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The temporal relationship of alcohol use and subsequent self-reported health status among people with HIV

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Declaration of Competing Interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

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Abstract

Background: Alcohol use among people with HIV is associated with worse HIV treatment outcomes. Its impact on self-reported health status is unclear.

Setting: Longitudinal cohort of people with HIV engaged in care across 7 clinics participating in the Centers for AIDS Research Network of Integrated Care Systems between January 2011 and June 2014.

Methods: A total of 5046 participants were studied. A quantile regression model estimated the association of alcohol use levels with subsequent self-reported health status score, accounting for multiple covariates including depressive symptoms. Women, men who have sex with women, and men who have sex with men were analyzed separately.

Results: Prevalence of heavy alcohol use was 21%, 31%, and 37% among women, men who have sex with women, and men who have sex with men, respectively. Women with heavy alcohol use had a subsequently decreased median self-reported health status score compared to women with no or moderate alcohol use (odds ratio [OR]: 0.76; 95% confidence interval [CI]: 0.58–0.99); this association was not explained by the presence of depressive symptoms. There was no observed association of alcohol use level on subsequent self-reported health status among men who have sex with women. Men who have sex with men reporting no alcohol use had a subsequently decreased median self-reported health status compared to moderate alcohol use (OR: 0.88; 95% CI: 0.80–0.97).

Conclusion: Heavy alcohol use is associated with worsened self-reported health status at subsequent visits among women with HIV and not men with HIV.

Keywords

HIV; Alcohol; Quality of life; Self-reported health status

Introduction

Understanding self-reported health status among people with HIV in the context of routine clinical care is a patient-centered approach to care.[19] Patients' self-reported health status is an indicator of their overall wellbeing and is informed by physical and mental health symptoms, functional status, and their interaction with characteristics of the patient and their environment.[59] Various measures of self-reported health status exist and they commonly include prompts such as, "In general, how would you rate your health?[29]" While the self-reported health status is a short and easily obtainable measure, it has been shown to be an independent predictor of mortality in the general population[15, 30, 40] and associated with HIV health related outcomes. [38, 39, 43, 50]

Alcohol use is a known modifiable risk factor associated with poor health outcomes among people with HIV which could lead to worse self-reported health status.[8, 10, 42, 56, 58] A 2019 metanalysis estimated the prevalence of alcohol use disorder was 31% among people with HIV based on Alcohol Use Disorders Identification Test (AUDIT)[18] which is substantially higher than the 6% prevalence in the general population.[54] Further, people with HIV who consumed any alcohol were twice as likely to be less adherent to antiretroviral therapy compared to people who abstain.[24] Heavy alcohol use also is associated with sexual risk behaviors which can increase transmission[27, 53] and lower retention in HIV care. [42]

While the impact of alcohol use on HIV clinical outcomes is clear, the evidence of a relationship between alcohol use and self-reported health status among people with HIV is limited. Furthermore, it is unknown if self-reported health status differs by gender since studies often combine the outcomes for all participants (men and women together) or report only on specific subsets of people with HIV (i.e. men who have sex with men). Peltier et. al.[46] highlighted the potential reasons for gender differences in alcohol related outcomes which include drinking in response to stress, hormones, and complex neurobiological mechanisms. Therefore, including multiple groups and exploring differences in alcohol related outcomes by gender offer an opportunity to understand the differential effect of alcohol on participants. Herein, we sought to determine the effect of alcohol use on subsequent self-reported health status among women, men who have sex with women (MSW), and men who have sex with men (MSM) who are all living with HIV engaged in HIV care.

Methods

Study sample

The Centers for AIDS Research Network of Integrated Clinical Systems (CNICS) is a cohort of people with HIV receiving continuity HIV care at one of eight HIV clinics in the United States who consent to share their clinical data from the electronic health record and other data sources.[32] The sites collect participant age, self-reported gender, race, ethnicity, probable route of HIV acquisition, and clinical and laboratory data. Data are standardized and reported by the cohort sites to a centralized system.

Approximately every 4 to 6 months during a routine clinical care visit, patients complete a clinical assessment of patient self-reported outcomes by tablet computer.[9] The assessment includes instruments measuring a variety of domains such as patients' recent depression symptoms, alcohol use, other drug use, and self-reported health status. Patients who are medically unstable, cognitively impaired, intoxicated at the time of a clinical encounter, or speak a language other than English, Spanish or Amharic do not complete the patient self-reported outcomes.

For this study, we included participants from seven sites where longitudinal patient self-reported outcomes were available: Fenway Community Health Center (Boston, MA); Johns Hopkins University (Baltimore, MD); University of Alabama at Birmingham (Birmingham, AL); University of California, San Diego (San Diego, CA); University of California, San Francisco (San Francisco, CA); University of North Carolina, Chapel Hill (Chapel Hill, NC); and University of Washington (Seattle, WA).

Our sample consisted of all patients who had at least two clinic visits with completed patient self-reported outcomes assessments between January 2011 and June 2014. We could not compare the population who completed a patient self-reported outcome assessment during the period compared to those who did not and were therefore not included in the study. However, the demographics of our study population is reflective of the larger CNICS cohort and similar to other studies using patient self-reported outcome assessment data.[11, 10, 27, 32, 37, 42] The exposure was the participant's recent alcohol use reported on the patient self-reported outcomes assessment during the index (first) visit of each person-period. The outcome, self-reported health status, was drawn from the next, subsequent patient self-reported outcomes assessment completed between and 18 months after the index assessment. Covariates were obtained from the index visit of each period. By pairing the reported alcohol use at the index visit (exposure) and subsequent self-reported health status at the next visit (outcome), we established the temporality. Our study design allowed for participants to contribute multiple person-periods. We included all eligible sets of paired patient self-reported outcomes assessments available for study participants. Fig. 1 provides an example of how person-periods were defined and included.

Exposure

At each visit, the patient self-reported outcomes assessment included questions from the Alcohol Use Disorders Identification Test-Consumption (AUDIT-C). The AUDIT-C is a 3-item assessment of past-year alcohol use to screen people for heavy alcohol use or alcohol use disorder. For men scoring ≥4, there is 86% sensitivity, and 72% specificity for identifying heavy alcohol use and/or active alcohol use disorder.[6] For women scoring ≥3, the sensitivity is 66%, and specificity is 94%.[4] Participants were classified based on their score. Men who scored 0 were classified as "No alcohol use," 1–3 were classified as "Moderate alcohol use," and ≥4 were classified as "Heavy alcohol use." Women who scored 0 were classified as "No alcohol use," 1–2 were classified as "Moderate alcohol use," and ≥3 were classified as "Heavy alcohol use."

Covariates

Covariates were selected based on previous Centers for AIDS Research Network of Integrated Clinical Systems cohort studies of alcohol and other drug use (e.g.,[27, 37]). We included baseline demographic information (self-reported gender and race/ethnicity) and HIV acquisition risk. Current antiretroviral use (yes or no), age, and laboratory measurements within 180 days prior or 10 days after the index visits were used. We defined undetectable viral load as below 100 copies/ml and categorized CD4 count in groups of 0–199, 200–349, 350–499, and ≥500 cells/μL. Self-reported past 3-month other substance use (cannabis, cocaine/crack, recreational opioid, and methamphetamine/crystal) was measured using the Alcohol, Smoking and Substance Involvement Screening Test.[26] Past 2-week depressive symptoms were measured using the Patient Health Questionnaire-2[35] which were dichotomized by score ≥3 as having depressive symptoms verses <3 having no depressive symptoms.

Outcome

To assess self-reported health status, participants were asked to report their overall perceived heath status on a visual analog scale from 0 (worst possible health status) to 100 (best possible health status). The self-reported health status is a component of the EuroQoL-5

Dimension questionnaire.[21] The EuroQoL-5 Dimension is a widely validated questionnaire that has been used in previous studies of people with HIV.[55]

Statistical analysis

We classified participants based on self-reported gender and HIV acquisition risk factors into three groups: women, MSW, and MSM. We analyzed women, MSW, and MSM separately examining the impact of alcohol use at the index visit in each person period on the distribution of self-reported health status scores at the subsequent visit. In order to examine the distribution of self-reported health status score, quantile regression was used to examine the 10th, 25th, 50th, 75th, and 90th percentiles of self-reported health status scores.[33] There are several advantages of quantile regression over standard linear models. First, quantile regression allows for examining multiple points of the distribution rather than only assessing the central tendency of the distribution via the mean. Second, quantile regression does not require distributional assumption for the residuals. Third, quantile regression is not influenced by outliers or skewness in the data. Finally, quantile regression is invariant to transformation of the outcome.[3, 2, 33] Since the self-reported health status score is bounded by zero, we logit transformed the data as $\log[(y + 0.01)/(100 - (y + 0.01))]$, where y are the self-reported health status scores and 0.01 was added to prevent negative infinity values should a self-reported health status score have a zero value. Results were transformed back to the original scale for interpretability. Given that individuals could contribute multiple person-periods, the repeated observations of self-reported health status scores are dependent. Nevertheless, with dependent data, the quantile estimator is consistent.[3, 28] We used a cluster bootstrap with 100 iterations to account for the dependencies in the data. The 95% confidence intervals (95% CI) were calculated using the standard deviation of the bootstrap beta coefficients.[3, 16] We do not present p-values, and instead, focus on the point estimate and level of precision as estimated by the 95% CI.[23, 36]

We standardized person-periods within each alcohol use group to have the same distribution of potential confounders and the self-reported health status score at the index visit as the whole (stratum-specific) sample. The result of the standardization is that differences in the distribution of self-reported health status scores at the subsequent assessment were not due to confounding by measured covariates. By accounting for the index visit self-reported health status score, the distribution of self-reported health status scores at the subsequent visit reflects a shift related to the alcohol use and not initial self-reported health status scores distribution. We standardized using stabilized inverse probability of exposure (alcohol use category) weights.[25, 49] Potential confounders measured at the participant’s first (index) person-period visit included in the estimation of the weights were: age (and age squared); race/ethnicity; antiretroviral use; detectable viral load; the length of time between visit pairs; CD4 at the index visit; other substance use within the past three months; and the index visit self-reported health status score. We controlled for possibly differential probability of missing outcome data using stabilized inverse probability of censoring weights.[48] Censoring weights were estimated conditional on reported alcohol use and the same set of covariates used in estimating inverse probability of exposure weights. Final weights were the product of inverse probability of exposure and inverse probability of censoring weights.

As a sensitivity analysis, we examined whether there was an interaction between alcohol drinking level and presence of depressive symptoms on self-reported health status scores. To test for interaction, we standardized using stabilized inverse probability of exposure (alcohol category) and inverse probability of depressive symptom weights. The final weights were the product of all the inverse probability weights.

Results

Participant characteristics

We observed 13,111 person-periods for 668 women, 978 MSW, and 3,400 MSM (total=5,046 participants). Table 1 describes the study population. Overall, the median of number of person-periods per person was 2 (interquartile range [IQR] 1, 4) and the median length of time between visits was 8.4 months (IQR 6.6, 11.9). Most women were Black (56%) with median age of 45 years (IQR 37, 52). Median CD4 cells/μL at the women's first person-period was 509 (IQR 309, 689) across categories of initial alcohol use, and slightly over a quarter of women (29%) had a detectable viral load proximate to their initial patient self-reported outcomes assessment. The majority of MSW were White (46%) with median age of 45 years (IQR 37, 51) and median CD4 cells/μL at their first patient self-reported outcomes assessment that was 434 (IQR 252, 633) across categories of initial alcohol use. Slightly over a quarter (26%) had a detectable viral load proximate to their initial patient self-reported outcomes assessment. The majority of MSM were White (59%) with median age of 44 years (IQR 36,50), and median CD4 cells/μL at their first person-period was 485 (IQR 308, 699) across categories of initial alcohol use. A quarter (25%) had a detectable viral load proximate to their initial patient self-reported outcomes assessment. The prevalence of heavy alcohol use at the initial patient self-reported outcomes assessment was 21%, 31%, and 37% among women, MSW, and MSM, respectively. Furthermore, the prevalence of depressive symptoms at baseline visit was 20%, 23%, and 22% among women, MSW, and MSM, respectively.

Relationship between alcohol use and self-reported health status VAS score

Women with heavy alcohol use had lower self-reported health status scores compared to women with no alcohol use and moderate alcohol use, particularly below the 50th percentile of self-reported health status scores (Table 2, Fig. 2: left column). The interpretation of this is the odds ratio (OR) of self-reported health status score among women with heavy alcohol use compared to moderate alcohol use at the 50th percentile of self-reported health status scores was 0.76 (95% CI: 0.58–0.99). Alternatively transforming back to the original 0–100 point scale, the median self-reported health status score for women with heavy alcohol use was 5-point lower than the median self-reported health status score for women with moderate alcohol use (Table 2, Fig. 2: left column). Fig. 2 (second row) shows that differences in self-reported health status scores between women with heavy compared with no alcohol use or moderate alcohol use were greater in the lower self-reported health status quartiles. The left shift in the distribution of self-reported health status scores demonstrates that more women with heavy alcohol use have lower self-reported health status scores. There was no observed difference between women with no alcohol use and those with moderate alcohol use.

There was no difference in self-reported health status score distributions among MSW as a function of alcohol use level (Table 2; Fig. 2: middle column). The point estimates for MSW with heavy alcohol use were consistently lower than MSW with moderate alcohol use across the distribution. The confidence intervals were wide, and there was lack of precision in the estimate (Table 2).

Lastly, MSM with no alcohol use had lower self-reported health status scores across most of the distribution compared to MSM with moderate alcohol use. The OR for the 50th percentile of self-reported health status scores for participants with no alcohol use was 0.88 (95% CI: 0.80–0.97; Table 2, Fig. 2: right column) compared to those with moderate alcohol use. MSM with heavy alcohol use had a similar distribution of self-reported health status compared to MSM with moderate use (Table 2, Fig. 2: right column).

We conducted a sensitivity analysis examining the potential effect modification of depressive symptoms within each of the alcohol use categories stratified by HIV risk group on self-reported health status score distribution. The presence of depressive symptoms resulted in a lower shift in the self-reported health status scores for all groups which translated into between a 4- and 18-point decrease depending on group (women, MSW, MSM), alcohol use category, and percentile (Table 3). The largest shifts were among the lower self-reported health status score quantiles. The confidence intervals around the interaction terms between depressive symptoms and alcohol use level were wide and lacked precision.

Discussion

In this longitudinal cohort of people with HIV receiving care in the US, we found a temporal relationship where heavy alcohol use was associated with subsequently lower self-reported health status among women at the next visit. By contrast, heavy alcohol use was not associated with change in self-reported health status among MSW, and no alcohol use was associated with worse self-reported health status when compared to moderate alcohol use among MSM. Our results reinforce the different relationship of alcohol use with health-related outcomes which exist for women, MSM, and MSW. Therefore a patient-centered approach to alcohol use counseling should take account of these different relationships of alcohol use and subsequent self-reported health status.

We found heavy alcohol use was associated with subsequent worse self-reported health status for women with HIV. A 2015 review found that, compared to men, women more often drink alcohol alone to change a negative mood (as opposed to drinking with others because of experiencing a positive mood) and experience more perceived negative judgement since alcohol use is seen as an undesirable feminine trait.[20] Peltier et. al.[46] found that women more often drink to regulate negative affect related to stress compared to men who drink for positive reinforcement. The neurobiological and hormonal differences are thought to contribute differential effect of stress and alcohol use among men and women and possibly explain the differences in health-related outcomes. For example, women who consume alcohol are more likely to develop alcohol related disorders after a shorter period of alcohol consumption[20, 51] and the rates of alcohol use disorder are increasing faster for women compared to men.[22]

While our study found that women with heavy alcohol use had worse self-reported health status, there is a complex relationship of HIV related stigma, gender, sex, race, and ethnicity which likely play a role in alcohol use and subsequent self-reported health status. People who experience racism have higher levels of stress which can contribute to poor health directly through racial discrimination experienced in the healthcare system and behaviors used to cope.[12, 17] Furthermore, minority women are disproportionately infected with HIV and have higher levels of internalized stigma.[7, 45] It is unlikely that the gender differences observed are due to gender alone but rather a result of multiple participants attributes and experiences. Future studies should employ an intersectionality framework to help describe these complex interactions and potentially inform care and tailored interventions to improve health.

We found no associations between increased alcohol use and lower self-reported health status among MSM and MSW and, in fact, found lower self-reported health status among those MSM with no alcohol use compared to those with moderate use. Our results are consistent with research on quality of life, which is a related construct to self-reported health,[29] where lower levels of alcohol use were associated with lower levels of physical quality of life.[57] Other studies have not shown an association of alcohol use and increased quality of life.[5, 34, 47] Nevertheless, observed differences in MSM and MSW are potentially related to the context in which alcohol is consumed, drinking alcohol to reduce negative affect versus increase positive reinforcement, and feelings of social connectedness versus isolation.[46]

Depression and depressive symptoms are closely related to self-reported health status and alcohol use. Alcohol use disorder is known to cause depression,[1] and depression leads to a lower quality of life[52] reflecting a complex and synergistic biological and behavioral relationship between alcohol use, self-reported health status and quality of life.[29] Furthermore, people with HIV experience depression and depressive symptoms at higher rates which has a negative impact on self-reported health status and quality of life.[14, 44] We did not find evidence of heterogeneity in the effect of alcohol use level on self-reported health status depending on the presence of depressive symptoms. Put differently, the impact of alcohol use level did not vary based on the presence of depressive symptoms which seems counter to previous research. A potential explanation is our measure of depressive symptoms using the Patient Health Questionnaire-2. While at our cut-off of 3, there is an estimated sensitivity and specificity of 76% and 89% for detecting a major depressive disorder respectively,[41] it is possible that a more discriminative measure of depressive symptoms (i.e., Patient Health Questionnaire-9) would clarify the relationship between alcohol use level, depression, and self-reported health status.

There are strengths to this study which support our conclusions. We accounted for baseline self-reported health status, controlled for potential confounders including the presence of depressive symptoms, and established a temporal relationship between alcohol use and subsequent self-reported health status. Most importantly, for clinicians caring for patients our study suggests that asking for a patient's self-reported heath status could be a useful in the context of alcohol use disorder treatment or when addressing heavy alcohol use in a patient-centered way. Eliciting patient-reported outcomes is consistent with Kiluk et al.'s[31] assertion that clinicians and researchers should focus on measuring the consequences of substance use (alcohol and other drugs) which would include a patient's self-reported health status.

Despite these strengths, the study limitations which should be considered. First, alcohol use was categorized based on AUDIT-C scores. These categories do not account for the nuance in drinking patterns or people with alcohol use disorders who are in early remission with recent cessation.[11] Recent cessation may be due to worsened physical or mental health problems and could attenuate the observed differences in self-reported health status between drinking groups.[13] The time between ascertaining alcohol use and self-reported health status extended to 18-months and it is possible alcohol consumption patterns change over the time period. Lesko et al.[37] evaluated the change in alcohol consumption in this cohort and found that while consumption patterns were stable across 44% of observation periods, 23% of observation periods had an increase in consumption and 24% had a decrease in consumption. Future studies evaluating the temporal effect of alcohol consumption on subsequent self-reported health status should attempt to account for changing alcohol consumption patterns over the observation period. Second, there are trade-offs to using a single measure of self-reported health status based on a visual analog scale which does not allow us to determine what domains of a person's health is most affected. As the discussion of what constitutes a "good outcome" in substance use disorder treatment continues, balancing the ease of a single measure of self-reported health status versus a more robust measure of quality of life needs to be considered as these measures are developed and implemented in clinical practice.[31] Finally, we could not account for the effect of the burden of medical or psychiatric comorbidities or social determinants of health vulnerabilities on alcohol use or self-reported health status.

Conclusion

Heavy alcohol use results in a significant healthcare burden in the US and was found to be related with subsequently lower self-report health status among women with HIV. The burden of heavy alcohol use is particularly acute among people with HIV who already experience higher levels of stress, substance use, and stigma. Incorporating screening for alcohol use and alcohol use disorders should be a routine component of HIV care to identify patients who could benefit from further interventions, treatment, and potentially improved outcomes including self-reported health status.

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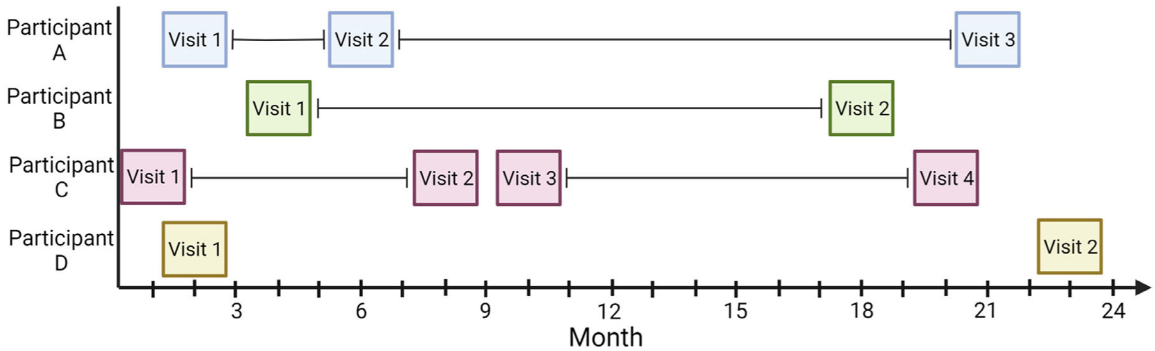

Fig. 1.

Study design and defining the person-periods pairing alcohol use with subsequent self-reported health status. The colored squares represent visits where patient-reported outcomes are collected. The closed-lines represent person-periods that would be included in the study. Participant A contributes two person-periods. The first person-period is between visit 1 and visit 2 (4 months apart) where alcohol use and covariates are ascertained at visit 1 and self-reported health status is ascertained at visit 2. The second person-period is between visit 2 and visit 3 (16 months apart) where alcohol use and covariates are collected at visit 2 and self-reported health status are ascertained at visit 3. Participant B contributes one person-period between visit 1 and visit 2 (14 months). Participant C contributes two person periods. The first person-period is between visit 1 and visit 2 (7 months apart) where alcohol use and covariates are ascertained at visit 1 and self-reported health status is ascertained at visit 2. The second person-period is between visit 3 and visit 4 (10 months apart) where alcohol use and covariates are collected at visit 3 and self-reported health status are ascertained at visit 4. The period between visit 2 and visit 3 is not included because it is less than 3.5 months. Participant D contributes no person-period because the visits are greater than 18 months apart.

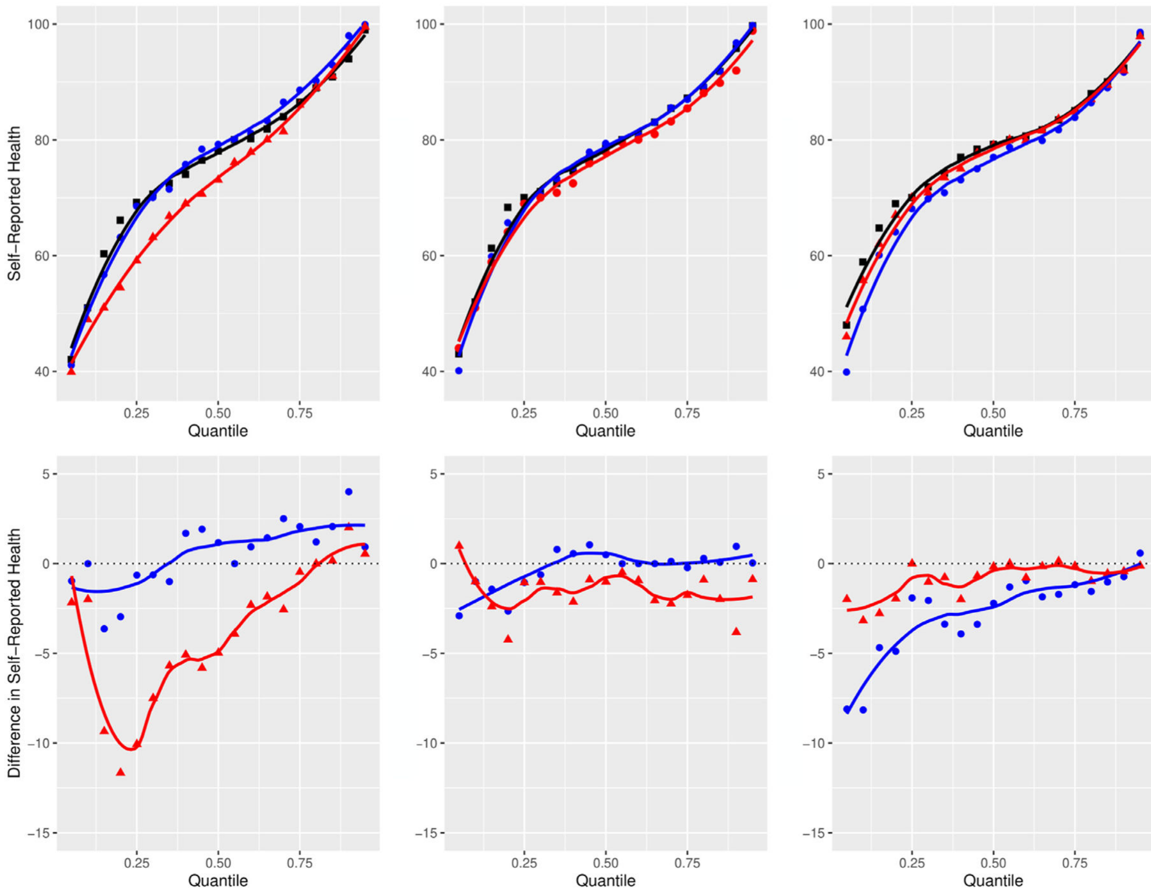

Fig. 2.

Title: Estimated self-reported health status score (top row) and difference in quantile score as compared to participants with moderate alcohol use by quantile for women (left column panels) MSW (center column panels), and MSM (right column panels). No alcohol use: blue line and circle points, Moderate alcohol use: black line and square points, Heavy alcohol use: red line and triangle points.

Table 1

Characteristics of persons in cohort who completed at least two patient self-reported outcomes assessment between January 2011 and June 2014, at first assessment, stratified by reported alcohol use and gender/HIV acquisition risk factor.

WOMEN (N=668)	**No alcohol use[a] N = 350**	**Moderate alcohol use[a] N = 175**	**Heavy alcohol use[a] N = 143**
Number of visits	1025	563	356
Observations/person, Median (IQR)	2 (1, 4)	2 (1, 4)	2 (1, 3)
Person-period length (months), Median (IQR)	8.1 (6.3, 11.5)	8.5 (6.7, 11.7)	8.2 (6.6, 11.7)
Age, Median (IQR)	46 (38, 53)	44 (38, 52)	44 (34, 50)
Race/ethnicity, N (%)			
Black	197 (56)	106 (61)	72 (50)
White	99 (29)	54 (31)	46 (32)
Hispanic	45 (13)	11 (6)	18 (13)
Other[b]	9 (3)	4 (2)	7 (5)
Drug use in the last 3 months, N (%)[c]	15 (4)	16 (10)	30 (21)
On antiretroviral treatment, N (%)	284 (81)	127 (73)	100 (70)
CD4 count, N (%) cells/μL			
0–199	52 (15)	16 (9)	25 (18)
200–349	49 (14)	32 (18)	21 (15)
350–499	65 (19)	29 (17)	35 (25)
500+	184 (53)	98 (56)	62 (43)
Viral load >100 copies/mL, N (%)	260 (74)	122 (70)	93 (65)
Depressive Symptoms, N (%)[d]	70 (20)	35 (20)	30 (21)
MSW (N=978)	N = 394	N = 286	N = 298
Number of visits	1011	749	736
Observations/person, Median (IQR)	2 (1, 3)	2 (1, 4)	2 (1, 3)
Person-period length (months), Median (IQR)	8.3 (6.4, 11.6)	8.0 (6.7, 10.8)	8.7 (6.6, 12.7)
Age, Median (IQR)	45 (39, 52)	45.0 (38, 52)	44 (34, 49)
Race/ethnicity, N (%)			
Black	145 (37)	113 (40)	92 (31)
White	168 (43)	131 (46)	151 (51)
Hispanic	69 (18)	31 (11)	40 (13)
Other[b]	12 (3)	11 (4)	15 (5)
Drug use in the last 3 months, N (%)[c]	49 (12)	54 (19)	80 (27)
On antiretroviral treatment, N (%)	336 (85)	242 (85)	238 (80)
CD4 count, N (%)			
0–199	75 (19)	52 (18)	55 (19)
200–349	71 (18)	60 (21)	59 (20)
350–499	88 (22)	64 (22)	70 (24)
500+	160 (41)	110 (39)	114 (38)
Viral load >100 copies/mL, N (%)	305 (77)	214 (75)	207 (70)

WOMEN (N=668)	No alcohol use[a] N = 350	Moderate alcohol use[a] N = 175	Heavy alcohol use[a] N = 143
Depressive Symptoms, N (%)[d]	95 (24)	60 (21)	74 (25)
MSM (N=3400)	N = 991	N = 1139	N = 1270
Number of visits	2610	3093	2968
Observations/person, Median (IQR)	2 (1, 3)	2 (1, 4)	2 (1, 3)
Person-period length (months), Median (IQR)	8.4 (6.7, 12.0)	8.3 (6.3, 11.4)	8.5 (6.8, 12.1)
Age, Median (IQR)	46 (40, 52)	45 (37, 51)	42 (32, 48)
Race/ethnicity, N (%)			
Black	218 (22)	229 (20)	204 (16)
White	544 (55)	681 (60)	781 (62)
Hispanic	185 (19)	177 (16)	224 (18)
Other[b]	44 (4)	52 (5)	61 (5)
Drug use in the last 3 months, N (%)[c]	103 (10)	138 (12)	254 (20)
On antiretroviral treatment, N (%)	830 (84)	933 (82)	966 (76)
CD4 count, N (%)			
0–199	139 (14)	162 (14)	154 (12)
200–349	181 (18)	181 (16)	223 (18)
350–499	203 (21)	246 (22)	299 (24)
500+	468 (47)	550 (48)	594 (47)
Viral load >100 copies/mL, N (%)	759 (77)	872 (77)	909 (72)
Depressive Symptoms, N (%)[d]	248 (25)	224 (20)	272 (21)

Abbreviations: IQR, interquartile range; MSW, men who have sex with women; MSM, men who have sex with men

[a]No alcohol use defined as AUDIT-C score of 0 for women and men. Moderate alcohol use defined as AUDIT-C score 1–2 for women or 1–3 for men; Heavy alcohol use defined as AUDIT-C score ≥3 for women or ≥4 for men

[b]Includes American Indian, Asian, Pacific Islander, multiracial, or unknown

[c]Including cannabis, cocaine/crack, recreational opioid, and methamphetamine use

[d]Depressive symptoms is defined as Patient Health Questionaire-2 score ≥3

Table 2

Adjusted odds ratios (OR), 95% confidence limits, and expected value of self-reported health status score associated with different levels of AUDIT-C score categories at the 10th, 25th, 50th, 75th, and 90th percentiles of self-reported health status scores among 5,046 women, men who have sex with women (MSW) and men who have sex with men (MSM) in the 13,111person-periods[a].

	Women			MSW			MSM		
	OR	**95% CI**	**Expected Value**	**OR**	**95% CI**	**Expected Value**	**OR**	**95% CI**	**Expected Value**
10th Percentile									
No alcohol use	1.0	0.79, 1.27	51	0.96	0.72, 1.28	51	0.72	0.65, 0.79	51
Moderate alcohol use	1	-	51	1	-	52	1	-	59
Heavy alcohol use	0.92	0.67, 1.27	49	0.96	0.74, 1.25	51	0.88	0.75, 1.02	56
25th Percentile									
No alcohol use	0.97	0.80, 1.17	69	0.95	0.85, 1.06	69	0.91	0.84, 0.98	68
Moderate alcohol use	1	-	69	1	-	70	1	-	70
Heavy alcohol use	0.64	0.48, 0.87	59	0.95	0.81, 1.13	69	1.00	0.95, 1.05	70
50th Percentile									
No alcohol use	1.07	0.88, 1.31	79	1.03	0.91, 1.16	79	0.88	0.80, 0.97	77
Moderate alcohol use	1	-	78	1	-	79	1	-	79
Heavy alcohol use	0.76	0.58, 0.99	73	0.94	0.78, 1.14	78	0.99	0.92, 1.05	79
75th Percentile									
No alcohol use	1.21	0.86, 1.68	89	0.98	0.76, 1.27	87	0.91	0.80, 1.03	84
Moderate alcohol use	1	-	87	1	-	87	1	-	85
Heavy alcohol use	0.96	0.62, 1.48	86	0.86	0.67, 1.11	85	0.99	0.89, 1.11	85
90th Percentile									
No alcohol use	3.1	1.36, 7.10	98	1.31	0.64, 2.69	97	0.91	0.68, 1.21	92
Moderate alcohol use	1	-	93	1	-	96	1	-	92
Heavy alcohol use	1.54	0.48, 4.85	96	0.50	0.26, 0.98	92	0.94	0.75, 1.19	92

[a]Expected value is the predicted value for the corresponding percentile with that level of drinking category stratified by women, MSW, MSM. Regression models included inverse probability of exposure (alcohol category) weights with adjustments for age, race/ethnicity, antiretroviral use, detectable viral load, time span between visit pairs, CD4 count, other drug use, and index self-reported health status score. The OR is a comparison of the self-reported health status score odds of each group. For example, consider the 25th percentile for women with moderate alcohol use compared to heavy alcohol use. The OR is obtained by calculating expected self-reported health status score of 69 for moderate alcohol use and the self-reported health status score of 59 for heavy alcohol use. The scores are divided by 100 and add 0.01 (to prevent issues of logit transformation of a 0 value) and the transformed values are 0.70 and 0.60 for heavy and moderate alcohol use, respectively. The self-reported health status score odds for moderate alcohol use are 0.70 / (1–0.70) = 2.33 and for heavy alcohol use are 0.60 / (1–0.60) = 1.50. Therefore, the odds ratio of high-risk drinkers to moderate drinkers is 1.50/2.33=0.64.

Table 3

Sensitivity analysis with adjusted odds ratios (OR), 95% confidence limits, and expected value of self-reported health status score associated with different levels of AUDIT-C score categories at the 10th, 25th, 50th, 75th, and 90th percentiles of self-reported health status scores among 5,046 women, men who have sex with women (MSW) and men who have sex with men (MSM) in the 13,111 person-periods[a].

	Women			MSW			MSM		
	OR	95% CI	Expected Value	OR	95% CI	Expected Value	OR	95% CI	Expected Value
10th Percentile									
No alcohol use	0.89	0.63, 1.23	52	0.92	0.64, 1.32	56	0.73	0.61, 0.88	52
Moderate alcohol use	1	-	55	1	-	58	1	-	60
Heavy alcohol use	0.82	0.59, 1.13	50	0.82	0.57, 1.19	53	1	0.90, 1.11	60
Depressive symptoms	0.56	0.31, 1.00	41	0.48	0.23, 1.00	40	0.63	0.48, 0.82	49
Interaction terms									
No alcohol use and Depressive Symptoms	1.21	0.62, 2.36	42	1.15	0.48, 2.80	41	1.13	0.76, 1.67	44
Heavy alcohol use and depressive symptoms	0.86	0.41, 1.80	32	1.62	0.73, 3.60	46	0.84	0.58, 1.19	44
25th Percentile									
No alcohol use	0.94	0.80, 1.11	69	0.97	0.83, 1.15	70	0.90	0.83, 0.99	69
Moderate alcohol use	1	-	70	1	-	71	1	-	71
Heavy alcohol use	0.75	0.53, 1.06	63	0.95	0.81, 1.13	70	0.98	0.90, 1.08	71
Depressive symptoms	0.66	0.43, 1.03	61	0.65	0.42, 1.01	62	0.59	0.49, 0.71	59
Interaction terms									
No alcohol use and Depressive Symptoms	0.79	0.49, 1.31	54	0.79	0.47, 1.31	55	1.00	0.78, 1.28	57
Heavy alcohol use and depressive symptoms	0.86	0.45, 1.63	50	0.98	0.61, 1.58	60	0.84	0.66, 1.08	55
50th Percentile									
No alcohol use	1.05	0.90, 1.23	80	1.00	0.89,1.13	80	0.94	0.89, 1.00	79
Moderate alcohol use	1	-	79	1	-	80	1	-	80
Heavy alcohol use	0.82	0.63, 1.06	76	1.00	0.89, 1.13	80	1.00	0.95, 1.05	80
Depressive symptoms	0.61	0.47, 0.78	70	0.58	0.50, 0.68	70	0.58	0.54, 0.63	70
Interaction terms									
No alcohol use and Depressive Symptoms	1.06	0.72, 1.57	72	1.00	0.73, 1.36	70	0.97	0.84, 1.14	68
Heavy alcohol use and depressive symptoms	0.80	0.49, 1.30	60	0.99	0.78, 1.25	70	0.95	0.82, 1.11	69
75th Percentile									
No alcohol use	1.17	0.87, 1.57	90	0.95	0.74, 1.23	88	0.91	0.76, 1.11	86
Moderate alcohol use	1	-	88	1	-	89	1	-	87
Heavy alcohol use	0.98	0.64, 1.51	88	0.88	0.68, 1.14	88	0.97	0.84, 1.14	87
Depressive symptoms	0.62	0.42, 0.90	82	0.50	0.36, 0.67	80	0.56	0.47, 0.66	79
Interaction terms									

	Women			MSW			MSM		
	OR	95% CI	Expected Value	OR	95% CI	Expected Value	OR	95% CI	Expected Value
No alcohol use and Depressive Symptoms	0.89	0.54, 1.46	82	1.17	0.73, 1.86	82	1.04	0.81, 1.32	78
Heavy alcohol use and depressive symptoms	0.97	0.46, 2.03	81	1.22	0.81, 1.82	81	1.03	0.84, 1.26	79
90th Percentile									
No alcohol use	3.49	1.38, 8.76	98	1.14	0.34, 3.74	97	0.92	0.68, 1.27	93
Moderate alcohol use	1	-	94	1	-	97	1	-	93
Heavy alcohol use	1.92	0.55, 6.62	97	0.49	0.16, 1.51	94	0.92	0.71, 1.21	93
Depressive symptoms	0.54	0.09, 3.32	90	0.25	0.08, 0.78	89	0.57	0.42, 0.76	89
Interaction terms									
No alcohol use and Depressive Symptoms	0.97	0.06, 15.03	97	0.98	0.25, 3.90	90	0.84	0.53, 1.35	86
Heavy alcohol use and depressive symptoms	0.67	0.03, 15.49	92	2.25	0.64, 8.00	90	1.01	0.66, 1.55	83

[a]Expected value is the predicted value for the corresponding percentile with those characteristics. Moderate drinking is the reference and expected value for depression row is the self-reported health status score for moderate drinkers with depressive symptoms. Similarly, for the interaction terms (e.g., heavy alcohol use), this is the self-reported health status score among those who have heavy alcohol use and have depressive symptoms as measured by the Patient Health Questionnaire-2. Regression models included inverse probability weight which was the product of the inverse probability of alcohol category and the inverse probability of depression weights. The inverse probability weights included adjustments for age, race/ethnicity, antiretroviral use, detectable viral load, time span between visit pairs, CD4 count, other drug use, and index self-reported health status score. See Table 2 caption for interpretation of the OR.