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Predictors of Longitudinal Trajectories of Alcohol Consumption in People with HIV

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Abstract

Background—To describe alcohol consumption trajectories in a cohort of People Living With HIV and determine clinical and sociodemographic predictors of each trajectory.

Methods—This is a prospective cohort study of 7906 patients in the 7 Centers for AIDS Research Network of Integrated Clinical Systems (CNICS) sites. Alcohol consumption was categorized as none, moderate, and alcohol misuse. Predictors included age, race/ethnicity, depressive or anxiety symptoms, illicit drug use (opioids, methamphetamines, cocaine/crack),

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marijuana use, hepatitis C virus (HCV) infection, HIV transmission risk factor, and HIV disease progression. We estimated sex-stratified alcohol consumption trajectories and their predictors.

Results—We found 7 trajectories of alcohol consumption in men: stable non-drinking and increased drinking (71% and 29% of initial non-drinking); stable moderate, reduced drinking and increased alcohol misuse (59%, 21% and 21% of initial moderate alcohol use); and stable alcohol misuse and reduced alcohol misuse (75% and 25% of initial alcohol misuse). Categories were similar in women, except lack of an increase to alcohol misuse trajectory among women that begin with moderate use. Older men and women were more likely to have stable non-drinking, while younger men were more likely to increase to or remain in alcohol misuse. Minorities, people with depressive or anxiety symptoms, HCV-infected individuals and people who injected drugs were more likely to reduce use. Illicit drug use was associated with a reduction in overall drinking, while marijuana use was associated with stable moderate drinking or misuse.

Conclusions—Longitudinal trajectories of increasing alcohol use and stable misuse highlight the need to integrate routine screening and alcohol misuse interventions into HIV primary care.

Keywords

HIV; alcoholic beverages; behavior; statistical models; US

INTRODUCTION

In the United States (US), alcohol related mortality represents ~10% of all deaths among working-age adults(Stahre, 2014). Recent reports have highlighted the increase in alcohol related mortality due to alcohol poisonings and alcohol-related chronic liver disease(Case and Deaton, 2015). In addition, alcohol misuse can exacerbate chronic health conditions including hypertension and increase the risk for a variety of cancers and other liver diseases unrelated to alcohol. Indeed, with the advent of new effective treatments for hepatitis C viral infection (HCV)(Sulkowski et al., 2014) and the potential decrease in the burden of HCV-related liver cirrhosis(Chhatwal et al., 2016), alcohol use may become the leading cause of liver disease in the US(Guirguis et al., 2015).

Alcohol misuse, which includes hazardous/heavy use, binge drinking, and alcohol use disorder (AUD), is prevalent and particularly risky among people with HIV (PWH)(Chander et al., 2006b, Chander et al., 2008). Blood alcohol levels for a given quantity of alcohol appear to be higher in PWH compared to those without HIV infection, especially among individuals who are not virologically suppressed(McCance-Katz et al., 2012, McGinnis et al., 2015). In addition, alcohol misuse decreases optimal engagement in the HIV care continuum, has been associated with lower use of antiretroviral therapy (ART)(Chander et al., 2006b), decreased rates of adherence(Hendershot et al., 2009) and viral suppression(Chander et al., 2006b), and increased mortality(DeLorenze et al., 2011, Neblett et al., 2011, Justice et al., 2016). Alcohol misuse has also been associated with an increase in HIV transmission risk behaviors(Shuper et al., 2009, Hutton et al., 2013), and potentially increased hepatotoxicity in combination with protease inhibitors(Bilal et al., 2016). In a recent multi-site cohort study, alcohol misuse was associated with worse retention in HIV care(Jenkins and Zucker, 2010, Monroe et al., 2016), which has been associated with poorer

treatment outcomes and increased mortality(Mugavero et al., 2014). Furthermore, as PWH age, alcohol misuse may complicate other comorbid conditions such as hypertension(Freiberg et al., 2010) and diabetes(Butt et al., 2009), and increase the risk for stroke and cognitive decline(Bryant, 2006).

Understanding trajectories of alcohol use over time, including predictors of persistence and change in use may assist providers in identifying individuals at particular risk for development and/or maintenance of alcohol misuse, and therefore worsening HIV and other treatment outcomes. Thus, we examined longitudinal trajectories of alcohol use in a large multi-site clinical cohort of PWH and determined clinical and potentially modifiable predictors of each specific trajectory.

MATERIALS AND METHODS

Study design and population

This is a longitudinal study of PWH receiving care across seven sites participating in the Centers for AIDS Research Network of Integrated Clinical Systems (CNICS), a multisite clinical cohort study of PWH(Kitahata et al., 2008). Clinical sites for this study included ambulatory HIV clinics affiliated with: 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, NC), and University of Washington (Seattle, WA). The institutional review board at each site approved the study protocol.

Study inclusion

For this analysis, we included PWH, age 18 or older, who completed more than 1 clinical assessment of alcohol use during the study period (January 2008 to July 2014). A total of 7,906 individuals (6,619 males and 1,287 females) were included, and completed 32,229 observations (clinical visits with patient reported outcomes assessments) for an average of 2.32 years of follow-up time and 4.1 observations per patient.

Data Sources

CNICS(Kitahata et al., 2008) collects longitudinal clinical, demographic, laboratory, and medication data from electronic health records and other sources at each site. In addition, the CNICS data repository integrates patient reported behaviors obtained at 4–6 month intervals at clinical care visits through touch-screen based computer-assisted assessments (CASI) that are self-administered. In some of the clinics, the results are subsequently fed back to the providers (after the patient has completed the questionnaire). Patients report using validated instruments on alcohol (Alcohol Use Disorders Identification Test [AUDIT-C])(Bradley et al., 2003, Bradley et al., 1998), substance use (modified Alcohol, Smoking, and Substance Involvement Screening Test [ASSIST])(Newcombe et al., 2005, 2002), depressive and anxiety symptoms (Patient Health Questionnaire depression and panic disorder modules [PHQ])(Löwe et al., 2005, Wittkampf et al., 2011), medication adherence(Feldman et al., 2013), and other health domains(Crane et al., 2007).

Outcome

Alcohol consumption was measured using the AUDIT-C questionnaire that includes three questions: frequency of drinking, quantity of drinks consumed on a drinking day, and binge drinking behaviors. Individuals were classified as reporting not drinking if they had an AUDIT-C score of 0; as reporting alcohol misuse if they had an AUDIT-C score of ≥4 in men and ≥3 in women; and as reporting moderate drinking otherwise.

Predictors

Sociodemographic data included: age (in quartiles), race/ethnicity (White, African American, Hispanic, or Other Race) and sex. Psychosocial variables included depressive symptoms (measured using the PHQ-2 questionnaire with a threshold of 3 or above for clinically significant symptoms(Löwe et al., 2005)) and anxiety symptoms (presence of any panic disorder symptoms(Wittkampf et al., 2011)). Covariates on other risk behaviors included illicit drug use (cocaine/crack, opioids/heroin, or methamphetamines, categorized as never/former/current use); marijuana use (never/former/current use); and injection drug use (ever/never). Clinical covariates included HCV infection (presence of HCV antibody on laboratory testing), detectable HIV viral load (>75 copies), and CD4 cell count (clinical cutoffs of <200/200–350/≥350 cells/mm^3). For men, we also included a covariate on whether the subject self-reported as a man who has sex with men (MSM). All covariates were measured at the first CASI.

Statistical analysis

All analysis were stratified by sex, given the previously reported differences in alcohol consumption trajectories(Jenkins and Zucker, 2010) and potential differences in alcohol metabolism by sex(Frezza et al., 1990). Descriptive statistics were calculated for alcohol consumption trajectory and the exposures. The main analysis was conducted in 3 stages.

First, we used a multinomial logistic model to assess the probability of non-drinking, moderate alcohol use, or alcohol misuse at the first CASI using the covariates listed above, adjusting for age, race, and site.

Second, we used a finite mixture model with multinomial distributions in order to classify individuals according to latent alcohol consumption trajectories (Grün and Leisch, 2008). Optimal number of classes were determined by fitting models with 3 to 9 classes and assessing stability using 1000 bootstrap resamples and by minimizing the Integrated Classification Likelihood Criterion (ICL-BIC) (Grun and Leisch, 2006, McLachlan and Peel, 2004). Appendix Table 1 shows the goodness of fit and goodness of classification statistics, along with the combined ICL-BIC.

Finally, we examined baseline (first CASI) predictors of latent alcohol consumption trajectories using Vermunt's 3-step approach(Vermunt, 2010). Each predictor was included in separate models adjusted for age, race and site. We also ran a model that included all variables to assess whether associations varied due to correlations with other variables.

To account for missing data (~15% of all observations) we used multiple imputation by chained equations (MICE)(Raghunathan et al., 2001) where the imputations were based on

other available covariates including the outcome of drinking behaviors(Moons et al., 2006), generating 21 imputed data sets and pooling the coefficients using Rubin's Formula(Rubin, 2004). In reporting our results, we do not make any mention of statistical significance (or p-values) since we are not explicitly testing any hypothesis. We report 95% confidence intervals to provide an estimate for the precision of our estimates. All analyses were conducted using R v3.2.2 and Mplus version 7.4.

RESULTS

Study Population

Characteristics of the study sample at first CASI, overall and by alcohol consumption category, are shown on table 1. In men, the median follow-up was 2 years (IQR: 1 to 3), with an average of 3 observations per patient (IQR: 2 to 5). The median age was 45 years (IQR: 37 to 51) overall. Men who reported not drinking were slightly older, more likely to be African Americans, less likely to report former marijuana use and more likely to have a HCV co-infection and undetectable viral load. Men with alcohol misuse were slightly younger and more likely to report former illicit drug use. In women, the median follow-up was 2 years (IQR 1 to 4), with an average of 4 visits per patient (IQR 2 to 6). Women with alcohol misuse had a higher prevalence of depressive and anxiety symptoms, while other patterns are similar to that of men.

Alcohol consumption at first CASI

Alcohol consumption categories at first CASI differed by sex. Thirty-three percent of men did not drink at their first CASI, while 40% drank moderately and 27% had alcohol misuse. In women, 56% did not drink at their first CASI while 26% drank moderately and 18% had alcohol misuse.

Table 2 (left) shows the predictors of alcohol consumption at first CASI for men. Men aged 38 and above were more likely to not drink and less likely to be report alcohol misuse, as compared to men aged 19 to 37. Men with depressive or anxiety symptoms were more likely to report non-drinking or alcohol misuse. Illicit drug and marijuana use were also associated with alcohol misuse, while HCV infection and injection drug use were associated with non-drinking. Men with undetectable viral loads were also more likely to report not drinking and less likely to report alcohol misuse. Finally, men who have sex with men were less likely to report not drinking. After adjusting for all other variables in the model, there was a decrease in the probability of alcohol misuse for men that injected drugs (Appendix Table 2).

Table 2 (right) shows the predictors of alcohol consumption at first CASI in women. Older women were more likely to report not drinking. Depressive and anxiety symptoms, illicit drug use and marijuana use were associated with higher odds of alcohol misuse. Women that were HCV infected were more likely to report non-use or misuse. After adjusting for all other covariates, there was no longer an increased probability of alcohol misuse in HCV infected women (Appendix Table 3).

Alcohol consumption trajectories

Figure 1 (upper panel for men, bottom panel for women) shows the predicted trajectories of alcohol consumption, along with the prevalence of each trajectory. Men that did not drink at first CASI were either in the stable non-drinking category (71%) or increased their drinking to moderate use or alcohol misuse (29%). Men that drank moderately at first CASI were classified into stable moderate use (59%), reduction (21%) or increase (21%) in alcohol use. Finally, men starting with alcohol misuse were classified into stable misuse with a long-term trend towards decreased drinking (75%) and those that decreased alcohol misuse more quickly (25%), either by alcohol cessation or reduction to moderate use. For women, the predicted categories and distribution of women across categories were similar to those observed for men, with the exception that we did not have enough data to support a third class of women who drank moderately at first CASI and increased their drinking to levels of misuse. These women were classified in the trajectory of stable moderate drinking, where there is a small trend towards increased alcohol misuse (absent in males).

Appendix Figures 1 and 2 show the observed alcohol consumption trajectories weighted by the probability of membership into each class, and Appendix Figures 3 and 4 show observed proportions of individuals in each class and alcohol consumption category every 6 months. All show good agreement with the predicted categories and a large amount of variability within each trajectory, as some patients change categories frequently during the study.

Predictors of alcohol consumption trajectories

Table 3 shows the association between each predictor (adjusted by age and race) and each alcohol consumption trajectory for men. Older men who did not drink at their first CASI were less likely to increase drinking (OR=0.7[0.5;1.0], 0.6[0.4;0.9] and 0.4[0.3;0.6] in ages 38–45, 46–51 and 52–84, compared to 19–37). African-American men were more likely to increase drinking as compared to whites (OR=1.4[1.0;1.9]). Men with CD4 above 350 cells/ml had decreased odds of being in the stable non-drinking trajectory (OR=0.7[0.5;0.9]).

In men who drank moderately at first CASI, a reduction in drinking was associated with being a minority (OR=1.5[1.0;2.2] and 2.1[1.4;3.2] for African-Americans and Hispanics), having depressive or anxiety symptoms (OR=1.8[1.3;2.6] and 1.7[1.2;2.3]), former or current drug use (OR=1.8[1.2;2.5] and 2.7[1.8;4.0]), and injection drug use (OR=3.1[2.1;4.7]) and HCV infection (OR=3.0[2.0;4.3]). Increasing to alcohol misuse from moderate drinking at first CASI was less likely in men aged 38 or above (OR=0.6[0.4;0.8], 0.6[0.4;0.9] and 0.3[0.2;0.5] for ages 38–45, 46–51 and 52–84, compared to 19–37), and more likely in people that used illicit drugs in the past (OR=1.8[1.3;2.5]). Men who have sex with men were less likely to either increase or decrease from moderate drinking (OR=0.3[0.2;0.5] and 0.7[0.5;1.1] for decreasing drinking or increasing to alcohol misuse).

In men with alcohol misuse at first CASI, a reduction in drinking was more likely in African Americans (OR=1.6[1.1;2.5]), with depressive or anxiety symptoms (OR=1.4[1.0;2.0] and 1.6[1.2;2.3]), among those with HCV infection (OR=1.8[1.1;2.7]), and in men who injected drugs (OR=2.2[1.4;3.3]). This drinking reduction was less likely in men with undetectable viral load (OR=0.6[0.4;0.9]).

After adjusting for all other covariates in the model, injection drug use was no longer associated with a reduction in drinking in men who drank moderately at first CASI (OR=1.3[0.8;2.1] as compared to OR=3.1[2.1;4.7] in the age-race-site adjusted model), while marijuana use became associated with reduction in moderate drinking (Appendix Table 3).

Table 4 shows the associations between predictors of alcohol consumption trajectories for women. Older women who did not drink at first CASI were less likely to increase drinking (OR=0.4[0.2;0.7], 0.6[0.3;1.1] and 0.2[0.1;0.5] for ages 37–44, 44–51 and 51–84, compared to 19–37). For women who drank moderately at first CASI, a reduction in drinking was more likely in women who were HCV infected (OR=3.5[1.1;11.2]). Most of the other patterns are similar to those in men, with higher uncertainty around their estimates. Adjusting for all covariates did not meaningfully change any association (Appendix Table 4).

DISCUSSION

In this longitudinal study of PWH across 7 HIV clinics in the US, we found that alcohol drinking trajectories varied widely. Many individuals had stable drinking trajectories—remaining persistently in one of the three categories of none, moderate, or alcohol misuse. However, among others, alcohol use changed over time. Among men, approximately 25% who did not drink or drank moderately at first CASI increased their alcohol use, while 22% with moderate or alcohol misuse reduced their use. Among women, 13% who did not drink or drank moderately at first CASI increased their use, while 29% with alcohol misuse or moderate use decreased their use. Given the persistence of alcohol misuse in approximately 20% of all men and 13% of all women, and the escalation of alcohol use among those with initial non- or moderate use, these results reinforce the need to routinely screen for alcohol use in HIV clinical encounters, even among those who previously reported no alcohol use.

Despite the potential negative consequences of alcohol misuse among PWH, there have been only a few studies examining their trajectories of alcohol use and how they change their alcohol consumption patterns over time(Cook et al., 2009, Cook et al., 2013, Marshall et al., 2015, Marshall et al., 2017, Kelso-Chichetto et al., 2017). These studies have focused on specific groups of PWH, including women(Cook et al., 2009, Cook et al., 2013), veterans(Jacob et al., 2013, Marshall et al., 2017), and veteran men who have sex with men(Marshall et al., 2015). Two of the studies described drinking trajectories as defined by drinking scores for the entire duration of the study and then in separate analyses examined associations with alcohol misuse at each visit(Marshall et al., 2015, Kelso-Chichetto et al., 2017), while a third study modeled trajectories and their predictors but only in women(Cook et al., 2013). There was, therefore, a need for analyses that jointly model alcohol use trajectories and their predictors, allowing for an understanding of correlates of complex trajectories. Our finite mixture modeling method allowed for this characterization and description of drinking trajectories and their determinants.

Overall, in both men and women, increasing age was associated with decreasing alcohol use. This is consistent with other cohort studies in the general population that demonstrate that

alcohol use decreases with age(Moore et al., 2005, Karlamangla et al., 2006). Among men, alcohol misuse was associated with increased odds of depressive and anxiety symptoms, former and current illicit drug use, marijuana use and detectable viral loads. These findings are consistent with numerous other studies that demonstrate that alcohol misuse frequently co-occurs with other substance use(Parsons et al.) and mental health disorders(Chander and McCaul, 2003, Chander et al., 2006a) and that those with alcohol misuse are less likely to be virologically suppressed(Gonzalez et al., 2011, Marshall et al., 2017, Kelso-Chichetto et al., 2017). Of interest, in our trajectory analysis, both depressive and anxiety symptoms were associated with reducing alcohol consumption to a lower category of use. Alcohol reduction may have led to a decrease in these mental health symptoms, or a decrease in depressive and anxiety symptoms may have resulted in decreased alcohol use if an individual was self-medicating mental health symptoms with alcohol use(Chander and McCaul, 2003, Chander et al., 2006a, Okafor et al., 2016). It is also possible that changes in mental health symptoms or drug use associated with changes in alcohol trajectories may have been mediated by entry into psychiatric care or alcohol and drug treatments, which were not systematically captured in this clinical cohort.

HCV infection was also associated with a drinking reduction among men and women. This may be secondary to messaging from providers that alcohol use should be reduced among individuals with HCV infection or secondary to a general worsening in health status associated with the infection that may lead to a reduction in alcohol consumption(Knott et al., 2015, Shaper et al., 1988). Marijuana use was associated with maintaining alcohol misuse in men and women. This finding is consistent with a recent trajectory analysis of marijuana consumption where alcohol misuse was associated with increasing marijuana use over time(Okafor et al., 2016). An analysis conducted in young adults found that marijuana and alcohol consumption trajectories in the transition to adulthood mirrored each other, which may reflect the patterns we are observing in a somewhat older population(Schulenberg et al., 2005).

Factors associated with alcohol misuse among women in this sample are similar to findings from the Women's Interagency HIV Study (WIHS) examining hazardous alcohol use over an 11-year period(Cook et al., 2009). Consistent with their study, we found that depressive symptoms (and anxiety symptoms in our study), current and former illicit drug use and HCV infection were associated with alcohol misuse. However, in contrast to a later study in WIHS examining alcohol consumption trajectory patterns(Cook et al., 2013), we did not find that any of these clinical comorbidities was associated with our trajectory of persistent misuse whereas their study found that depressive symptoms, HCV infection and cocaine use were all associated with this trajectory. This difference may be due issues of statistical power, given that our sample size of women was less than half of the WIHS sample.

This study has several strengths. Our sample included a large cohort of patients in routine ambulatory HIV clinical care throughout the US, which increases the generalizability of our results. Second, patients were followed at approximately 4–6 month intervals, allowing for a detailed measurement of medium term alcohol consumption trajectories. Third, use of a finite mixture modeling approach where trajectories and their determinants are modeled in the same framework allows for a better and more integrated description of the alcohol

burden in PWLH. Finite mixture models are flexible enough to accommodate outcomes of continuous and categorical nature(McLachlan and Peel, 2004). In fact, the modeling approaches used in previous studies of alcohol consumption trajectories are specific instances of finite mixture models (with continuous outcomes).

This study has some limitations. First, we relied on self-reported alcohol consumption which is known to have some measurement error(Litten and Allen, 2012). Nonetheless, our use of a validated instrument (the AUDIT-C), delivered by a computer assisted interview, has been shown to be a valid and reliable method to measure alcohol consumption(Meneses-Gaya et al., 2010), and a recent analysis of trajectories using AUDIT-C has shown that they are correlated with alcohol consumption biomarkers(Marshall et al., 2017). Second, the time period for this study is prior to the widespread use of direct acting agents for HCV infection, and it is unknown how HCV cure may affect drinking over time. Third, this is a clinic-based study of PWH, which means our data collection is dependent on the health care process. While this may affect the quality of our measurements, this may increase the generalization of our results to the population of diagnosed and linked to care PWH(Lau et al., 2007). Also, we do not know what the drinking patterns of participants were prior to study start. It is possible that some of the people that did not drink at their first CASI who subsequently transitioned to moderate or alcohol misuse had prior misuse, which is an important predictor of subsequent alcohol use. In a recent study in this same cohort, greater than 1/3 of current individuals reporting non-use had a prior alcohol use disorder(Crane et al., 2016). Fourth, we only considered predictors measured at baseline (first CASI). Previous research has shown the importance of considering longitudinal changes in some clinical factors such as depression or anxiety(Pence et al., 2010), which may be cause and consequence of specific alcohol consumption patterns. However, our study was descriptive in nature and we did not aim at making inferences about the causal direction of this association. Furthermore, our main analysis only presents the age-, race-, and site-adjusted associations. We believe this represents the clinical reality better than a multivariate model that adjusts for every other factor available, where associations may be harder to interpret. However, we include the fully adjusted multivariate model in the appendix for transparency. Finally, our study classifies all individuals with AUDIT-C scores between 3 (in women) or 4 (in men) to 12 in the same group (alcohol misuse). Recent studies have shown that people with AUDIT-C scores equal or above 8 have increased risk for mortality(Justice et al., 2016). Future studies with adequate sample size to examine trajectories among individuals in this group would provide greater insights about those with heavier alcohol misuse.

Our study has important implications for the management of alcohol use in HIV clinical settings. First, given that trajectories of alcohol use do change, it is important to routinely screen all individuals for alcohol use, including those who report no or moderate use. Second, it is also important to ensure that individuals with alcohol use are screened for comorbid mental health and substance use disorders. With the relatively high frequency of comorbid mental health and substance use among those with alcohol misuse, it may be important to develop bundled interventions for these comorbid conditions. Finally, with significant alcohol related morbidity and mortality among PWH, integration of evidence-based alcohol interventions into HIV clinical settings is an important aspect of the primary

care of PWH. Future studies must work to identify how best to implement these interventions at both the provider and the system-level.

Conclusions

In conclusion, alcohol consumption trajectories are heterogeneous among PWH and range from people with stable use, who tend to have lower levels of other risk behaviors, to those whose consumption patterns vary, and have a higher prevalence of risk behaviors and other comorbidities. With the increased life expectancy of PWH, the potential for increased alcohol-related morbidity and mortality has grown and highlights the need to integrate routine screening and interventions for alcohol misuse into HIV primary care.

Supplementary Material

Refer to Web version on PubMed Central for supplementary material.

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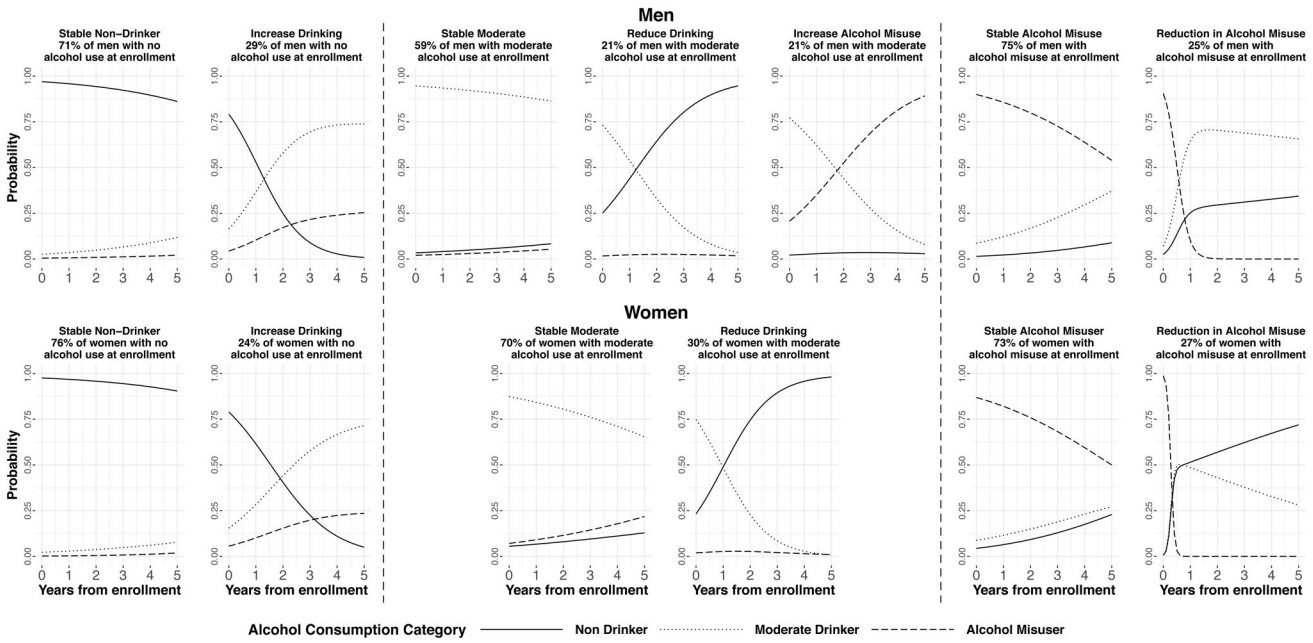

Figure 1.

Predicted alcohol consumption trajectories in men (upper panels) and women (bottom panels)

Table 1

Characteristics of the study population by sex and alcohol consumption at first CASI

	MEN				WOMEN			
	Overall	**No Alcohol Use**	**Moderate Alcohol Use**	**Alcohol Misuse**	**Overall**	**No Alcohol Use**	**Moderate Alcohol Use**	**Alcohol Misuse**
Prevalence	100%	33.5%	40.0%	26.5%	100%	56.1%	25.6%	18.3%
Sample Size	6201	2075	2482	1644	1220	684	313	223
Median Visits	3 [2–5]	3 [2–5]	3 [2–5]	3 [2–5]	4 [2–6]	4 [2–6]	4 [2–6]	3 [2–5]
Median Follow-up	2 [1–3]	2 [1–3]	2 [1–4]	2 [1–4]	2 [1–4]	2 [1–4]	2 [1–4]	2 [1–3]
Median Age (yrs.)	45 [37–51]	47 [40–53]	44 [36–50]	43 [33–49]	45 [38–52]	46 [39–53]	43 [37–50]	45 [36–51]
Race:								
African American	29%	36%	26%	23%	64%	67%	64%	57%
Other	15%	16%	15%	16%	9%	9%	7%	10%
Depressive Symptoms	22%	22%	20%	24%	21%	18%	20%	30%
Anxiety Symptoms	27%	26%	26%	30%	24%	21%	24%	33%
Illicit Drugs:								
Current	37%	36%	35%	42%	22%	22%	21%	25%
Former	17%	14%	16%	23%	12%	8%	12%	26%
Marijuana:								
Current	34%	34%	35%	34%	24%	21%	28%	28%
Former	33%	19%	35%	46%	16%	10%	18%	33%
Hepatitis C Infection	19%	26%	15%	14%	27%	32%	18%	27%
Undetect. Viral Load	59%	63%	59%	55%	57%	61%	58%	45%
Median CD4 [IQR]	454 [280–645]	435 [265–642]	467 [285–648]	458 [296–642]	506 [315–708]	511 [326–718]	529 [315–711]	464 [290–668]
MSM	72%	62%	76%	77%	N/A	N/A	N/A	N/A

Footnote: for race and illicit drugs, % whites and % never use is the complementary of the percentage shown. MSM: Men who have sex with men. Medians are shown as Median [IQR]. Each individual is weighted by the posterior class membership probabilities.

Table 2

Predictors of alcohol consumption at first CASI in men and women.

	MEN			WOMEN		
	No Alcohol Use	**Moderate Alcohol Use**	**Alcohol Misuse**	**No Alcohol Use**	**Moderate Alcohol use**	**Alcohol Misuse**
	OR (95% CI)		**OR (95% CI)**	**OR (95% CI)**		**OR (95% CI)**
Age *						
19–37	1 (Ref.)		1 (Ref.)	1 (Ref.)		1 (Ref.)
38–45	**1.6 (1.3–1.9)**		**0.7 (0.6–0.8)**	1.1 (0.8–1.7)		0.9 (0.6–1.4)
46–51	**1.8 (1.5–2.1)**		**0.7 (0.6–0.8)**	1.3 (0.9–2.0)		1.2 (0.7–1.9)
52–84	**1.9 (1.6–2.3)**		**0.6 (0.5–0.7)**	**1.6 (1.1–2.4)**		0.9 (0.6–1.6)
Race/Ethnicity *						
White	1 (Ref.)		1 (Ref.)	1 (Ref.)		1 (Ref.)
African-American	**1.4 (1.2–1.7)**		**0.8 (0.7–1.0)**	1.0 (0.7–1.4)		0.9 (0.6–1.4)
Hispanic	**1.3 (1.1–1.5)**		1.0 (0.8–1.2)	**1.8 (1.0–3.1)**		1.7 (0.9–3.2)
Other	1.1 (0.8–1.5)		**0.7 (0.5–1.0)**			
Depressive Symptoms †	**1.2 (1.0–1.4)**		**1.3 (1.1–1.5)**	1.0 (0.7–1.4)		**1.7 (1.1–2.5)**
Anxiety Symptoms †	**1.1 (1.0–1.3)**	**REFERENCE CATEGORY**	**1.2 (1.0–1.3)**	1.0 (0.7–1.3)	**REFERENCE CATEGORY**	**1.5 (1.0–2.3)**
Illicit Drug Use †						
Never	1 (Ref.)		1 (Ref.)	1 (Ref.)		1 (Ref.)
Former	**1.2 (1.0–1.3)**		**1.7 (1.5–2.0)**	1.4 (0.9–2.0)		**1.7 (1.1–2.7)**
Current	0.8 (0.7–1.0)		**2.0 (1.6–2.3)**	**0.6 (0.4–1.0)**		**2.8 (1.7–4.6)**
Marijuana Use †						
Never	1 (Ref.)		1 (Ref.)	1 (Ref.)		1 (Ref.)
Former	**0.8 (0.7–0.9)**		**1.5 (1.2–1.8)**	0.8 (0.6–1.2)		**1.6 (1.0–2.6)**
Current	**0.4 (0.3–0.5)**		**1.9 (1.6–2.3)**	**0.5 (0.3–0.8)**		**2.5 (1.6–4.0)**
Hepatitis C Infection †	**1.5 (1.3–1.8)**		1.0 (0.8–1.2)	**1.9 (1.3–2.7)**		**1.7 (1.1–2.6)**
Undetectable Viral Load †	**1.1 (1.0–1.3)**		**0.8 (0.7–1.0)**	1.0 (0.7–1.3)		**0.5 (0.3–0.7)**
CD4 Categories †						

	MEN			WOMEN		
	No Alcohol Use	**Moderate Alcohol Use**	**Alcohol Misuse**	**No Alcohol Use**	**Moderate Alcohol use**	**Alcohol Misuse**
	OR (95% CI)		**OR (95% CI)**	**OR (95% CI)**		**OR (95% CI)**
<200	1 (Ref.)		1 (Ref.)	1 (Ref.)		1 (Ref.)
>=200–<350	1.0 (0.8–1.2)		**1.2 (1.0–1.5)**	**0.6 (0.3–1.0)**		0.6 (0.3–1.3)
>=350	0.9 (0.8–1.1)		1.1 (0.9–1.3)	0.8 (0.5–1.2)		0.7 (0.4–1.2)
MSM †	**0.6 (0.5–0.7)**		0.9 (0.8–1.1)	N/A		N/A
Injection Drug Use †	**1.6 (1.4–1.9)**		1.0 (0.8–1.2)	**2.6 (1.7–4.0)**		**2.6 (1.6–4.4)**

*model adjusted by age, race and site.

†all other models are adjusted by age, race, site and the corresponding covariate.

All coefficients come from 21 runs of a multinomial logistic model over 21 imputed datasets. Reported are Odds Ratios and 95% confidence intervals. MSM: men who have sex with men.

Table 3

Predictors of alcohol consumption trajectories in men

Alcohol Use at first CASI	No Alcohol Use		Moderate Alcohol Use			Alcohol Misuse	
Trajectory	**Stable Non-Drinking**	**Increase in Drinking**	**Stable Moderate Drinking**	**Reduction in Drinking**	**Increase in Alcohol Misuse**	**Stable Alcohol Misuse**	**Reduction in Alcohol Misuse**
		OR (95% CI)		**OR (95% CI)**	**OR (95% CI)**		**OR (95% CI)**
Age *							
19–37		1 (Ref.)		1 (Ref.)	1 (Ref.)		1 (Ref.)
38–45		**0.7 (0.5–1.0)**		0.9 (0.6–1.4)	**0.6 (0.4–0.9)**		0.8 (0.5–1.2)
46–51		**0.6 (0.4–0.9)**		1.3 (0.8–1.9)	**0.6 (0.4–0.9)**		1.2 (0.8–1.9)
52–84		**0.4 (0.3–0.6)**		1.2 (0.8–1.8)	**0.3 (0.2–0.5)**		1.1 (0.7–1.8)
Race/Ethnicity *							
White		1 (Ref.)		1 (Ref.)	1 (Ref.)		1 (Ref.)
African-American		**1.4 (1.0–1.9)**		**1.5 (1.0–2.2)**	1.0 (0.6–1.5)		**1.6 (1.1–2.5)**
Hispanic		0.9 (0.6–1.4)		**2.1 (1.4–3.2)**	1.2 (0.8–1.8)		1.3 (0.8–2.0)
Other		0.9 (0.4–1.8)		1.0 (0.4–2.0)	0.5 (0.2–1.2)		1.2 (0.5–2.5)
Depressive Symptoms †		1.2 (0.9–1.7)		**1.8 (1.3–2.6)**	1.2 (0.8–1.8)		**1.4 (1.0–2.0)**
Anxiety Symptoms †	**REFERENCE TRAJECTORY**	1.1 (0.9–1.5)	**REFERENCE TRAJECTORY**	**1.7 (1.2–2.3)**	1.3 (0.9–1.8)	**REFERENCE TRAJECTORY**	**1.6 (1.2–2.3)**
Illicit Drug Use †							
Never		1 (Ref.)		1 (Ref.)	1 (Ref.)		1 (Ref.)
Former		1.0 (0.7–1.3)		**1.8 (1.2–2.5)**	**1.8 (1.3–2.5)**		0.8 (0.5–1.2)
Current		0.9 (0.6–1.4)		**2.7 (1.8–4.0)**	1.3 (0.8–2.2)		1.2 (0.8–1.8)
Marijuana Use †							
Never		1 (Ref.)		1 (Ref.)	1 (Ref.)		1 (Ref.)
Former		0.9 (0.7–1.3)		0.9 (0.6–1.3)	1.3 (0.9–1.9)		0.8 (0.5–1.2)
Current		1.3 (0.9–1.9)		1.0 (0.7–1.5)	1.4 (0.9–2.0)		**0.6 (0.4–0.9)**
Hepatitis C Infection †		1.0 (0.7–1.4)		**3.0 (2.0–4.3)**	1.1 (0.7–1.8)		**1.8 (1.1–2.7)**
Undetectable Viral Load †		0.9 (0.7–1.2)		0.9 (0.6–1.2)	1.0 (0.7–1.4)		**0.6 (0.4–0.9)**
CD4 Categories †							

Alcohol Use at first CASI	No Alcohol Use		Moderate Alcohol Use			Alcohol Misuse	
Trajectory	Stable Non-Drinking	Increase in Drinking	Stable Moderate Drinking	Reduction in Drinking	Increase in Alcohol Misuse	Stable Alcohol Misuse	Reduction in Alcohol Misuse
		OR (95% CI)		OR (95% CI)	OR (95% CI)		OR (95% CI)
<200		1 (Ref.)		1 (Ref.)	1 (Ref.)		1 (Ref.)
>=200–<350		0.9 (0.6–1.3)		1.0 (0.6–1.6)	0.7 (0.4–1.3)		1.0 (0.6–1.8)
>=350		**0.7 (0.5–0.9)**		0.8 (0.5–1.2)	0.8 (0.5–1.2)		1.0 (0.6–1.6)
MSM		1.2 (0.9–1.6)		**0.4 (0.3–0.5)**	0.7 (0.5–1.1)		0.9 (0.6–1.3)
Injection Drug Use[†]		0.8 (0.6–1.1)		**3.1 (2.1–4.7)**	1.4 (0.8–2.2)		**2.2 (1.4–3.3)**

[*] model is adjusted by age, race and site.

[†] all other models include age, race, site and the covariate of interest.

All coefficients come from 21 runs of a finite mixture model over 21 imputed datasets. Reported are Odds Ratios and 95% confidence intervals. All variables were measured at baseline. MSM: men who have sex with men.

Table 4

Predictors of alcohol consumption trajectories in women

Alcohol Use at first CASI	No Alcohol Use		Moderate Alcohol Use		Alcohol Misuse	
Trajectory	**Stable Non-Drinking**	**Increase in Drinking**	**Stable Moderate Drinking**	**Reduction in Drinking**	**Stable Alcohol Misuse**	**Reduction in Alcohol Misuse**
		OR (95% CI)		**OR (95% CI)**		**OR (95% CI)**
Age *						
19–37		1 (Ref.)		1 (Ref.)		1 (Ref.)
38–45		**0.4 (0.2–0.7)**		0.7 (0.2–2.0)		1.0 (0.3–2.8)
46–51		0.6 (0.3–1.1)		1.7 (0.6–4.8)		0.8 (0.3–2.3)
52–84		**0.2 (0.1–0.5)**		0.9 (0.3–2.5)		1.4 (0.5–4.2)
Race *						
White		1 (Ref.)		1 (Ref.)		1 (Ref.)
African-American		0.9 (0.5–1.8)		0.6 (0.2–1.3)		1.2 (0.5–3.1)
Other		0.4 (0.2–1.3)		2.3 (0.6–8.9)		0.7 (0.1–3.6)
Depressive Symptoms †		0.8 (0.4–1.7)		1.0 (0.4–2.4)		1.3 (0.5–3.4)
Anxiety Symptoms †		1.3 (0.7–2.4)		1.3 (0.5–3.4)		1.1 (0.5–2.5)
Illicit Drug Use †	**REFERENCE TRAJECTORY**		**REFERENCE TRAJECTORY**		**REFERENCE TRAJECTORY**	
Never		1 (Ref.)		1 (Ref.)		1 (Ref.)
Former		1.3 (0.6–2.5)		1.1 (0.4–3.0)		1.4 (0.5–3.8)
Current		1.6 (0.6–4.7)		1.7 (0.6–4.6)		0.7 (0.2–3.3)
Marijuana Use †						
Never		1 (Ref.)		1 (Ref.)		1 (Ref.)
Former		1.4 (0.7–2.9)		0.8 (0.3–2.0)		0.3 (0.09–1.3)
Current		1.2 (0.5–3.1)		1.0 (0.4–2.9)		0.5 (0.2–1.5)
Hepatitis C Infection †		1.3 (0.7–2.3)		**3.5 (1.1–11.2)**		0.9 (0.3–2.2)
Undetectable Viral Load †		0.8 (0.5–1.5)		0.8 (0.3–1.8)		0.8 (0.4–1.8)
CD4 Categories †						
<200		1 (Ref.)		1 (Ref.)		1 (Ref.)

Alcohol Use at first CASI	No Alcohol Use		Moderate Alcohol Use		Alcohol Misuse	
Trajectory	**Stable Non-Drinking**	**Increase in Drinking**	**Stable Moderate Drinking**	**Reduction in Drinking**	**Stable Alcohol Misuse**	**Reduction in Alcohol Misuse**
		OR (95% CI)		**OR (95% CI)**		**OR (95% CI)**
>=200–<350		0.7 (0.2–1.9)		0.8 (0.2–2.9)		1.9 (0.5–6.9)
>=350		1.1 (0.5–2.2)		0.7 (0.2–2.3)		1.2 (0.4–3.6)
Injection Drug Use †		1.4 (0.7–2.6)		1.2 (0.4–4.1)		1.1 (0.4–3.1)

*model is adjusted by age, race and site.

†all other models include age, race, site and the covariate of interest.

All coefficients come from 21 runs of a finite mixture model over 21 imputed datasets. Reported are Odds Ratios and 95% confidence intervals. All variables were measured at baseline. MSM: men who have sex with men.