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ORIGINAL PAPER

Alcohol Use and Multimorbidity Among Individuals Living with HIV

Timothy N. Crawford[1,2,4] · **Alice C. Thornton**[3]

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Abstract
Alcohol is prevalent among people living with HIV and can lead to multiple comorbid conditions (multimorbidity). The purpose of this study was to examine the relationship between alcohol use history and multimorbidity among people living with HIV. A retrospective cohort study design was conducted at an urban, academic infectious disease clinic in Kentucky. Individuals seeking care between 2010 and 2014 were included. Modified Poisson regression was used to examine the relationship between alcohol use history (never, current, and former use) and multimorbidity (≥2 conditions). A total of 949 individuals were included in the study, with 5.1 and 17.6% reporting former and current alcohol use, respectively. Sixty-five percent had ≥1 condition and 82.6% of those had ≥2 conditions diagnosed. The risk of multimorbidity was 1.70 (95% CI 1.35–2.14) times higher for a current user compared to a never user. Reductions in alcohol use may lead to lower rates of multimorbidity.

Keywords Multimorbidity · Comorbid conditions · Alcohol use · PLWH · HIV

Introduction

Alcohol use is highly prevalent among people living with HIV (PLWH), with over half of PLWH reporting alcohol use in the past year [1, 2]. Alcohol use among PLWH impedes successful management of their disease as it negatively influences diagnosis of HIV [3], linkage to care [3], retention in HIV care [3], medication adherence [4–6], and suppression of viral loads [5–7]. In addition, alcohol use among PLWH may lead to numerous mental and physical health conditions, such as anxiety, depression, hypertension, diabetes, liver disease, and cardiovascular disease [6, 8–13].

As PLWH age, the risk of acquiring a comorbid condition increases [14] and alcohol use has been shown to exacerbate that risk [6]. However, despite prolonged viral suppression, alcohol associated conditions that are generally seen in older non-HIV infected adults are now common in younger PLWH who consume alcohol [6, 8, 15]. This is potentially due to immuno-senescence, chronic inflammation, and hypercoagulability [6, 16]. In addition to HIV status, alcohol is known to play a role in some of these mechanisms suggesting a multiplicative effect on acquiring a comorbid condition [6]. Studies have shown that up to 60% of PLWH have at least one co-morbid condition diagnosed throughout the course of their infection [17, 18]. In addition, individuals who consume alcohol are more likely to acquire comorbid conditions such as cardiovascular disease, hypertension, and liver disease [6]. In one study involving HIV-infected veterans, alcohol dependence was significantly associated with congestive heart failure and coronary heart disease [19]. Kahler et al. [12] examined the direct and indirect effects of heavy alcohol use on clinical outcomes among patients on antiretroviral therapy and found significant direct and total effects of heavy alcohol use on liver fibrosis.

Although alcohol use has been shown to be a significant risk factor for acquiring a comorbid condition, researchers have generally focused on individual conditions. Approximately 1 in 4 individuals (regardless of HIV status) in the

✉ Timothy N. Crawford
timothy.crawford@wright.edu

1 Department of Population and Public Health Sciences, Wright State University, Boonshoft School of Medicine, Dayton, OH, USA

2 Department of Family Medicine, Wright State University, Boonshoft School of Medicine, Dayton, OH, USA

3 University of Kentucky, College of Medicine, Lexington, KY, USA

4 Department of Population and Public and Public Health Sciences, 3123 Research Blvd #200, Kettering, OH 45420, USA

United States (US) have at least two chronic conditions (multimorbidity). In addition, it is estimated that, approximately half of the US population living with a chronic condition have two or more additional chronic conditions [20]. Among PLWH, research has shown that up to 65% of those with a chronic condition have two or more conditions additionally diagnosed following infection [15, 16, 21, 22]. Multimorbidity is steadily increasing among PLWH. A recent study showed a 3-fold increase in the prevalence of multimorbidity from 2000 to 2009 [23]. Multimorbidity can have a negative impact on the health of PLWH as it can lower quality of life, increase disability, and increase viremia [16, 24]. Therefore, it is important to examine the relationship between alcohol use and multimorbidity among PLWH as alcohol use is a modifiable risk factor.

The purpose of this study was to examine the relationship between reported history of alcohol use and multimorbidity among individuals living with HIV. We hypothesize that individuals living with HIV who are former or current alcohol users will have greater rates of multiple comorbid conditions compared to those who never consume.

Methods

Study Design and Participants

A retrospective cohort study was conducted at an academic infectious disease clinic located in an urban city in Kentucky to examine the relationship between history of alcohol use and multimorbidity. Data from this retrospective study were collected from medical records housed at the clinic. The clinic is home to approximately 1700 active patients of which 50% are from rural areas. Individuals who were diagnosed with HIV and seeking care at the clinic between January 1, 2010 and August 1 2014 were eligible to be included in the study. Individuals were excluded from the study if they were diagnosed or living with a chronic condition (in addition to HIV) at the time, they entered care at the clinic. This allowed researchers to capture exposure at the time of entry into care and for follow-up until an event did or did not occur. Individuals included in the study were followed from the time they entered care (which could be before the study period) at the clinic until the end of the study period, transfer out of the service region, or died. The study was approved by the University of Louisville and the University of Kentucky Institutional Review Boards.

Study Measures

Demographic and clinical characteristics were obtained from the medical records database. Demographic data included age, sex, race (white or non-white), foreign-born status (U.S. born or Foreign born), HIV risk behavior (men who have sex with men (MSM), heterosexual contact, injection drug use (IDU), MSM + IDU, and other), level of poverty (living below federal poverty line or living above federal poverty line), insurance status (private, public, none), smoking status (current smoker, former smoker, never smoker), and history of drug use. Clinical data included history of an AIDS diagnosis, HIV duration (in years), baseline CD4 + cell counts, and baseline undetectable viral load (≤ 50 copies/ml).

The primary exposure of interest (independent variable) for this study was history of alcohol use. Alcohol use was self-reported and assessed at intake. As part of intake, individuals were asked whether they had a history of alcohol consumption. If so, they were asked whether they were currently drinking alcohol or had stopped drinking alcohol. Based on responses, individuals were categorized as using alcohol never, formerly, or currently. Quantity and frequency of alcohol use were not captured for this study.

The main outcome of this study was the presence of multiple comorbid conditions (multimorbidity) after an HIV diagnosis. Comorbid conditions were defined using the modified 21-item chronic illness checklist [15, 25]. The presence of comorbid conditions were screened for via medical records and grouped into the following categories based on the modified checklist: renal disease, chronic back pain, hepatitis C, respiratory disease (including chronic obstructive pulmonary disorder and asthma), cardiovascular disease, stroke, cancer (any non-HIV related cancers), diabetes, hypertension, mental health disorders (including depression, anxiety disorder, and bipolar disorder), stomach problems, arthritis, urinary/bladder problems, osteoporosis, dementia, hearing problems, headaches, and other chronic pain. The presence of multimorbidity was defined as having two or more diagnosed chronic conditions.

Statistical Analysis

Descriptive statistics including means, medians, standard deviations, and interquartile ranges (IQR) for all continuous variables and frequencies and percentages for all categorical variables were used. For the bivariate analysis, χ^2 tests were conducted to examine relationships between number of comorbid conditions and categorical variables; ANOVAs and Kruskall-Wallis tests were conducted to examine relationships with continuous variables and number of comorbid conditions.

The purpose of the study was to examine an association between alcohol use history and the number of comorbid conditions. To examine this relationship, we used a modified Poisson regression, with robust error variance. Incidence rates per 100 person-years were calculated by alcohol use history. Crude and adjusted incidence rate ratios (IRR) and 95% confidence intervals (CI) were calculated

to determine the risk of multimorbidity (≥ 2 conditions vs. 0–1 condition). Initially for the multivariable model, all variables with a p value ≤ 0.15 in the bivariate analysis and any known confounding variables were included in the model. Variables that were initially included that were not significant or did not appear to be confounders were removed from the model. The final model included alcohol use history, drug use, smoking status, insurance status, age group (< 50 years vs. ≥ 50 years), duration of HIV infection, baseline CD4 + cell counts, and baseline log viral load. A sensitivity analysis was conducted to examine the association between alcohol use history and any comorbid condition (≥ 1 condition).

A secondary analysis was conducted to examine the prevalence of chronic conditions among the sample of eligible participants that were removed from the analysis due to having a chronic condition at the time of entering care. A modified Poisson regression, with robust error variance, was conducted to obtain prevalence ratios (PR) and 95% CIs for multimorbidity.

All data were analyzed using SAS version 9.4 (Cary NC) and p-values < 0.05 were regarded as statistically significant.

Results

There were 1635 individuals eligible to be included in the study with 686 (42.0%) being excluded because they had a chronic condition diagnosed, in addition to HIV, at the time they entered care leaving 949 individuals in the final analysis. The average age of the study sample was 36.8 (Standard Deviation = 10.9) years and the median follow-up was 2.75 years (IQR = 0.8–6.12). Approximately 4.0% of the participants died during the study period. The majority of the study sample were male (80.9%), white, non-Hispanic (68.5%), MSM (60.2%), and were living below the federal poverty line (57.2%). Approximately 54% were current and former smokers and 24.9% had a history of drug use. Of the 949 individuals included in the analysis, 215 (22.7%) reported a history of alcohol use; 5.1% and 17.6% were former and current alcohol drinkers, respectively. Alcohol use history was significantly associated with age (p = 0.04), sex (p = 0.001), race (p = 0.03) HIV risk behavior (p = 0.01), smoking status (p < 0.0001), and drug use (p = 0.03) (Table 1).

Sixty-five percent of the study sample had at least one comorbid condition diagnosed during the study period. Figure one shows the incidence of the comorbid conditions diagnosed (Fig. 1). The majority of individuals had at least two or more conditions diagnosed (54.1%); of those with a comorbid condition, 82.6% had multimorbidity. Alcohol use history was statistically significantly associated with the number of comorbid conditions diagnosed as those with two or more conditions were more likely to be former and current alcohol drinkers (p < 0.0001) (Table 2). The rate of multimorbidity for a never drinker, former drinker, and current drinker was 9.9 per 100 person-years, 21.5 per 100 person-years, and 19.3 per 100 person-years, respectively. Other factors associated with the number of comorbid conditions included age (p < 0.0001), insurance type (p < 0.0001), smoking status (p < 0.0001), drug use (p < 0.0001), HIV duration (p < 0.0001), CD4 cell count (p < 0.0001), and undetectable viral load (p < 0.0001) (Table 2).

Table 3 and Fig. 2 shows the prevalence of each specific chronic condition. Of the 18 selected chronic conditions, mental health (34.7%) and hypertension (30.9%) were the two most common conditions diagnosed among the study sample; followed by diabetes (18.9%), cancer (16.7%), and cardiovascular disease (13.8%). Alcohol use history was significantly associated with hypertension (p = 0.01), diabetes (p < 0.0001), cancer (p < 0.0001), cardiovascular disease (p < 0.0001), and stroke (p < 0.0001) (Table 3).

Table 4 presents the crude and adjusted IRRs from the modified Poisson regression. Unadjusted, the risk of multimorbidity (≥ 2 conditions) is 2.17 (95% CI 1.45–3.24) times higher for former drinkers compared to never drinkers. In addition, the risk if 1.95 (95% CI 1.56–2.43) times higher for a current drinker compared to a never drinker. However, when controlling for the other variables in the model (i.e., age, drug use, smoking status, insurance status, HIV duration, CD4 + cell counts, and log viral load), only current drinkers, compared to never drinkers, had a significant increased risk of multimorbidity (aIRR = 1.70; 95% CI 1.35–2.14). In addition, older adults (≥ 50 years old) (aIRR = 2.06; 95% CI 1.52–2.78) and publicly insured individuals (aIRR = 1.47; 95% CI 1.18–1.83) had an increased risk of multimorbidity. A sensitivity analysis was conducted to examine the association between alcohol use history and having at least one comorbid condition. Unadjusted, the risk of at least one condition was 1.3 (95% CI 1.06–1.63) times higher for a current drinker compared to a never drinker. However, when adjusting for the same variables as above, there was no significant association between alcohol use history and have at least one comorbid condition.

A total of 686 individuals were excluded from the primary analysis due to having a chronic condition diagnosed at the time they entered HIV care. A secondary analysis was conducted to examine the prevalence of multimorbidity and the association between alcohol use history and multimorbidity. Those excluded from the study were similar to those included in the study, except they were more likely to be IDU, smokers, older, and privately insured. Approximately 81% have ≥ 2 chronic conditions diagnosed. In addition, they were more likely to have diabetes (31.9%), mental health (57.7%), cardiovascular disease (27.7%), hypertension (56.4%), respiratory (22.6%), and hepatitis C (24.9%). There

Table 1 Demographic and clinical characteristics by history of alcohol use among individuals living with HIV and seeking care, 2010–2014 (N = 949)

Characteristics		Alcohol use				
	Total N (%)	Never n (%)	Former n (%)	Current n (%)	χ^2 or F	p-value
Total	949 (100)	734 (77.3)	48 (5.1)	167 (17.6)		
Age-mean years (std)	36.8 (10.9)	36.8 (10.8)	40.2 (10.7)	35.7 (10.9)	3.27	0.04
Age group					6.04	0.05
< 50 years	837 (88.2)	651 (88.7)	37 (77.7)	149 (89.2)		
≥ 50 years	112 (11.8)	83 (11.3)	11 (22.9)	18 (10.8)		
Sex-male	768 (80.9)	579 (78.9)	40 (83.3)	149 (89.2)	18.71	0.001
Race					7.15	0.03
White	643 (68.5)	510 (70.5)	33 (68.8)	100 (59.9)		
Non-white	295 (31.5)	213 (29.5)	15 (31.3)	67 (40.1)		
Foreign-born status					1.74	0.42
US-born	608 (84.4)	443 (83.6)	34 (82.9)	131 (87.9)		
Foreign-born	112 (15.6)	87 (16.4)	7 (17.1)	18 (12.1)		
HIV risk behavior					19.33	0.01
MSM	551 (60.2)	403 (56.8)	27 (60.0)	121 (74.7)		
Heterosexual	272 (29.7)	226 (31.9)	15 (33.3)	31 (19.1)		
IDU	34 (3.7)	29 (4.1)	1 (2.2)	4 (2.5)		
MSM + IDU	26 (2.8)	21 (3.0)	1 (2.2)	4 (2.5)		
Other	33 (3.6)	30 (4.2)	1 (2.2)	2 (1.2)		
Poverty level-below poverty line	451 (57.2)	352 (59.5)	22 (51.2)	77 (50.3)	4.83	0.09
Insurance					7.85	0.10
Private	286 (30.1)	216 (29.4)	9 (18.8)	61 (36.5)		
Public	420 (44.3)	326 (44.4)	28 (58.3)	66 (39.5)		
None	243 (25.6)	192 (26.2)	11 (22.9)	40 (24.0)		
Smoking status					35.3	< 0.0001
Current smoker	391 (41.2)	296 (40.3)	19 (39.6)	76 (45.5)		
Former smoker	120 (12.6)	72 (9.8)	15 (31.3)	33 (19.8)		
Never smoker	438 (46.2)	366 (49.9)	14 (29.2)	58 (34.7)		
History of drug use-yes	236 (24.9)	171 (23.3)	19 (39.6)	46 (27.5)	7.17	0.03
AIDS diagnosis-yes	433 (45.6)	341 (46.5)	24 (50.0)	68 (40.7)	2.20	0.33
HIV duration-mean years (std)	8.7 (7.3)	9.2 (7.5)	7.6 (6.9)	6.7 (6.3)	9.00	0.0001
CD4 cell count-mean (std)	592.8 (347.0)	591.3 (350.8)	578.1 (417.0)	603.3 (309.3)	0.12	0.88
Undetectable viral load-yes	648 (76.8)	489 (77.1)	34 (73.9)	125 (76.2)	0.28	0.87
Death-yes	39 (4.1)	35 (4.8)	1 (2.1)	3 (1.8)	3.58	0.17

was a significant association between alcohol use history and multimorbidity in the modified Poisson regression. The PRs for former and current alcohol use, compared to never use, was 1.10 (95% CI 1.02–1.20) and 1.08 (95% CI 1.00–1.17), respectively.

Discussion

The purpose of this study was to examine the relationship between alcohol use history and multimorbidity among PLWH. We hypothesized that alcohol use history would be associated with multimorbidity among PLWH. In this study, we found that a majority of individuals were diagnosed with at least one comorbid condition and over half had 2 or more conditions. In addition, alcohol use history was significantly associated with multimorbidity; current alcohol users had an increased risk of multimorbidity compared to never drinkers. The results of our study corroborates with other studies suggesting a relationship between alcohol use and comorbidities [8–10, 19, 26, 27]. However, few studies have examined alcohol use as a risk factor for multimorbidity.

The majority of studies that have addressed the relationship between alcohol use and comorbid conditions have focused on a single comorbid condition; for example depression, hypertension, or cardiovascular disease. There

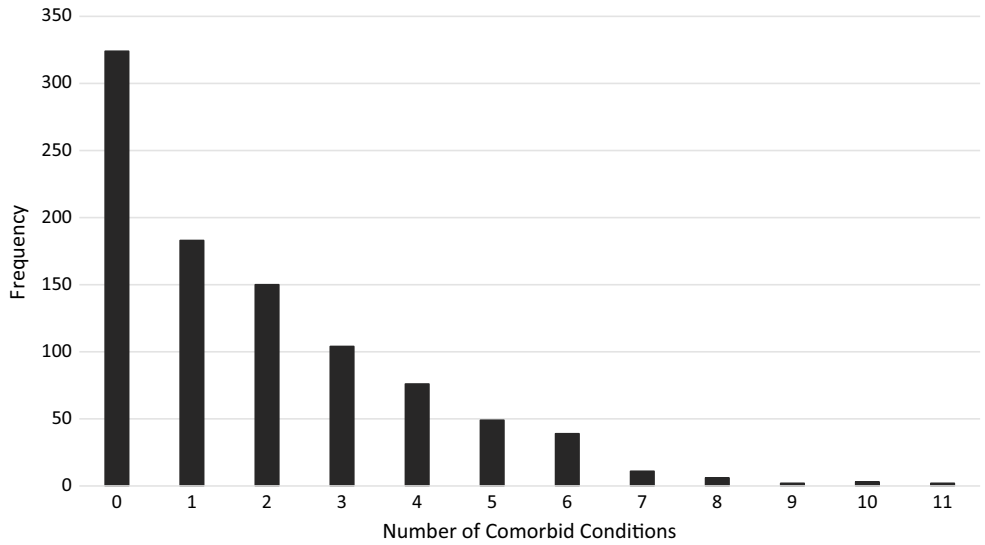

Fig. 1 Number of comorbid conditions diagnosed among individuals living with HIV and seeking care at the Clinic (N = 949)

is a paucity of research addressing multimorbidity and the association between alcohol and multimorbidity among PLWH [15, 16]. Researchers have shown multimorbidity to be as high as 65% among PLWH [17, 18, 21, 22, 24]. In our study, 54.1% of participants had two or more comorbid conditions diagnosed after being diagnosed with HIV. Consistent with other studies, the most common conditions diagnosed among this group were mental health disorders, hypertension, diabetes, cancer, and cardiovascular disease. The risk of acquiring a comorbid condition is already increased for individuals living with HIV due to chronic inflammation, immune-senescence, and hypercoagulability; coupled with alcohol, the risk is much higher as it is also associated with comorbid conditions among PLWH. It is important that researchers and clinicians address alcohol use and multimorbidity as it is a modifiable risk factor. In addition, multimorbidity is associated with a poor quality of life, increased hospitalization, poor functional status, and mortality [24].

Although not their focus, two studies assessed the relationship between multimorbidity and alcohol. Williams et al. [15] conducted a study to describe alcohol use, severity, and associated characteristics among older PLWH. The authors captured comorbid conditions in a similar way to our study (using the modified 21-item checklist), but categorized the number of conditions into 0, 1–2, and 3 + conditions. Using the Alcohol Use Disorders Identification Test Consumptions (AUDIT–C), the authors did not find an association between any past year drinking and number of comorbid conditions ($p = 0.09$). In addition, the authors did not find an association between number of comorbid conditions and severity of alcohol use ($p = 0.92$) [15]. Salter et al. [16] conducted a study to investigate the prevalence of multimorbidity and evaluated factors associated with multimorbidity among aging PLWH who were injection drug users. The authors defined multimorbidity (0, 1, 2, & 3+) based on 7 chronic conditions and looked at the number of alcoholic drinks/day; no association was found between multimorbidity and number of alcoholic drinks/day ($p = 0.158$) [16]. Comparing past and current alcohol use to never drinkers, we were able to show a significant association with multimorbidity.

Although alcohol use was the primary independent variable in the current study, we did observe factors that were associated with multimorbidity. Notably, in the univariate analysis, individuals with a history of drug use and former smokers had an increased risk of multimorbidity. In addition, age was significantly associated with multimorbidity. These results are consistent with other studies that have observed factors associated with comorbidity among PLWH [17, 24, 28–30]. However, when including all variables in the model, those associations with multimorbidity (except age) were attenuated. The attenuation of these associations may suggest potential mediation and/or confounding that needs to be teased out in future research. Understanding factors that contribute to the risk of multimorbidity is important, as this can assist in developing interventions to reduce modifiable factors, which in turn reduces multimorbidity.

There are a few limitations to this study. First, this study was a retrospective cohort study using medical records and was subject to uncontrolled confounders for which there were no information available. In addition, the retrospective study allowed for associations and not causation. Our results may not be generalizable to other populations of PLWH. Our study sample were predominately white and resided in rural areas. The results of our study should be assessed with caution. We assessed the relationship between alcohol use

Table 2 Demographic and clinical characteristics by number of comorbid conditions among individuals living with HIV and seeking care, 2010–2014 (N = 949)

Characteristics	Number of comorbidities				
	None n (%)	One n (%)	Two or more n (%)	χ^2 or F	p-value
Total	325 (34.5)	107 (11.4)	509 (54.1)		
Age-mean years (std)	40.6 (11.7)	41.3 (10.9)	46.4 (11.2)	27.48	< 0.0001
Age group					
< 50 years	288 (88.9)	167 (91.3)	382 (86.4)	3.13	0.21
≥ 50 years	36 (11.1)	16 (8.7)	60 (13.6)		
Sex-Male	270 (83.3)	149 (81.4)	349 (79.0)	3.99	0.41
Race				18.84	< 0.0001
White	194 (61.8)	116 (63.4)	333 (75.5)		
Non-white	120 (38.2)	67 (36.6)	108 (24.5)		
Foreign-born status				18.44	< 0.0001
US-born	180 (79.3)	115 (78.2)	313 (90.5)		
Foreign-born	47 (20.7)	32 (21.8)	33 (9.5)		
HIV risk behavior				6.95	0.54
MSM	197 (64.4)	107 (60.8)	247 (56.9)		
Heterosexual	80 (26.1)	53 (30.1)	139 (32.0)		
IDU	11 (3.6)	7 (4.0)	16 (3.7)		
MSM + IDU	8 (2.6)	2 (1.1)	16 (3.7)		
Other	10 (3.3)	7 (4.0)	16 (3.7)		
Poverty level-below poverty line	136 (62.4)	94 (58.8)	221 (53.9)	4.37	0.11
Insurance				77.63	< 0.0001
Private	90 (27.8)	70 (38.3)	126 (28.5)		
Public	106 (32.7)	64 (35.0)	250 (56.6)		
None	128 (39.5)	49 (26.8)	66 (14.9)		
Smoking status				28.20	< 0.0001
Current smoker	129 (39.8)	75 (41.0)	187 (42.3)		
Former smoker	23 (7.1)	17 (9.3)	80 (18.1)		
Never smoker	172 (53.1)	91 (49.7)	175 (39.6)		
Drug use-yes	48 (14.8)	42 (23.0)	146 (33.0)	33.65	< 0.0001
Alcohol use				35.22	< 0.0001
Current	32 (9.9)	33 (18.0)	102 (23.1)		
Former	7 (2.2)	10 (5.5)	31 (7.0)		
Never	285 (88.0)	140 (76.5)	309 (69.9)		
AIDS diagnosis-yes	132 (40.7)	75 (41.0)	226 (51.1)	10.11	0.006
HIV duration-mean years (std)	5.8 (6.1)	7.7 (7.0)	11.0 (7.5)	56.77	< 0.0001
CD4 cell count-median (IQR)	527.6 (318.2)	574.2 (331.3)	642.5 (363.6)	10.79	< 0.0001
Undetectable viral Load-yes	176 (69.0)	131 (78.4)	341 (80.8)	12.71	0.002
Death-yes	10 (3.1)	6 (3.3)	23 (5.2)	2.52	0.28

history and multimorbidity. However, it is possible that multimorbidity may be due to other risk factors such as smoking and/or drug use. However, we did control for some of these risk factors in our regression model. Another limitation was the alcohol use measurement. Alcohol use history was self-reported and only measured whether an individual had a history of alcohol use (yes/no) and if so, was it current or past. We did not have data regarding degrees of consumption, so we were not able to assess the level of severity and its association with multimorbidity. In addition, we did not have the duration of alcohol use, specifically for those who stopped drinking at the time they entered care. Although, the results showed a relationship between a history of alcohol use and multiple comorbid conditions, it is important to understand how the frequency and quantity of alcohol use impacts the prevalence of comorbid conditions. However, it has been suggested that many PLWH will experience conditions related to alcohol consumption even though they may no longer consume alcohol [8]. Social desirability is another limitation, as some individuals may not disclose their alcohol use history to their medical provider—this would lead to an underestimation of alcohol use history. Finally, we

Table 3 Chronic conditions by history of alcohol use among individuals living with HIV and seeking care at the clinic, 2010–2014 (N = 949)

Chronic condition		Alcohol use				
	Total N (%)	Never n (%)	Former n (%)	Current n (%)	χ^2	p-value
Mental health-yes	329 (34.7)	249 (33.9)	20 (41.7)	60 (35.9)	1.33	0.51
Hypertension-yes	293 (30.9)	211 (28.8)	22 (45.8)	60 (35.9)	8.59	0.01
Diabetes-yes	179 (18.9)	112 (15.3)	10 (20.8)	57 (34.1)	31.79	< 0.0001
Cancer-yes	158 (16.7)	87 (11.9)	18 (37.5)	53 (31.7)	54.60	< 0.0001
Cardiovascular-yes	131 (13.8)	79 (10.8)	15 (31.3)	37 (22.2)	27.77	< 0.0001
Respiratory-yes	121 (12.8)	93 (12.7)	11 (22.9)	17 (10.2)	5.46	0.07
Stomach problems-yes	112 (11.8)	91 (12.4)	7 (14.6)	14 (8.4)	2.48	0.29
Chronic back pain-yes	103 (10.9)	81 (11.0)	5 (10.4)	17 (10.2)	0.12	0.95
Headaches-yes	75 (7.9)	59 (8.0)	7 (14.6)	9 (5.4)	4.41	0.11
Arthritis-yes	62 (6.5)	44 (6.0)	4 (8.3)	14 (8.4)	1.54	0.46
hepatitis C-yes	47 (5.0)	34 (4.6)	3 (6.3)	10 (6.0)	0.71	0.70
Stroke-yes	38 (4.0)	18 (2.5)	6 (12.5)	14 (8.4)	21.94	< 0.0001
Renal-yes	36 (3.8)	29 (4.0)	3 (6.3)	4 (2.4)	1.74	0.42
Urinary/bladder-yes	24 (2.5)	21 (2.9)	1 (2.1)	2 (1.2)	1.57	0.46
Osteoporosis-yes	19 (2.0)	16 (2.2)	1 (2.1)	2 (1.2)	0.69	0.71
Other pain-yes	17 (1.8)	12 (1.6)	2 (4.2)	3 (1.8)	1.64	0.44
Dementia-yes	16 (1.7)	14 (1.9)	1 (2.1)	1 (0.6)	1.45	0.48
Hearing problems-yes	13 (1.4)	10 (1.4)	1 (2.1)	2 (1.2)	0.22	0.90

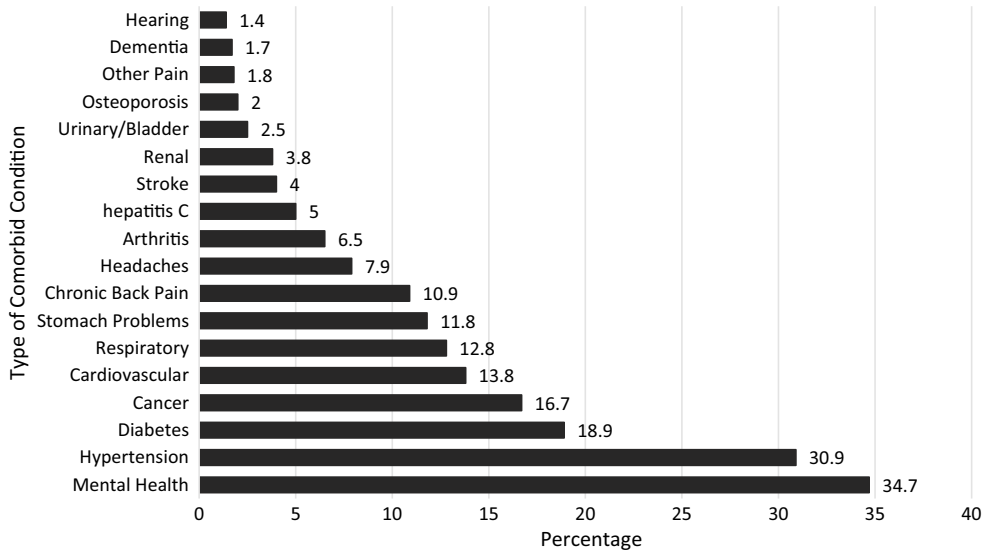

Fig. 2 Type of comorbid condition diagnosed among individuals living with HIV and seeking at the Clinic (n = 616)

removed approximately 42% of eligible participants because they had a chronic condition diagnosed in addition to HIV at the time they entered care. This led to an underestimation of multimorbidity. The underestimation of multimorbidity and alcohol use history could potentially bias the results closer to the null.

As individuals living with HIV age, the risk of acquiring a chronic comorbid condition increases and alcohol use may have an impact on that risk. It is important that researchers and clinicians address alcohol consumption among PLWH and develop strategies to reduce this modifiable risk factor. Future research should be conducted to continue to explore this relationship. Specifically, studies should be conducted to assess how alcohol use may impact the management and severity of chronic conditions.

Table 4 Unadjusted and adjusted incidence rate ratios for multimorbidity (≥2 conditions) among individuals living with HIV and seeking care (N = 836)

Variables	IRR (95% CI)	aIRR[a] (95% CI)
Alcohol use		
(Former vs. Never)	**2.17 (1.45–3.24)**	1.49 (0.99–2.24)
(Current vs. Never)	**1.95 (1.56–2.43)**	**1.70 (1.35–2.14)**
Age (≥50 vs. < 50)	**2.14 (1.59–2.88)**	**2.06 (1.52–2.78)**
Drug use (yes vs. no)	**1.22 (1.01–1.47)**	1.11 (0.90–1.38)
Smoking status		
(Current vs. Never)	1.08 (0.88–1.33)	0.95 (0.75–1.20)
(Former vs. Never)	**1.62 (1.26–2.09)**	1.22 (0.93–1.58)
Insurance status		
(None vs. Private)	0.99 (0.74–1.34)	1.10 (0.80–1.50)
(Public vs. Private)	**1.42 (1.15–1.75)**	**1.47 (1.18–1.83)**

Note Bolded Numbers Signify p-values < 0.05, *aIRR* adjusted incidence rate ratios, *CI* Confidence Interval

[a]Poisson regression model adjusted for age, drug use, smoking status, insurance status, HIV duration, cd4 + cell counts, and log viral load

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Compliance with Ethical Standards

Conflict of interest The authors declare that they have no conflict of interest.

Ethical Approval All procedures performed in studies involving human participants were in accordance with the ethical standards of the University of Louisville and with the 1964 Helsinki declaration and its later amendments or comparable ethical standards. For this type of study, formal consent was not required.

Human and Animal Rights This article does not contain any studies with animals performed by any of the authors.

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