor. Two GLMM models were calculated to test: (1) the total effect of the relationship between traumatic stress and the unprotected sex outcome (model 2 to determine path c); and (2) the direct effect of the relationship between traumatic stress and unprotected stress (model 3 to determine path c') while adjusting for alcohol use (path b). The three models (one linear mixed model and two GLMMs) were estimated with and without adjustment for significant demographic covariates (race, mean-centered age, education). The findings were not different between the unadjusted and adjusted models, and therefore, only the adjusted models are reported.

Longitudinal data allows for disaggregating the between-person effects from the within-person effects, unlike cross-sectional data which only allows for examination of between-person effects.³⁷ Modeling within-person differences, i.e., an individual's fluctuations from her personal average, assesses how periods of increased traumatic stress and/or alcohol use affect the concurrent rates of unprotected sex during that period. Therefore, in addition to estimating the overall longitudinal mediation models (which can confound within and between person effects), within-person mediation was also conducted using the three models to test for mediation, controlling for race, age, education and assessment wave.

The mediated effect represents the proportion of the estimated total effect of traumatic stress on unprotected sex that results from alcohol use. To calculate the mediated effect of alcohol use and its significance, the distribution of the products ($a*b$) approach was used.^{38,39} The asymmetric distribution of the products of the coefficients, and thus the 95% confidence intervals for the mediated effect, was determined with an interactive web tool (Rmediation) that uses Monte Carlo simulations and accounts for the correlation between traumatic stress and alcohol use.⁴⁰ The proportion of the total effect of traumatic stress on unprotected sex due alcohol use was determined using the $ab/(c'+ab)$ ratio of the mediated effect to the total effect.⁴¹ This ratio was calculated with the unexponentiated coefficients from the GLMM models.

RESULTS

Sample description

The average age of study participants was 33.6 (SD=11.4) years. The majority of the women were Coloured (69.7%), followed by Black (37.1%) and Other (2.2%). Approximately a third of the sample was either married (28.1%) or cohabiting (8.9%). Few participants had completed secondary school (14.9%) or beyond (3.7%). Nearly three quarters were unemployed (74.1%). At baseline, many of the women had been HIV tested (82.7%), and 10.6% of the sample reported an HIV positive serostatus. An additional 38 participants (7.1%) reported receiving an HIV positive result for the first time during the study follow-up period.

Distribution of traumatic stress, alcohol use, and sexual risk behavior

Table 1 presents the means and standard deviations for the time-varying variables at each assessment. Unprotected sexual intercourse occasions in the 4-month recall period fluctuated

over time, with the lowest value of 3.34 (SD=7.11) at the 8-month assessment and a high of 3.93 (SD=9.79) at the 4-month assessment. There was no significant change in unprotected sex over time (time slope=-0.01, SE=0.03, $p=.67$). At baseline, the mean traumatic stress symptoms score was 36.47 (SD=16.41) and decreased to 34.20 (SD=15.87) by 12-months; a linear decrease in traumatic stress was observed over time (time slope=-0.04, SE=0.01, $p<.001$). At baseline, 56.2% had a traumatic stress score meeting the criterion for a potential PTSD diagnosis and 79.7% met this criterion at least once during the study period. Alcohol use was the highest at baseline ($M=13.91$, $SD=8.51$) and decreased to 11.62 ($SD=8.50$) at 12-months; a linear decrease in alcohol use was observed over time (time slope=-0.07, SE=0.01, $p<.001$). At baseline, 73.4% had an alcohol use score that indicated hazardous drinking, and 88.1% reported hazardous drinking at least once during the study period.

Factors associated with unprotected sex at baseline

Table 2 presents the correlations between the variables of interest measured at baseline. Traumatic stress and alcohol use had a positive correlation, and those with higher traumatic stress and alcohol use scores reported more unprotected sex. Black participants, compared to Coloured/Other participants, had less traumatic stress, alcohol use, and unprotected sex. Participants with more education had less traumatic stress, alcohol use, and unprotected sex. Older participants had higher traumatic stress and alcohol use, but age was not related to unprotected sex. Relationship status, employment, and HIV status were not significantly related to unprotected sex, nor to traumatic stress and alcohol use.

Longitudinal mediation analysis

Results from the mediation analysis are presented in Table 3. Alcohol use increased as traumatic stress symptoms increased (path a: $b=0.27$, $SE=0.02$, $t=14.25$, $p<.001$). For the total effect, rates of unprotected sex increased as traumatic stress increased (path c: $b=0.28$, $SE=0.06$, $t=4.82$, $p<.001$); a one unit increase in traumatic stress was associated with a 32% ($1-e^{\beta}$) increase in rates of unprotected sex. For the direct effect, traumatic stress was also positively associated with unprotected sex (path c': $b=0.20$, $SE=0.06$, $t=3.27$, $p<.01$) when adjusting for alcohol use (path b: $b=0.28$, $SE=0.07$, $t=4.25$, $p<.001$). One unit increases in traumatic stress and alcohol use were associated with 22% and 32% increases, respectively, in unprotected sex rates.

Significant mediation effects of alcohol use occurred for the relationship between traumatic stress and unprotected sex ($a*b=0.08$, $SE=0.02$, 95% CI: 0.038–0.118). Alcohol use accounted for approximately 27% [$0.27*0.28/(0.27*0.28+0.20)$] of the total effect of traumatic stress on unprotected sex.

For the within-person longitudinal mediation models (data not shown), periods of increased traumatic stress were significantly related to increased alcohol use during the same assessment (path a: $b=0.22$, $SE=0.02$, $t=9.63$, $p<.001$), and increased alcohol use was significantly related to unprotected sex (path b: $b=0.23$, $SE=0.08$, $t=2.68$, $p<.01$) controlling for traumatic stress. Using the products of the coefficients ($a*b$), there was a significant mediated effect ($a*b=0.05$, $SE=0.02$, 95% CI: 0.01–0.09), even though the total effect (path c: $b=0.10$, $SE=0.08$, $t=1.32$, $p=.19$) and the direct effect (path c': $b=0.05$, $SE=0.08$, $t=0.63$,

$p=.53$) between traumatic stress and unprotected sex were not significant. Within-person alcohol use accounted for approximately 50% $[0.22*0.23/(0.22*0.23+0.05)]$ of the total effect of within-person traumatic stress on unprotected sex.

DISCUSSION

Drawing on longitudinal data collected from a prospective cohort of 560 South African women who attend alcohol-serving venues, mediation analysis was used to evaluate the relationship between traumatic stress and unprotected sex via an alcohol use mediator. This study extends the research literature linking alcohol use to the HIV epidemic by evaluating traumatic stress as a critical precursor. These linkages are important to understand because traumatic stress has independently been associated with alcohol use and sexual risk behavior, and separately, alcohol use has been shown to be associated with increased risk for HIV.⁴² The current study examines these relationships simultaneously, and the results indicate that alcohol use partially mediates the relationship between traumatic stress and unprotected sex. In addition, the study sample reported high levels of distress (traumatic stress symptoms) and alcohol use, which has been found in other populations of drinkers in South Africa.⁴³ The data presented here highlight the continued importance of addressing the nexus of traumatic stress, alcohol use, and risk behavior among women who attend alcohol serving venues.

The findings suggest that alcohol use is a significant mediator explaining a potential causal pathway through which traumatic stress could affect sexual risk behavior. Women who scored high on traumatic stress symptoms (3), while controlling for alcohol use, would be expected to have 82% ($1.22^3=1.82$) greater rates in unprotected sex compared to women with no traumatic stress. Alcohol use, while controlling for traumatic stress, was similarly associated with greater rates of unprotected sex. These findings are consistent with research demonstrating that those with greater traumatic stress¹² and alcohol use⁴⁴ are at higher risk for HIV, and that problem drinking mediates the relationship between trauma experiences and sexual risk behavior.⁴⁵ One possible explanation is that participants may use alcohol to self-medicate and cope with the experience of traumatic stress²⁸ and the alcohol use in turn affects the decision making process associated with engaging in protective sexual behaviors.⁴⁶

Women may experience higher traumatic stress than usual as a result of experiencing new traumas and/or delayed-onset traumatic stress triggered by memories of previous trauma. When an individual experiences more traumatic stress than usual, the findings for the within-person mediation model suggest that she does not also have more unprotected sex than usual. Nevertheless, during periods when a woman experienced more alcohol use than usual, she was likely to have more unprotected sex, and alcohol use in the within-person model continued to mediate the relationship between traumatic stress and unprotected sex. The lack of a significant relationship (for direct and total effects) between traumatic stress and unprotected sex in the within-person mediation analysis does not preclude significant mediation by alcohol use, and could result from two potential explanations. First, the cues that lead to sexual risk behaviors are highly varied and context-dependent.⁴⁷ As a result, the effect of traumatic stress on sexual behavior over the long (4-month) recall period may be

too sporadic and variable to capture with the current study design. The data from this study are global measures of the key outcome across the recall period, rather than capturing event-specific data at the time of the drinking and/or sexual episode. Daily diary studies with shorter, more frequent recall periods have been conducted successfully in South Africa⁸ and could be used to capture a wealth of information describing episodes of traumatic stress, alcohol use, and/or sexual behavior. Second, the lack of effects could be explained by additional mediating variables not explored in these analyses.³⁹ Additional, unexplored mediators could suppress a positive association between traumatic stress and unprotected sex by causing those with higher traumatic stress than usual to have less unprotected sex. For example, although women may drink more alcohol during periods when they experience higher traumatic stress, they may also feel less sexual desire and otherwise distance themselves from sex partners particularly if their traumatic stress results from sexual trauma.⁴⁸ Future longitudinal research should consider other personal factors and partner characteristics that are affected by higher traumatic stress than usual, and in turn, affect sexual risk behaviors.

To intervene effectively on alcohol use and HIV risk, traumatic stress must be conceptualized and addressed using a syndemic approach. The syndemic approach is defined as two or more psychosocial issues, such as traumatic stress and alcohol use, that synergistically co-occur to heighten the risk of disease.⁴⁹ To decrease alcohol use, structural interventions have been called upon to address the policies controlling access to alcohol use.⁵⁰ However, focusing solely on issues of access and distribution of alcohol may ignore the broader reasons why women use alcohol, and leave women without a means to cope, even if ineffectively, with the stress from trauma. As an alternative focus, structural interventions could increase the provision of mental health services and intervene on the social context that causes women to experience traumas in the first place. At the individual level, women who attend venues could be referred to healthcare services, as they become available, to be screened for traumatic stress and alcohol use, and then treated with dual diagnosis treatment⁵¹ that simultaneously addresses their traumatic stress and alcohol use. Increasingly, screening and brief interventions for alcohol use are being introduced within existing South African healthcare settings and delivered by paraprofessionals, such as in tuberculosis clinics⁵² and primary care settings.⁵³ The screening and brief intervention modality should be expanded to address mental health distress, such as traumatic stress, simultaneously with alcohol use. Identifying and treating mental health distress that is comorbid with hazardous drinking could potentially improve the impact of screening and brief interventions on alcohol use and thus reducing HIV risk. Strengths of this study include the large, longitudinal cohort followed prospectively, and the high retention rates of a vulnerable sample of women maintained during the study period. In interpreting the findings, there are three potential limitations to the study. First, this study relied on self-reported measures that are subject to social desirability and recall bias. The impact of social desirability bias was likely mitigated because participants' responses did not influence their ability to access services⁵⁴ and data were collected via ACASI.⁵⁵ For recall bias, the length of the recall period has been shown to be ideal for reports on sexual behaviors.⁵⁶ Second, retrospective recall periods differed for traumatic stress, alcohol use, and unprotected sex occasions. The influence of the predictors on unprotected sex may have had a different value

at the time when they were measured compared to the time in the previous four months when they most influenced sexual risk behavior. For example, participants recalled drinking-related problems over the previous year when responding to items on the AUDIT measure capturing alcohol use. Further, the within-person mediation analysis was conducted so that key variables (traumatic stress, alcohol use, and HIV risk behavior) were measured as they co-occurred in the same assessment, rather than occurring temporally over multiple assessments over time. Finally, mediation analysis cannot prove that the proposed mediator is a mediator; rather the analysis demonstrates a statistical mediated effect if it is indeed a mediator.⁵⁷ Because of evidence for the reciprocal relationship between psychological distress and alcohol use,⁵⁸ alcohol use could have been transposed with traumatic stress in the analysis with traumatic stress acting as the mediator. Nevertheless, the decision to look at alcohol use as a mediator was driven by theoretical considerations supporting the hypothesis that psychological distress contributes to maintenance of alcohol use among drinkers because alcohol use decreases negative feelings.^{59,60}

CONCLUSION

In conclusion, the findings demonstrate that alcohol use mediates the association between traumatic stress and alcohol use. These results extend other research linking alcohol use to the HIV epidemic by examining the role that traumatic stress may play as an important precursor of alcohol use and sexual risk behavior among South African women who attend alcohol-serving venues. To affect the impact of alcohol use on HIV risk, interventions need to be adapted to the South African setting that concurrently address traumatic stress and alcohol use. Further research is needed for how best to identify women at risk for traumatic stress and substance use in the alcohol serving venues in South Africa to address their HIV risk.

Acknowledgments

Source of Funding: This project was funded by the National Institute of Alcohol Abuse and Alcoholism (R01 AA018074) with support from the Duke Center for AIDS Research (NIAID P30 AI064518).

References

1. UNAIDS. Global report: UNAIDS report on the global AIDS epidemic 2013. 2013.
2. Martinez P, Roislien J, Naidoo N, Clausen T. Alcohol abstinence and drinking among African women: data from the World Health Surveys. *BMC Public Health*. 2011; 11:160. [PubMed: 21392398]
3. WHO. Global status report on alcohol and health-2014. Geneva: World Health Organization; 2014.
4. Peltzer K, Ramlagan S. Alcohol use trends in South Africa. *J Soc Sci*. 2009; 18(1):1–12.
5. WHO. Global status report on alcohol and health. Geneva: World Health Organization; 2011.
6. Setshedi M, de la Monte SM. Changing trends and the impact of alcohol on the HIV/AIDS epidemic in South Africa: review. *SAHARA*. 2011; 8(2):89–96.
7. Scott-Sheldon LA, Carey MP, Carey KB, et al. Patterns of alcohol use and sexual behaviors among current drinkers in Cape Town, South Africa. *Addict Behav*. Apr; 2012 37(4):492–497. [PubMed: 22273585]
8. Kiene SM, Simbayi LC, Abrams A, Cloete A, Tennen H, Fisher JD. High rates of unprotected sex occurring among HIV-positive individuals in a daily diary study in South Africa: the role of alcohol

- use. *Journal of acquired immune deficiency syndromes* (1999). 2008; 49(2):219. [PubMed: 18769345]
9. Pitpitan EV, Kalichman SC, Eaton LA, et al. Co-occurring psychosocial problems and HIV risk among women attending drinking venues in a South African township: a syndemic approach. *Ann Behav Med*. Apr; 2013 45(2):153–162. [PubMed: 23054944]
 10. Fisher JC, Cook PA, Sam NE, Kapiga SH. Patterns of alcohol use, problem drinking, and HIV infection among high-risk African women. *Sex Transm Dis*. Jun; 2008 35(6):537–544. [PubMed: 18418292]
 11. Elkington KS, Bauermeister JA, Zimmerman MA. Psychological distress, substance use, and HIV/STI risk behaviors among youth. *Journal of Youth and Adolescence*. May; 2010 39(5):514–527. [PubMed: 20229264]
 12. Reisner SL, Mimiaga MJ, Safren SA, Mayer KH. Stressful or traumatic life events, post-traumatic stress disorder (PTSD) symptoms, and HIV sexual risk taking among men who have sex with men. *AIDS Care*. Dec; 2009 21(12):1481–1489. [PubMed: 20024727]
 13. Machtinger EL, Wilson TC, Haberer JE, Weiss DS. Psychological trauma and PTSD in HIV-positive women: a meta-analysis. *AIDS Behav*. Nov; 2012 16(8):2091–2100. [PubMed: 22249954]
 14. Choi KW, Watt MH, Macfarlane JC, et al. Drinking in the context of life stressors: A multidimensional coping strategy among South African women. *Subst Use Misuse*. Aug 1; 2013 49(1–2):66–76.
 15. Armeli S, Tennen H, Todd M, et al. A daily process examination of the stress-response dampening effects of alcohol consumption. *Psychol Addict Behav*. 2003; 17(4):266. [PubMed: 14640822]
 16. Keyes KM, Hatzenbuehler ML, Hasin DS. Stressful life experiences, alcohol consumption, and alcohol use disorders: the epidemiologic evidence for four main types of stressors. *Psychopharmacology (Berl)*. Nov; 2011 218(1):1–17. [PubMed: 21373787]
 17. Boden JM, Fergusson DM. Alcohol and depression. *Addiction*. 2011; 106(5):906–914. [PubMed: 21382111]
 18. Morojele NK, Saban A, Seedat S. Clinical presentations and diagnostic issues in dual diagnosis disorders. *Curr Opin Psych*. May; 2012 25(3):181–186.
 19. Dinan BA, McCall GJ, Gibson D. Community violence and PTSD in selected South African townships. *Journal of interpersonal violence*. 2004; 19(6):727–742. [PubMed: 15140321]
 20. Williams SL, Williams DR, Stein DJ, Seedat S, Jackson PB, Moomal H. Multiple traumatic events and psychological distress: the South Africa stress and health study. *J Trauma Stress*. Oct; 2007 20(5):845–855. [PubMed: 17955545]
 21. Dunkle KL, Jewkes RK, Brown HC, et al. Prevalence and patterns of gender-based violence and revictimization among women attending antenatal clinics in Soweto, South Africa. *Am J Epidemiol*. 2004; 160(3):230–239. [PubMed: 15257996]
 22. Seedat M, Van Niekerk A, Jewkes R, Suffla S, Ratele K. Violence and injuries in South Africa: prioritising an agenda for prevention. *The Lancet*. 2009; 374(9694):1011–1022.
 23. Gass JD, Stein DJ, Williams DR, Seedat S. Gender differences in risk for intimate partner violence among South African adults. *Journal of Interpersonal Violence*. 2011; 26(14):2764–2789. [PubMed: 21156693]
 24. Zlotnick C, Franklin CL, Zimmerman M. Does “subthreshold” posttraumatic stress disorder have any clinical relevance? *Compr Psychiatry*. 2002; 43(6):413–419. [PubMed: 12439826]
 25. McFarlane AC. The long-term costs of traumatic stress: intertwined physical and psychological consequences. *World Psychiatry*. 2010; 9(1):3–10. [PubMed: 20148146]
 26. Williams D, Herman A, Stein D, et al. Twelve-month mental disorders in South Africa: prevalence, service use and demographic correlates in the population-based South African Stress and Health Study. *Psychol Med*. 2008; 38(2):211. [PubMed: 17903333]
 27. Watt MH, Ranby KW, Meade CS, et al. Posttraumatic stress disorder symptoms mediate the relationship between traumatic experiences and drinking behavior among women attending alcohol-serving venues in a South African township. *Journal of Studies on Alcohol and Drugs*. 2012; 73(4):549. [PubMed: 22630793]

28. Khantzian EJ. The self-medication hypothesis of substance use disorders: a reconsideration and recent applications. *Harv Rev Psychiatry*. 1997; 4(5):231–244. [PubMed: 9385000]
29. Eaton LA, Pitpitan EV, Kalichman SC, et al. Food Insecurity and Alcohol Use Among Pregnant Women at Alcohol-Serving Establishments in South Africa. *Prev Sci*. Mar 23.2013
30. Weathers, FW.; Litz, BT.; Herman, DS.; Huska, JA.; Keane, TM. The PTSD Checklist (PCL): Reliability, validity, and diagnostic utility. Annual Convention of the International Society for Traumatic Stress Studies; October, 1993; Austin, TX.
31. Lang AJ, Laffaye C, Satz LE, Dresselhaus TR, Stein MB. Sensitivity and specificity of the PTSD checklist in detecting PTSD in female veterans in primary care. *J Trauma Stress*. 2003; 16(3):257–264. [PubMed: 12816338]
32. Saunders JB, Aasland OG, Babor TF, Grant M. Development of the alcohol use disorders identification test (AUDIT): WHO collaborative project on early detection of persons with harmful alcohol consumption-II. *Addiction*. 1993; 88(6):791–804. [PubMed: 8329970]
33. Allen JP, Reinert DF, Volk RJ. The alcohol use disorders identification test: an aid to recognition of alcohol problems in primary care patients. *Prev Med*. 2001; 33(5):428–433. [PubMed: 11676584]
34. Jellic H, Phelps E, Lerner RM. Use of missing data methods in longitudinal studies: the persistence of bad practices in developmental psychology. *Dev Psychol*. Jul; 2009 45(4):1195–1199. [PubMed: 19586189]
35. Zuur, AF.; Ieno, EN.; Walker, NJ.; Saveliev, AA.; Smith, GM. Mixed effects models and extensions in ecology with R. Springer; 2009. Zero-truncated and zero-inflated models for count data; p. 261-293.
36. Singer, JD.; Willett, JB. Applied longitudinal data analysis: Modeling change and event occurrence. Oxford university press; 2003.
37. Hoffman L, Stawski RS. Persons as Contexts: Evaluating Between-Person and Within-Person Effects in Longitudinal Analysis. *Research in Human Development*. 2009; 6(2–3):97–120.
38. MacKinnon DP, Fairchild AJ, Fritz MS. Mediation analysis. *Annu Rev Psychol*. 2007; 58:593–614. [PubMed: 16968208]
39. Mackinnon DP, Lockwood CM, Williams J. Confidence Limits for the Indirect Effect: Distribution of the Product and Resampling Methods. *Multivariate Behav Res*. Jan 1.2004 39(1):99. [PubMed: 20157642]
40. Tofighi D, MacKinnon DP. RMediation: an R package for mediation analysis confidence intervals. *Behav Res Methods*. Sep; 2011 43(3):692–700. [PubMed: 21487904]
41. Shrout PE, Bolger N. Mediation in experimental and nonexperimental studies: new procedures and recommendations. *Psychol Methods*. 2002; 7(4):422. [PubMed: 12530702]
42. Kalichman SC, Simbayi LC, Kaufman M, Cain D, Jooste S. Alcohol use and sexual risks for HIV/AIDS in sub-Saharan Africa: systematic review of empirical findings. *Prev Sci*. Jun; 2007 8(2): 141–151. [PubMed: 17265194]
43. Sikkema KJ, Watt MH, Meade CS, et al. Mental health and HIV sexual risk behavior among patrons of alcohol serving venues in Cape Town, South Africa. *J Acquir Immune Defic Syndr*. Jul 1; 2011 57(3):230–237. [PubMed: 21372724]
44. Woolf-King SE, Maisto SA. Alcohol use and high-risk sexual behavior in Sub-Saharan Africa: a narrative review. *Arch Sex Behav*. Feb; 2011 40(1):17–42. [PubMed: 19705274]
45. Icard LD, Jemmott JB III, Teitelman A, O’Leary A, Heeren GA. Mediation effects of problem drinking and marijuana use on HIV sexual risk behaviors among childhood sexually abused South African heterosexual men. *Child Abuse Negl*. 2014; 38:234–242. [PubMed: 24041455]
46. Cook RL, Clark DB. Is there an association between alcohol consumption and sexually transmitted diseases? A systematic review. *Sex Transm Dis*. 2005; 32(3):156–164. [PubMed: 15729152]
47. Cooper ML. Does drinking promote risky sexual behavior? A complex answer to a simple question. *Curr Dir Psychol Sci*. 2006; 15(1):19–23.
48. Campbell JC. Health consequences of intimate partner violence. *The Lancet*. 2002; 359(9314): 1331–1336.
49. Singer M, Clair S. Syndemics and public health: Reconceptualizing disease in bio-social context. *Med Anthropol Q*. 2003; 17(4):423–441. [PubMed: 14716917]

50. Bradshaw D, Norman R, Lewin S, et al. Strengthening public health in South Africa: Building a stronger evidence base for improving the health of the nation. *S Afr Med J*. 2007; 97(8):643–651. [PubMed: 17957837]
51. Phillips, P.; McKeown, O.; Sandford, T. Dual diagnosis: practice in context. John Wiley & Sons; 2009.
52. Pengpid S, Peltzer K, Skaal L, Van der Heever H. Screening and brief interventions for hazardous and harmful alcohol use among hospital outpatients in South Africa: results from a randomized controlled trial. *BMC Public Health*. Jul 11.2013 13(1):644. [PubMed: 23844552]
53. Mertens JR, Ward CL, Bresick GF, Broder T, Weisner CM. Effectiveness of Nurse-Practitioner-Delivered Brief Motivational Intervention for Young Adult Alcohol and Drug Use in Primary Care in South Africa: A Randomized Clinical Trial. *Alcohol Alcohol*. 2014:agu030.
54. Minnis AM, Steiner MJ, Gallo MF, et al. Biomarker validation of reports of recent sexual activity: results of a randomized controlled study in Zimbabwe. *Am J Epidemiol*. 2009; 170(7):918–924. [PubMed: 19741042]
55. Beauclair R, Meng F, Deprez N, et al. Evaluating audio computer assisted self-interviews in urban south African communities: evidence for good suitability and reduced social desirability bias of a cross-sectional survey on sexual behaviour. *BMC Med Res Methodol*. 2013; 13(1):11. [PubMed: 23368888]
56. Napper LE, Fisher DG, Reynolds GL, Johnson ME. HIV risk behavior self-report reliability at different recall periods. *AIDS Behav*. 2010; 14(1):152–161. [PubMed: 19475504]
57. Fiedler K, Schott M, Meiser T. What mediation analysis can (not) do. *J Exp Soc Psychol*. 2011; 47(6):1231–1236.
58. Swendsen JD, Merikangas KR. The comorbidity of depression and substance use disorders. *Clin Psychol Rev*. 2000; 20(2):173–189. [PubMed: 10721496]
59. McKimman DJ, Venable PA, Ostrow DG, Hope B. Expectancies of sexual “escape” and sexual risk among drug-and alcohol-involved gay and bisexual men. *J Subst Abuse*. 2001; 13(1):137–154. [PubMed: 11547615]
60. Kuntsche E, Knibbe R, Gmel G, Engels R. Why do young people drink? A review of drinking motives. *Clin Psychol Rev*. Nov; 2005 25(7):841–861. [PubMed: 16095785]

Figure 1.

Mediation model estimating the total effect (path c) of traumatic stress on unprotected sex, as well as the direct effect of traumatic stress on unprotected sex (path c') while adjusting for alcohol use (path b). The mediation model also estimates alcohol use regressed on traumatic stress (path a) in order to calculate the mediated effect using the product of coefficients approach ($a*b$). All path estimates are adjusted for potential confounders.

Table 1

Descriptive statistics for traumatic stress, alcohol use, and unprotected sex across assessments

	Range	Baseline (n=537)	4-months (n=515)	8-months (n=506)	12-months (n=504)
Traumatic stress score, <i>M</i> (<i>SD</i>)	17–85	36.47 (16.41)	35.67 (16.07)	35.20 (15.12)	34.20 (15.87)
Met criteria for PTSD (30), n (%)	–	302 (56.2%)	298 (57.9%)	289 (57.1%)	272 (54.0%)
Alcohol use score, <i>M</i> (<i>SD</i>)	0–40	13.91 (8.51)	12.68 (8.10)	12.27 (8.30)	11.62 (8.50)
Hazardous drinking (8), n (%)	–	394 (73.4%)	356 (69.1%)	341 (67.4%)	312 (61.9%)
Frequency of unprotected sex, <i>M</i> (<i>SD</i>)	0–97	3.72 (8.63)	3.93 (9.79)	3.34 (7.11)	3.76 (9.45)
Any unprotected sex, n (%)	–	375 (69.8%)	351 (69.2%)	353 (69.8%)	353 (70.0%)

Table 2

Correlations among baseline measures (n=537)

	1	2	3	4	5	6	7	8
1. Traumatic stress	–							
2. Alcohol use	0.39 ***	–						
3. Unprotected sex	0.11 *	0.10 *	–					
4. Age	0.25 ***	0.10 *	0.04	–				
5. Relationship status	0.08	0.01	0.08	0.37 ***	–			
6. Race	–0.15 ***	–0.13 **	–0.17 ***	–0.31 ***	–0.31 ***	–		
7. Education	–0.18 ***	–0.15 ***	–0.11 *	–0.48 ***	–0.23 ***	0.38 ***	–	
8. Employment	–0.06	0.08	–0.02	0.02	–0.03	0.00	0.05	–
9. HIV status	0.01	0.03	–0.08	–0.08	–0.11 **	0.21 ***	0.00	0.03

* p<0.05;

** p<0.01;

*** p<0.001.

Correlations were between the continuous measures of traumatic stress, alcohol use, age, and education; the frequency of unprotected sex occasions; and the dichotomous relationship status (0=single, 1=married/cohabiting), race (0=Coloured/other, 1=Black), employment (0=no, 1=yes), and HIV status (0=negative/unknown, 1=positive) variables.

Table 3

Longitudinal mixed models testing the relationship between traumatic stress and unprotected sex mediated by alcohol use (n=537)

	Model 1			Model 2			Model 3		
	Outcome: Alcohol use			Outcome: Unprotected sex			Outcome: Unprotected sex		
	Primary Predictor: Traumatic stress			Primary Predictor: Traumatic stress			Primary Predictors: Traumatic stress and alcohol use		
	path	β (SE)	p	path	β (SE)	p	path	β (SE)	p
Intercept		0.96 (0.08)	<.001		0.47 (0.22)	.03		0.22 (0.23)	.33
Traumatic stress	a	0.27 (.02)	<.001	c	0.28 (0.06)	<.001	c'	0.20 (0.06)	<.01
Alcohol use		–			–	–	b	0.28 (0.07)	<.001
Age		–0.005 (0.00)	.042		–0.02 (0.01)	<.001		–0.02 (0.01)	<.001
Race		–0.12 (0.06)	.049		–0.63 (0.15)	<.001		–0.61 (0.15)	<.001
Education		–0.02 (0.01)	.03		–0.05 (0.03)	.12		–0.04 (0.03)	0.17

Notes: All models adjusted for assessment wave.