Received: 8 June 2022 | Accepted: 19 January 2023

DOI: 10.1111/hiv.13466

ORIGINAL ARTICLE

Associations between alcohol and cigarette use and type 1 and 2 myocardial infarction among people with HIV

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Funding information
National Institutes of Health; National

Abstract

Objectives: People with HIV have a higher risk of myocardial infarction (MI) than the general population, with a greater proportion of type 2 MI (T2MI) due to oxygen demand–supply mismatch compared with type 1 (T1MI) resulting from atherothrombotic plaque disruption. People living with HIV report a greater prevalence of cigarette and alcohol use than do the general population. Alcohol use and smoking as risk factors for MI by type are not well

Heart, Lung, and Blood Institute (NHLBI), Grant/Award Number: R01 HL126538; National Institute of Alcohol Abuse and Alcoholism (NIAAA), Grant/Award Numbers: U01AA020802, U01AA020793, U24AA020801; National Institute of Allergy and Infectious Diseases (NIAID), Grant/Award Numbers: P30 AI094189, P30 AI050410, P30 AI027767, P30 AI027757, R24 AI067039; National Institute on Drug Abuse (NIDA), Grant/Award Numbers: R01DA044112, R01DA047045; National Institute on Aging (NIA), Grant/Award Number: R33AG067069

studied among people living with HIV. We examined longitudinal associations between smoking and alcohol use patterns and MI by type among people living with HIV.

Design and Methods: Using longitudinal data from the Centers for AIDS Research Network of Integrated Clinical Systems cohort, we conducted time-updated Cox proportional hazards models to determine the impact of smoking and alcohol consumption on adjudicated T1MI and T2MI.

Results: Among 13 506 people living with HIV, with a median 4 years of follow-up, we observed 177 T1MI and 141 T2MI. Current smoking was associated with a 60% increase in risk of both T1MI and T2MI. In addition, every cigarette smoked per day was associated with a 4% increase in risk of T1MI, with a suggestive, but not significant, 2% increase for T2MI. Cigarette use had a greater impact on T1MI for men than for women and on T2MI for women than for men. Increasing alcohol use was associated with a lower risk of T1MI but not T2MI. Frequency of heavy episodic alcohol use was not associated with MI.

Conclusions: Our findings reinforce the prioritization of smoking reduction, even without cessation, and cessation among people living with HIV for MI prevention and highlight the different impacts on MI type by gender.

KEYWORDS

alcohol use, binge drinking, HIV, people with HIV, smoking, type 1 myocardial infarction, type 2 myocardial infarction

BACKGROUND

People with HIV have a higher risk of myocardial infarction (MI) and other cardiovascular disease (CVD) than those without HIV [1–8]. According to the universal definition of MI, there are five types based on underlying mechanisms of myocardial ischemia [9]. Type I MI (T1MI) is attributable to disruption of atherothrombotic plaques [9]. Type 2 MI (T2MI) results from an acute imbalance in myocardial oxygen (i.e., increased demand or decreased supply), such as occurs with hypotension or vasospasm [9]. Type 3 MIs, defined by MI-related death without cardiac biomarkers, and type 4 and 5 MIs, which occur in coronary revascularization, are rare. In the general population, T1MI is five to ten times more common than T2MI [10–14]. In contrast, we have demonstrated that the incidence of T2MI is almost as frequent as that of T1MI among people living with HIV receiving care across the USA [15].

Associations between MI and both tobacco cigarette smoking and alcohol consumption have been widely studied in the general population but to a lesser extent among people living with HIV and, more importantly, not by MI type. Cigarette smoking is considered one of the leading risk factors for CVD events [16]. In large cohort studies of the general population, people who smoke tend to have at least two times the risk of MI than those who never smoked [17–22], with hazard ratios (HRs) consistently higher for women than for men [18–22]. Conversely, alcohol consumption has been reported to be protective against MI in most studies in the general population [23–28]. Several large cohort and case–control studies have demonstrated that increased alcohol intake [25, 27, 29, 30], even above recommended limits [24, 27], had a greater protective effect than no or light alcohol consumption. People living with HIV report a greater prevalence of smoking [31, 32] than the general population, and a meta-analysis suggested a 24% prevalence of alcohol use disorder among people living with HIV compared with 5–15% in the general population [33]. In addition, both smoking and alcohol use have been associated with a lower likelihood of HIV viral suppression in large diverse samples [34–38].

Given the different epidemiological presentation of MI among people living with HIV and the high prevalence of smoking and alcohol use, it is important to assess risk factors for MI by type among people living with HIV to determine whether the dynamics of MI are the same as in the general population. Using a large, well-characterized cohort of people living with HIV with comprehensive clinical data, including alcohol use, smoking, and clinical MI adjudication by type, we examined the associations between alcohol use and smoking and T1MI and T2MI.

METHODS

Population, setting, and data sources

Data from the Centers for AIDS Research Network of Integrated Clinical Systems (CNICS) cohort, comprising >37 000 people living with HIV in care at eight clinical sites across the USA (http://www.uab.edu/cnics/) were included [39]. CNICS sites received institutional review board approval for the use of data collected from participants. The CNICS data repository integrates comprehensive longitudinal data from outpatient and inpatient encounters, including demographic, clinical, medication, and laboratory data from each site's electronic health record and other data sources [39]. Data from CNICS clinical assessments of patient-reported outcomes and measures (PROs) are also integrated into the data repository [40].

We included data from six sites (University of Alabama at Birmingham, University of Washington, University of California at San Diego, University of California at San Francisco, University of North Carolina, and Johns Hopkins University) where sufficient MI adjudication was completed. The last adjudication date varied by site with ongoing assessments. People living with HIV who completed at least one PRO were included in the analysis. Baseline date was defined as the initial CNICS visit date plus 6 months or first completed PRO, whichever was later and within the MI adjudication period for that site, resulting in a study time period from September 2005 to December 2017. Participants who had a potential MI event before baseline ($n = 295$) were excluded, as were those with incomplete data ($n = 139$). Cohort exit, i.e., when data collection for an individual stopped, occurred on the earliest of the following: (a) date of first MI, (b) 9 months after last CNICS visit or laboratory test, (c) death, or (d) end of the site-specific MI adjudication period.

Predictors and covariates

Data on cigarette smoking and alcohol consumption were collected via PROs at routine care appointments every ~4–6 months. Participants were asked if they have ever smoked or currently smoke tobacco cigarettes, including the current number of cigarettes smoked per day. Current alcohol consumption was assessed using the Alcohol Use Disorders Identification Test-Consumption (AUDIT-C) [41, 42] and modelled as (1) continuous AUDIT-C scores (0–12) [42] and (2) AUDIT-C-derived categories; (3) AUDIT-C use frequency, and (4) heavy-episodic use, defined as six or more drinks in one sitting. We categorized AUDIT-C scores into no current use, no current use with a prior alcohol use disorder (AUD), non-hazardous alcohol use, and hazardous alcohol use defined as five or more drinks for men and four or more for women per day [43]. Prior AUD was defined by either clinical diagnoses of alcohol abuse/dependency in the participants' medical records or ever reporting treatment for an AUD on the CNICS PROs. Both alcohol use and smoking were time updated for every PRO completed and carried forward until the next measurement.

CNICS has standard operational definitions for other key covariates at baseline. Diabetes was defined as a prior glycated haemoglobin of ≥6.5 or use of a diabetes-specific or diabetes-associated medication in the setting of also having a diabetes diagnosis [44]. Hypertension was defined as a recorded diagnosis of hypertension and receiving an antihypertensive medication prescription. Dyslipidaemia was identified by receipt of lipid-lowering medications, such as statins. Estimated glomerular filtration rate (eGFR) was calculated [45] based on baseline serum creatinine, age, sex, and race/ethnicity, with an eGFR <30 defined as severe kidney disease [46]. HIV viral load (VL) and CD4 counts assessed as part of clinical care were time updated for each new result from baseline until cohort exit.

Outcomes

All MI events were adjudicated as previously described [15, 47]. Ascertainment for potential MIs includes MI diagnoses, elevated cardiac biomarkers (e.g., troponin I or T), or documentation of coronary interventions (e.g., coronary artery bypass). For each potential event, sites assembled and uploaded de-identified packets of primary data to a secure central review site. Event packets, including medical notes, laboratory tests, imaging results, and electrocardiograms, were reviewed independently by two expert physicians, who categorized potential events as no, probable, or definite MI, with further differentiation into MI types. Discordance between reviewers' findings resulted in review by a third physician, and the three resolved any discrepancies. MIs for this study included all events adjudicated as definite or probable MI and only the first MI a participant has had.

Statistical analyses

Unadjusted summary statistics, including comparisons of central tendency and frequencies, were applied to baseline measures collected from clinical assessments to describe the cohort by type of MI event. As other MI

types were rare (e.g., <10 type 4 or 5 MIs in CNICS to date), they are not discussed further.

We used time-updated Cox proportional hazards models to determine associations between cigarette smoking or alcohol consumption and MI by type, adjusted for known MI risk factors, in which smoking status, alcohol consumption, VL, and CD4 count were updated as new data became available. Alcohol use was based on each of the four models described above and shown in Table 1. Smoking status (never, former, current) and number of cigarettes smoked per day among current smokers, centred on the median number of cigarettes, was modelled the same way in all models. Given associations of current smoking with both T1MI and T2MI and potentially differential associations by age and sex by type of MI, we graphed type-specific MI-free survival among smokers and non-smokers by age and cigarettes per day (pack equivalent) among males and females in models that included smoking but not alcohol. All models were adjusted for age, birth sex, race/ethnicity, hepatitis C virus (HCV) infection, hepatitis B virus (HBV) infection, dyslipidaemia, hypertension, diabetes, and time-updated VL and CD4 count. The assumption of proportional hazards was assessed by Schoenfeld residuals. Analyses were conducted using STATA v17.0.

RESULTS

In total, 13 506 people living with HIV were included, with a median follow-up time of 4.04 years (interquartile range [IQR] 1.8–12.3 years), median of 8.1 PROs per person (IQR 3.6–24.6), and a mean age of 44 years (median 44; range 19–87) at baseline; 18% of participants were female ($n = 2491$); and race/ethnicity was reported as follows: 43% White, 38% African American/Black, and 14% Hispanic/Latinx (Table 1). T1MI occurred in 177 participants and T2MI occurred in 141 during the study period. In univariate analyses, participants who had either a T1MI or a T2MI were significantly older and were more likely to report current smoking and smoking more cigarettes per day at baseline than those who did not experience an MI during the study period (Table 1). Current alcohol use, frequency of use, heavy episodic use, frequency of heavy episodic consumption, and AUDIT-C scores were lower among those who experienced a T1MI than among those with no MI; those who had a T1MI or T2MI were also more likely to report not consuming alcohol than those who did not have an MI. Female participants were significantly less likely than males to have a T1MI but more likely to have a T2MI.

Adjusting for potential confounders, including time-updated VL and CD4 count, those reporting current cigarette use had a consistently increased risk of T1MI than those reporting never smoking, regardless of how alcohol was modelled (HR range 1.61–1.67) (Table 2). Furthermore, the risk of T1MI increased by 4% for every cigarette currently smoked per day in all models. Current cigarette use was associated with a similar significant increase in risk for T2MI across all four models of alcohol use (HR range 1.57–1.64; Table 2). A similar pattern to that of T1MI was observed in T2MI for impact of cigarettes smoked per day, including similar stability in the point estimate and confidence intervals (CIs), but did not achieve significance in T2MI models. Those reporting former smoking did not have an increased risk of either MI type compared with those who had never smoked. Consistent results were observed in sensitivity analyses including time updated body mass index as a confounder in the models (Table S1). Similarly, in sensitivity analyses including polynomial terms for smoking to examine linearity of association and separate models to examine the impact of cigarettes per day on only people living with HIV who reported ever smoking, we observed consistent associations for dose-dependent effects (Table S2). Generalized additive model plots provided further visualization of the impact of cigarettes per day on risk of T1MI (Figure S1) and T2MI (Figure S2).

People living with HIV who had a higher AUDIT-C score by continuous measure were significantly less likely to experience a T1MI (HR 0.91; 95% CI 0.84–0.98) but not a T2MI (Table 2). Additionally, in models where alcohol use was categorized into current non-use without AUD, non-use with AUD, non-hazardous drinking, and hazardous drinking, the risk of T1MI was reduced among those reporting alcohol consumption, regardless of category. In contrast, the risk of T2MI was reduced for those reporting non-hazardous alcohol consumption but not for those reporting hazardous consumption. Neither frequency of alcohol use nor heavy episodic consumption in the past 30 days was associated with either MI type.

Given that aging is associated with increased risk of MI in the general population, among people living with HIV [48], and in this study (data not shown), we examined the impact of aging and smoking within our models of T1MI and T2MI by plotting survival curves for decade of age and smoking status (Figure 1). For every decade of age (from 30–60 years), current smoking increased our participants' risk of T1MI by approximately one age decade. However, for T2MI, the increased risk from smoking was greater than a single decade of age. Similarly, when we plotted amount smoked by sex, we saw different patterns for the types of MI (Figure 2). The

TABLE 1 Baseline demographic, behavioural, and clinical characteristics of participants by occurrence of MI and type of MI during the study period ($N = 13\ 506$).

Characteristics[a]	Total ($n = 13\ 506$)	No MI ($n = 13\ 188$)	Type 1 MI ($N = 177$)	Type 2 MI ($n = 141$)
Age mean (SD)	44 (10.9)	43 (10.9)	51 (8.5)	49 (10.5)
Female	2491 (18.4)	2440 (18.5)	16 (9.0)	35 (24.8)
Race/ethnicity				
White	5819 (43.1)	5679 (43.1)	93 (52.5)	47 (33.3)
Black	5155 (38.2)	5021 (38.1)	54 (30.5)	80 (56.7)
Hispanic	1903 (14.1)	1866 (14.2)	25 (14.1)	12 (8.5)
Other	629 (4.7)	622 (4.7)	5 (2.8)	2 (1.4)
Smoking status				
Never	4948 (36.6)	4853 (36.8)	55 (31.1)	40 (28.4)
Former	3109 (23.0)	3047 (23.1)	37 (20.9)	25 (17.7)
Current	5449 (40.4)	5288 (40.1)	85 (48.0)	76 (53.9)
Cigarettes/day among those ever smoking (n = 8558), median (IQR)	10 (5–15)	10 (5–15)	12.5 (10–15)	10.0 (5–15)
AUDIT-C score, mean (SD)	2.1 (2.5)	2.1 (2.5)	1.6 (2.1)	1.7 (2.8)
Hazardous alcohol consumption				
No consumption	4948 (36.6)	4782 (36.3)	89 (50.3)	79 (56.0)
Non-hazardous drinking	6263 (46.4)	6155 (46.7)	69 (39.0)	39 (27.7)
Hazardous drinking	2295 (17.0)	2251 (17.1)	19 (10.7)	23 (16.3)
Current alcohol use	8558 (63.4)	8408 (63.8)	88 (49.7)	62 (44.0)
Frequency use (in prior 30 days) among users (n = 8558), days, mean (SD)	5.3 (6.1)	5.3 (6.1)	4.5 (5.4)	6.5 (7.1)
Binge alcohol use	4410 (32.7)	4336 (32.9)	45 (25.4)	29 (20.6)
Frequency (prior 30 days) in binge users (n = 4410), days, mean (SD)	2.5 (6.3)	2.5 (6.2)	2.6 (7.4)	8.1 (12.6)
Hepatitis C	2373 (17.6)	2293 (17.4)	34 (19.2)	46 (32.6)
Hepatitis B	750 (5.6)	728 (5.2)	14 (7.9)	8 (5.7)
Diabetes	1105 (8.2)	1037 (7.9)	36 (20.3)	32 (22.7)
Hypertension	3257 (24.1)	3104 (23.5)	89 (50.3)	64 (45.4)
Dyslipidaemia	2113 (15.6)	2004 (15.2)	75 (42.4)	34 (24.1)
Severe kidney disease (eGFR <30)	176 (1.3)	150 (1.1)	10 (5.7)	16 (11.4)
Detectable HIV viral load	2879 (21.32)	2793 (21.2)	41 (23.2)	45 (31.9)
CD4 count cells/mm^3, median (IQR)	484 (301–691)	486 (303–692)	455 (278–688)	373 (161–572)

Abbreviations: eGFR, estimated glomerular filtration rate; IQR, interquartile range; MI, myocardial infarction; SD, standard deviation.
[a]Data are presented as N (%) unless otherwise specified.

impact of increased number of cigarettes per day (assessed by intervals of half packs) on T1MI was greater for men than for women. However, the reverse pattern was seen for T2MI.

DISCUSSION

Among people living with HIV who completed detailed longitudinal assessments on cigarette/alcohol use with a median follow-up of 4 years, there was a 60% higher risk of either T1MI or T2MI among those who currently smoked than among those who never smoked. We also observed that current smoking increased the risk of MI by the equivalent of one or more decade of age and that smoking appeared to have a greater association with T1MI risk in men and T2MI risk in women. There was no difference in risk for either type of MI for those who formerly smoked compared with those who never smoked. These findings taken together with the observed

TABLE 2 Risk for MI by type and alcohol use and tobacco cigarette smoking in time updated adjusted analyses among people living with HIV[a] ($n = 13\,506$).

		Type 1 MI			Type 2 MI		
Model		**HR**	**95% CI**	***p*-value**	**HR**	**95% CI**	***p*-value**
1	AUDIT-C score	**0.91**	**0.84, 0.98**	**0.014**	0.97	0.90, 1.04	0.385
	Cigarette use: never	REF			REF		
	Former	1.02	0.68, 1.53	0.931	1.28	0.79, 2.07	0.303
	Current	**1.67**	**1.14, 2.45**	**0.009**	**1.64**	**1.08, 2.49**	**0.021**
	Current cigarettes per day	**1.04**	**1.01, 1.06**	**0.003**	1.02	0.99, 1.05	0.148
2	Hazardous alcohol						
	No consumption, no AUD	REF			REF		
	No consumption, former AUD	1.02	0.64, 1.63	0.940	1.20	0.74, 1.95	0.460
	Non-hazardous drinking	**0.64**	**0.45, 0.90**	**0.011**	**0.61**	**0.40, 0.93**	**0.020**
	Hazardous drinking	**0.51**	**0.29, 0.80**	**0.017**	0.87	0.51, 1.46	0.595
	Cigarette use: never	REF			REF		
	Former	1.02	0.68, 1.54	0.916	1.29	0.80, 2.08	0.293
	Current	**1.66**	**1.13, 2.44**	**0.009**	**1.60**	**1.05, 2.44**	**0.028**
	Current cigarettes per day	**1.03**	**1.01, 1.06**	**0.004**	1.02	0.74, 1.95	0.460
3	Alcohol frequency (days/month)	0.98	0.95,1.01	0.117	1.00	0.96, 1.03	0.744
	Cigarette use: never	REF			REF		
	Former	1.00	0.66, 1.50	0.991	1.27	0.79, 2.05	0.321
	Current	**1.61**	**1.10, 2.36**	**0.014**	**1.61**	**1.06, 2.45**	**0.025**
	Current cigarettes per day	**1.04**	**1.01,1.06**	**0.003**	1.02	0.99, 1.05	0.154
4	Binge frequency (days/month)	0.94	0.85,1.03	0.2	1.03	0.99, 1.06	0.122
	Cigarette use: never	REF			REF		
	Former	0.99	0.66, 1.49	0.961	1.26	0.78, 2.02	0.344
	Current	**1.62**	**1.11, 2.37**	**0.013**	**1.57**	**1.03, 2.39**	**0.034**
	Current cigarettes per day	**1.04**	**1.01, 1.06**	**0.002**	1.02	0.99, 1.04	0.183

Note: $P<0.05$ (as shown in the *p*-value column) in bold.

Abbreviations: AUD, alcohol use disorder; AUDIT-C, Alcohol Use Disorders Identification Test-Consumption; CI, confidence interval; HR, hazard ratio; MI, myocardial infarction; REF, reference.

[a]Cox proportional hazards models adjusted for age, birth sex, race/ethnicity, hepatitis C virus infection, hepatitis B virus infection, dyslipidaemia, hypertension, diabetes, and time updated viral load and CD4 count.

increasing risk per cigarette smoked daily for T1MI suggests that both smoking cessation *and* reduction among people living with HIV are important for mitigating their already increased risk of MI. The association of alcohol consumption with MI among people living with HIV was similar to that in the general population, where alcohol use was associated with lower MI risk. However, this association was only observed for AUDIT-C score and hazardous/non-hazardous drinking for T1MI and non-hazardous alcohol consumption for T2MI. Our study is also one of the few to examine T1MI and T2MI separately, regardless of population.

We found that current, but not former, smoking among people living with HIV was associated with an increase in MI risk with a similar or slightly smaller effect size compared with most studies in the general population [17–22]. Unlike our study, most studies had not differentiated between T1MI and T2M. Our study also collected smoking status at more frequent intervals than other studies, and these were time updated in our models. We adjusted for a number of factors known to be associated with both MI and smoking, including HCV infection, diabetes, and hypertension, whereas prior studies rarely adjusted for these [21]. Our study had greater racial/ethnic diversity and a higher prevalence of smoking than many of the general population studies, as representative of people living with HIV.

Similarities in MI risk in our cohort and the general population were also observed for the impact of number of cigarettes smoked per day, where a greater number of

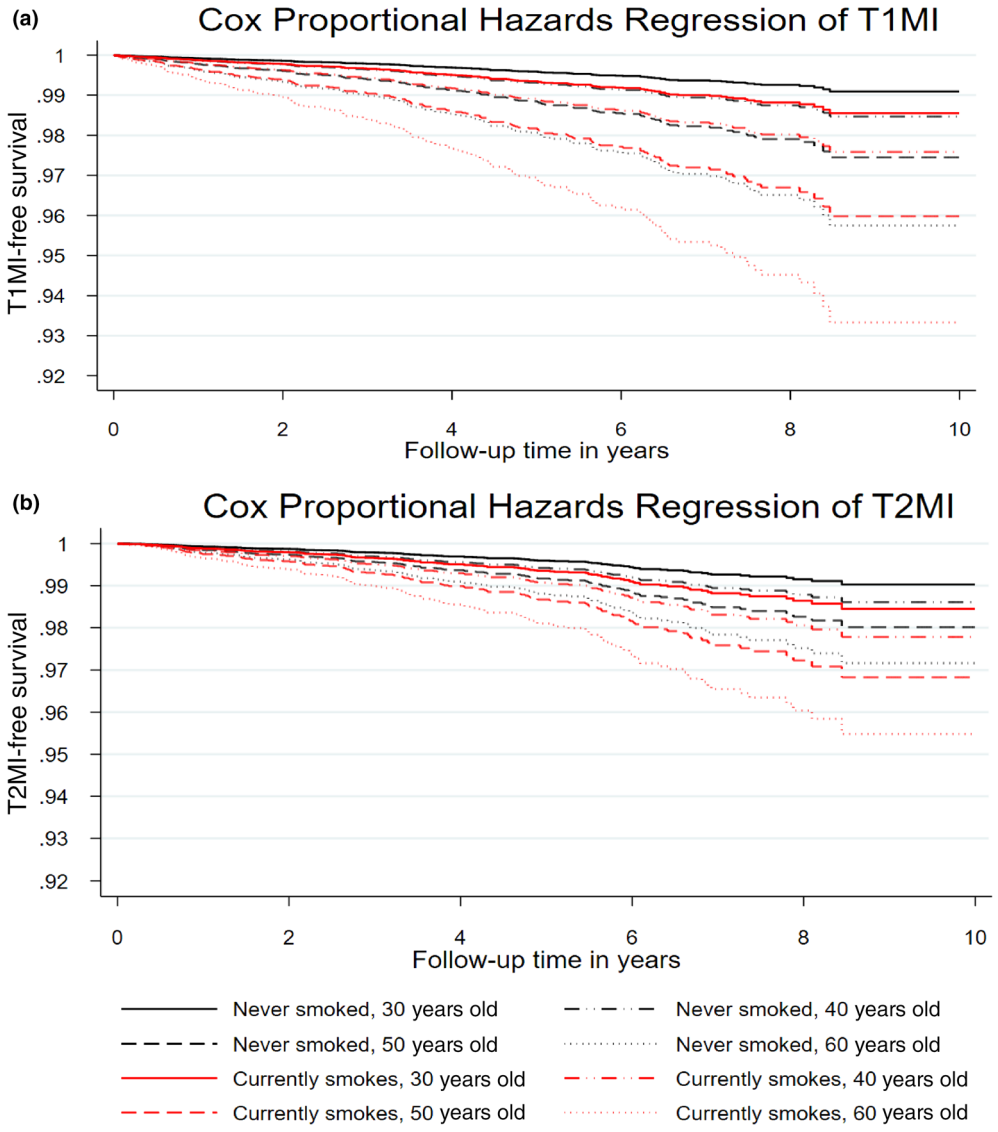

FIGURE 1 (a) T1MI- and (b) T2MI-free survival by daily current cigarette use and age adjusted for number of cigarettes smoked per day for current smokers, sex, race/ethnicity, hepatitis C virus infection, hepatitis B virus infection, dyslipidaemia, treated hypertension, diabetes, severe chronic kidney disease, and time updated viral load and CD4 count. Panel (a) shows that current smokers have a T1MI risk similar to that of a person with HIV a decade older, whereas the risk of T2MI is similar to that of someone even more than a decade older. T1MI, type 1 myocardial infarction; T2MI, type 2 myocardial infarction.

cigarettes smoked per day was associated with increased MI risk [18, 19, 30, 49]. While general population studies tended to categorize cigarettes used per day, we examined this association continuously, demonstrating a 4% increase in T1MI risk per cigarette per day. While this association did not reach significance in our T2MI analyses, Figure 2 demonstrates the impact that each half pack (i.e., 10 cigarettes/day) had on increasing risk of T1MI and T2MI. This could be explained by reduced power for T2MI, due to fewer events, or differences in mechanism of how cigarette smoking results in T1MI and T2MI. Non-nicotine components of cigarettes have been shown to result in platelet activation, which has been associated with atherosclerotic plaque formation [50], increasing the risk for T1MI, which would be consistent with a dose–response dynamic. A proposed mechanism for smoking resulting in T2MI susceptibility suggests that an oxygen supply versus demand imbalance is created when high blood carboxyhaemoglobin is present, reducing oxygen levels in the blood, while nicotine stimulates the sympathetic nervous system, resulting in elevated heart rate and blood pressure as well as coronary vasoconstriction [16, 51]. This could be dose–response related (i.e., the longer one smokes at any one time, the higher the risk) but not necessarily over the long term.

Interestingly, our data demonstrated differential risk for men and women by MI type with respect to smoking. Most studies of MI, regardless of population, combine all

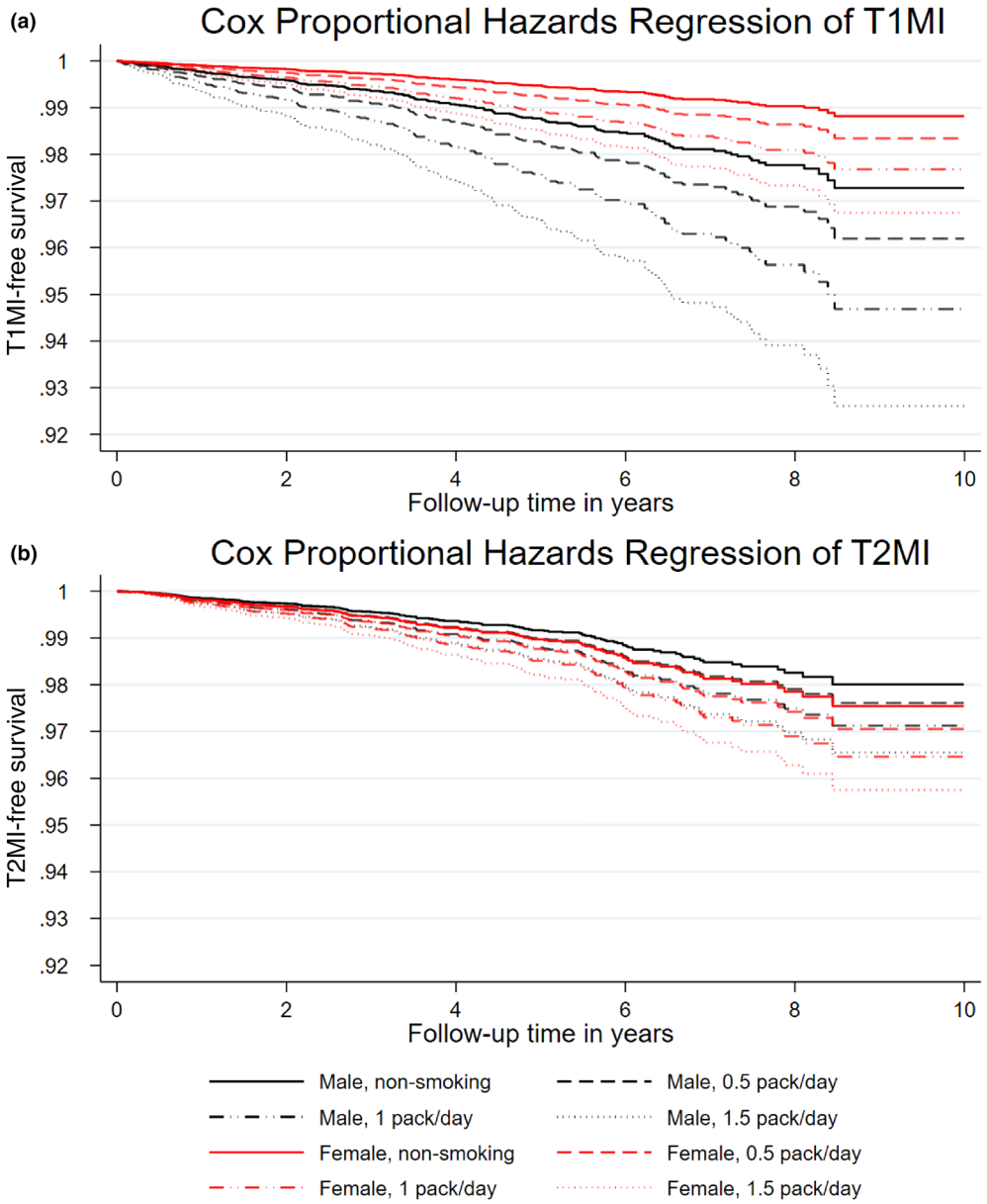

FIGURE 2 (a) T1MI- and (b) T2MI-free survival by sex and current daily cigarette use adjusted for age, race/ethnicity, hepatitis C virus infection, hepatitis B virus infection, dyslipidaemia, treated hypertension, diabetes, severe chronic kidney disease, and time updated viral load and CD4 count. Panel (a) highlights the impact of sex on T1MI, where male non-smokers had a risk similar to that of females who smoked more than one pack per day; however, this observation was reversed for T2MI (panel b), where women had a significantly greater risk of T2MI than did men. T1Mi, type 1 myocardial infarction; T2MI, type 2 myocardial infarction.

types, so less is known about sex differences with respect to MI type. Recent studies examining sex differences in the general population highlighted that men tend to be more likely to experience T1MI than women but that men and women experience T2MI at similar rates [52, 53]. This is consistent with our T1MI findings, reinforcing the idea that T1MI is also likely to be higher among men in people living with HIV. With respect to T2MI, our previous work demonstrated that the top three causes in our cohort were sepsis/bacteraemia, illicit drug use, and hypertensive urgency/emergency. While information on sepsis/bacteraemia was not available for people living with HIV in the analysis cohort, a greater proportion of women than men in our cohort reported injection drug use as an HIV risk factor, suggesting they may have greater risk of sepsis/bacteraemia. Additionally, women were more likely than men to have hypertension and report regular use of opioids and cocaine, suggesting that these could contribute to the higher risk of T2MI with smoking observed in women; however, we suggest the need for further investigations of mechanisms that may result in differential impact of smoking on sex and MI

type. This study, taken with evidence from the general population, suggests that both smoking cessation and reduction are critically important for preventing MI risk among people living with HIV. In addition to assessing and preventing atherosclerosis for both men and women with HIV who smoke, careful attention to factors associated with T2MI, such as infection, low CD4 cell count, higher VLs, and stimulant use, is also important for preventing and managing MI in people living with HIV, particularly among women with HIV who smoke.

We observed an inverse association between continuous AUDIT-C score and both hazardous and non-hazardous categories of AUDIT-C compared with no alcohol use with T1MI and the non-hazardous AUDIT-C category compared with no alcohol use with T2MI. These associations were not observed for frequency of alcohol or heavy episodic use over a 30-day period. Most studies in the general population demonstrated more consistent inverse associations with measures of alcohol use, but they used different categories of alcohol consumption than we did, such as moderate and heavy [24, 26], sometimes and regularly [23], any consumption in the past 12 months [54], timing of consumption prior to MI (e.g., hours, weeks, days) [55, 56], and grams/day or week [27, 29], which might explain why we saw an inverse association with MI on some measures and not others. Indeed, when we examined associations between T1MI/T2MI and categories of numbers of drinks per month (i.e., 0, 1–4, ≥5), we observed a similar association with studies in the general population categorizing frequency of consumption [25, 30]. Results from our study were consistent with results regarding no association between heavy episodic/binge alcohol consumption and MI [26]. It is also important to note that the inverse association between alcohol use and MI is not observed in all populations [54], and our sample is racially/ethnically diverse. Furthermore, epidemiological studies have suggested that the mechanisms by which alcohol may lower the risk of MI include lowering blood lipids [23], increasing high-density lipoprotein cholesterol [29], and improving insulin sensitivity [29]. Experimental studies demonstrate that feeding participants ≥30 g of alcohol/day increased high-density lipoprotein cholesterol levels [57] and insulin sensitivity [58, 59]. However, HIV infection results in increased dyslipidaemia and insulin resistance [59, 60], which may attenuate the positive effects of moderate alcohol consumption observed in the general population and might explain the moderate and inconsistent association between alcohol consumption and MI in our study.

While this and most other studies among the general population identify a potentially moderate protective effect of alcohol consumption on the risk of T1MI, these findings should be tempered with regard to health more generally. Studies examining the effects of alcohol in the general population on all types of CVD demonstrate heterogeneous effects [24, 27], where the risk of stroke and other cardiovascular events are increased by alcohol consumption, even though alcohol consumption appears protective for MI. When comparing heavy (>167 g/week) and more moderate (12–83 g/week) alcohol consumption, an increased risk of MI was observed in a moderately sized cohort from northern Europe [61]. Furthermore, although alcohol consumption may be associated with a reduced risk of MI, it has also been associated with an increased risk of cancer and all-cause mortality within the same study [26]. Other studies have demonstrated associations with increased risk of renal damage [62], cirrhosis [63], cancer [64], and all-cause mortality [64, 65]. Furthermore, alcohol consumption is the seventh leading cause of death worldwide [66]. While complete alcohol cessation has been recommended for people living with HIV [67], this study suggests that smoking cessation and/or reduction might be a more important priority for long-term health outcomes over cessation of light/moderate alcohol use among people living with HIV who do not have HCV infection or liver disease.

Our study had several limitations with respect to measurement of primary exposures and follow-up. We collected robust measures on participant smoking behaviour but not passive exposure to cigarette smoke, which has been associated with increased risk for MI [18]. If non-smoking participants had significant exposure to second-hand cigarette smoke, this could reduce the strength of the association between smoking and MI observed in our study. Additionally, we did not have the opportunity to include vaping or e-cigarette use in these analyses, as data collection on this measure started in the final year of cohort inclusion, so only 44% of participants answered this question, among whom 10% reported ever vaping or using e-cigarettes. Associations between MI by type and vaping or e-cigarette use is of interest and will be examined in future analyses. Although we used AUDIT-C as a robust measure of alcohol consumption, we did not measure whether alcohol was paired with food, which has been shown to support insulin sensitivity [68], a mechanism by which alcohol is thought to be protective against MI [29]. Additionally, we measured alcohol consumption over discrete time periods rather than by daily journaling. This has advantages for understanding overall impact, but we could not examine the effect of alcohol consumption on the day of or just before an MI. Previous studies have shown that alcohol consumption has been associated with an acute increased risk of MI within a few hours after consumption [54–56]. Additionally, we did not examine modifications in

associations between smoking and MI with respect to illicit substance use, because illicit substance use was not measured in the entire cohort. There is significant interest in the impact of illicit substance use on MI by type; however, the focus of this study was to determine whether the effects of alcohol and smoking on MI among people living with HIV differed from those in the general population, where illicit substance use is not normally studied. Although we had a sufficiently long median follow-up of 4 years, events and longitudinal follow-up continue to accrue, allowing greater opportunity to examine changes in alcohol use and smoking patterns and the effects of illicit substance use in the future.

Our study has several strengths. CNICS has a large population with demographic, clinical, and geographic diversity. CNICS collects consistent and robust repeated measures on alcohol use, smoking, clinical laboratory measures, and other health measures, which allowed for time-varying assessment of important factors within this study. The assessment of MI through our clinical adjudication process reduced the risk of misclassification of the outcome and allowed for examination of risk by MI type. Our data collection and assessment processes also enhanced the completeness of data on all participants.

In this study of 13 506 people living with HIV with repeated measures on smoking/alcohol consumption over a median of 4 years of follow-up, we demonstrated that current cigarette smoking was associated with a 1.6-fold increased risk of both T1MI and T2MI compared with not smoking. Furthermore, 4% of this risk could be decreased for every cigarette per day reduction, and this had a greater impact on T1MI in men and on T2MI in women. Although alcohol consumption was associated with a moderately lower risk of T1MI compared with no consumption, we would not recommend an increase in alcohol consumption among people living with HIV given the other serious consequences of alcohol consumption. This study highlights the potential benefits of not only cessation but also reducing the number of cigarettes per day, even without achieving cessation, on CVD health among people living with HIV, with potentially different impacts on MI type between men and women.

AUTHOR CONTRIBUTIONS

All authors have made significant contributions to the concept, study design, acquisition, and analysis and/or interpretation of the findings and have been involved in the drafting of the manuscript, including final approvals of the published version. Specific contributions are as follows. LND: concept and design of study and analyses, data analyses, interpretation of findings, primary author in drafting and editing the manuscript. RMN: design of analyses, data analyses, interpretation findings, editing and approval of manuscript. SAR and BMW: design of analyses, interpretation of findings, editing and approval of manuscript. JM, AH, RJF, and BL: interpretation of findings, editing and approval of manuscript. WBL and RDM: concept and design of cohort elements, acquisition of data, interpretation of findings, editing and approval of manuscript. MJB, MJF: interpretation of findings – especially with respect to cardiology, editing and approval of manuscript. JCK, KCh, SP, AW, KCr, and MEM: interpretation of findings, editing and approval of manuscript. WCM: concept and design of cohort, acquisition of data, interpretation of findings, editing and approval of manuscript. EC, SN, KHM, COC, GC, MSS, and MMK: concept and design of cohort, acquisition of data, interpretation of findings, editing and approval of manuscript. LB, and JJE: concept and design of cohort, acquisition of data, editing and approval of manuscript. SRH: interpretation of findings – especially with respect to epidemiology, editing and approval of manuscript. HMC: concept and design of cohort and study, acquisition of data, interpretation of findings, editing and approval of manuscript. JACD: concept and design of study and analyses, data analysis, interpretation of findings, editing and approval of manuscript.

FUNDING INFORMATION

This study was funded by the National Heart, Lung, and Blood Institute (NHLBI) [R01 HL126538]; the National Institute of Alcohol Abuse and Alcoholism (NIAAA) [U24AA020801, U01AA020793, and U01AA020802], the National Institute of Allergy and Infectious Diseases (NIAID) [CNICS R24 AI067039; UW CFAR NIAID grant P30 AI027757; UAB CFAR grant P30 AI027767; UNC CFAR grant P30 AI050410; and JHU CFAR grant P30 AI094189], the National Institute on Drug Abuse (NIDA) [R01DA047045 and R01DA044112], and the National Institute on Aging (NIA) [R33AG067069].

CONFLICT OF INTEREST

No conflict of interest has been declared for any of the authors. The authors thank our participants for their generosity in sharing their de-identified information to support research that can lead to better health outcomes for all people living with HIV. We also thank all care providers, staff, and researchers across CNICS for their time and effort in supporting all CNICS activities, making this research possible.

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REFERENCES

1. Alonso A, Barnes AE, Guest JL, Shah A, Shao IY, Marconi V. HIV infection and incidence of cardiovascular diseases: an analysis of a large healthcare database. *J Am Heart Assoc*. 2019;8(14):e012241.
2. Drozd DR, Kitahata MM, Althoff KN, et al. Increased risk of myocardial infarction in HIV-infected individuals in North America compared to the general population. *J Acquir Immune Defic Syndr (1999)*. 2017;75(5):568-576.
3. Durand M, Sheehy O, Baril J-G, Lelorier J, Tremblay CL. Association between HIV infection, antiretroviral therapy, and risk of acute myocardial infarction: a cohort and nested case–control study using Quebec's public health insurance database. *J Acquir Immune Defic Syndr*. 2011;57(3):245-253.
4. Eyawo O, Brockman G, Goldsmith CH, et al. Risk of myocardial infarction among people living with HIV: an updated systematic review and meta-analysis. *BMJ Open*. 2019;9(9):e025874.
5. Freiberg MS, Chang C-CH, Kuller LH, et al. HIV infection and the risk of acute myocardial infarction. *JAMA Intern Med*. 2013;173(8):614-622.
6. Gutierrez J, Albuquerque ALA, Falzon L. HIV infection as vascular risk: a systematic review of the literature and meta-analysis. *PloS One*. 2017;12(5):e0176686.
7. Rao SG, Galaviz KI, Gay HC, et al. Factors associated with excess myocardial infarction risk in HIV-infected adults: a systematic review and meta-analysis. *J Acquir Immune Defic Syndr (1999)*. 2019;81(2):224-230.
8. Rosenson RS, Hubbard D, Monda KL, et al. Excess risk for atherosclerotic cardiovascular outcomes among US adults with HIV in the current era. *J Am Heart Assoc*. 2020;9(1):e013744.
9. Thygesen K, Alpert JS, Jaffe AS, et al. Fourth universal definition of myocardial infarction (2018). *Eur Heart J*. 2019;40(3):237-269.
10. Gupta S, Vaidya SR, Arora S, Bahekar A, Devarapally SR. Type 2 versus type 1 myocardial infarction: a comparison of clinical characteristics and outcomes with a meta-analysis of observational studies. *Cardiovasc Diagn Ther*. 2017;7(4):348-358.
11. López-Cuenca A, Gómez-Molina M, Flores-Blanco PJ, et al. Comparison between type-2 and type-1 myocardial infarction: clinical features, treatment strategies and outcomes. *J Geriatr Cardiol*. 2016;13(1):15-22.
12. McCarthy CP, Kolte D, Kennedy KF, Vaduganathan M, Wasfy JH, Januzzi JL Jr. Patient characteristics and clinical outcomes of type 1 versus type 2 myocardial infarction. *J Am Coll Cardiol*. 2021;77(7):848-857.
13. Putot A, Derrida SB, Zeller M, et al. Short-term prognosis of myocardial injury, type 1, and type 2 myocardial infarction in the emergency unit. *Am J Med*. 2018;131(10):1209-1219.
14. Sandoval Y, Jaffe AS. Type 2 myocardial infarction: JACC review topic of the week. *J Am Coll Cardiol*. 2019;73(14):1846-1860.
15. Crane HM, Paramsothy P, Drozd DR, et al. Types of myocardial infarction among human immunodeficiency virus–infected individuals in the United States. *JAMA Cardiol*. 2017;2(3):260-267.
16. Services UDoHaH. The biology and behavioral basis for smoking-attributable disease: a report of the surgeon general. In. Atlanta, GA, USA; 2010.
17. Banks E, Joshy G, Korda RJ, et al. Tobacco smoking and risk of 36 cardiovascular disease subtypes: fatal and non-fatal outcomes in a large prospective Australian study. *BMC Med*. 2019;17(1):1-18.
18. Iversen B, Jacobsen BK, Løchen M-L. Active and passive smoking and the risk of myocardial infarction in 24,968 men and women during 11 year of follow-up: the Tromsø study. *Eur J Epidemiol*. 2013;28(8):659-667.
19. Jonsdottir LS, Sigfússon N, Gunason V, Sigvaldason H, Thorgeirsson G. Do lipids, blood pressure, diabetes, and

smoking confer equal risk of myocardial infarction in women as in men? The Reykjavik study. *J Cardiovasc Risk*. 2002;9(2):67-76.
20. Nyboe J, Jensen G, Appleyard M, Schnohr P. Smoking and the risk of first acute myocardial infarction. *Am Heart J*. 1991;122(2):438-447.
21. Prescott E, Hippe M, Schnohr P, Hein HO, Vestbo J. Smoking and risk of myocardial infarction in women and men: longitudinal population study. *BMJ*. 1998;316(7137):1043-1047.
22. Mähönen M, McElduff P, Dobson A, Kuulasmaa K, Evans A. Current smoking and the risk of non-fatal myocardial infarction in the WHO MONICA project populations. *Heart*. 2004;90(12):1416.
23. Hange D, Sigurdsson JA, Björkelund C, Sundh V, Bengtsson C. A 32-year longitudinal study of alcohol consumption in Swedish women: reduced risk of myocardial infarction but increased risk of cancer. *Scand J Prim Health Care*. 2015;33(3):153-162.
24. Bell S, Daskalopoulou M, Rapsomaniki E, et al. Association between clinically recorded alcohol consumption and initial presentation of 12 cardiovascular diseases: population based cohort study using linked health records. *BMJ*. 2017;356.
25. Gémes K, Janszky I, Laugsand L, et al. Alcohol consumption is associated with a lower incidence of acute myocardial infarction: results from a large prospective population-based study in Norway. *J Intern Med*. 2016;279(4):365-375.
26. Smyth A, Teo KK, Rangarajan S, et al. Alcohol consumption and cardiovascular disease, cancer, injury, admission to hospital, and mortality: a prospective cohort study. *Lancet*. 2015;386(10007):1945-1954.
27. Wood AM, Kaptoge S, Butterworth AS, et al. Risk thresholds for alcohol consumption: combined analysis of individual-participant data for 599 912 current drinkers in 83 prospective studies. *Lancet*. 2018;391(10129):1513-1523.
28. Cleophas T. Wine, beer and spirits and the risk of myocardial infarction: a systematic review. *Biomed Pharmacother*. 1999;53(9):417-423.
29. Mukamal KJ, Jensen MK, Grønbæk M, et al. Drinking frequency, mediating biomarkers, and risk of myocardial infarction in women and men. *Circulation*. 2005;112(10):1406-1413.
30. Tavani A, Bertuzzi M, Negri E, Sorbara L, La Vecchia C. Alcohol, smoking, coffee and risk of non-fatal acute myocardial infarction in Italy. *Eur J Epidemiol*. 2001;17(12):1131-1137.
31. Frazier EL, Sutton MY, Brooks JT, Shouse RL, Weiser J. Trends in cigarette smoking among adults with HIV compared with the general adult population, United States-2009–2014. *Prev Med*. 2018;111:231-234.
32. Johnston PI, Wright SW, Orr M, et al. Worldwide relative smoking prevalence among people living with and without HIV. *Aids*. 2021;35(6):957-970.
33. Duko B, Ayalew M, Ayano G. The prevalence of alcohol use disorders among people living with HIV/AIDS: a systematic review and meta-analysis. *Subst Abuse Treat Prev Policy*. 2019;14(1):1-9.
34. King D, Grasso C, Dant L, et al. Treatment outcomes associated with quitting cigarettes among sexual minority men living with HIV: antiretroviral adherence, engagement in care, and sustained HIV RNA suppression. *AIDS Behav*. 2018;22(9):2868-2876.
35. O'Cleirigh C, Valentine SE, Pinkston M, et al. The unique challenges facing HIV-positive patients who smoke cigarettes: HIV viremia, ART adherence, engagement in HIV care, and concurrent substance use. *AIDS Behav*. 2015;19(1):178-185.
36. Cropsey KL, Willig JH, Mugavero MJ, et al. Cigarette smokers are less likely to have undetectable viral loads: results from four HIV clinics. *J Addict Med*. 2016;10(1):13-19.
37. Vagenas P, Azar MM, Copenhaver MM, Springer SA, Molina PE, Altice FL. The impact of alcohol use and related disorders on the HIV continuum of care: a systematic review. *Curr HIV/AIDS Rep*. 2015;12(4):421-436.
38. Williams EC, McGinnis KA, Edelman EJ, et al. Level of alcohol use associated with HIV care continuum targets in a national US sample of persons living with HIV receiving healthcare. *AIDS Behav*. 2019;23(1):140-151.
39. Kitahata MM, Rodriguez B, Haubrich R, et al. Cohort profile: the centers for AIDS research network of integrated clinical systems. *Int J Epidemiol*. 2008;37(5):948-955.
40. Crane HM, Lober W, Webster E, et al. Routine collection of patient-reported outcomes in an HIV clinic setting: the first 100 patients. *Curr HIV Res*. 2007;5(1):109-118.
41. Dawson DA, Grant BF, Stinson FS, Zhou Y. Effectiveness of the derived alcohol use disorders identification test (AUDIT-C) in screening for alcohol use disorders and risk drinking in the US general population. *Alcohol Clin Exp Res*. 2005;29(5):844-854.
42. Bush K, Kivlahan DR, McDonell MB, Fihn SD, Bradley KA. The AUDIT alcohol consumption questions (AUDIT-C): an effective brief screening test for problem drinking. *Arch Intern Med*. 1998;158(16):1789-1795.
43. Gual A, Segura L, Contel M, Heather N, Colom J. AUDIT-3 and AUDIT-4: effectiveness of two short forms of the alcohol use disorders identification test. *Alcohol*. 2002;37(6):591-596.
44. Crane HM, Kadane JB, Crane PK, Kitahata MM. Diabetes case identification methods applied to electronic medical record systems: their use in HIV-infected patients. *Curr HIV Res*. 2006;4(1):97-106.
45. Levey AS, Bosch JP, Lewis JB, Greene T, Rogers N, Roth D. A more accurate method to estimate glomerular filtration rate from serum creatinine: a new prediction equation. *Ann Intern Med*. 1999;130(6):461-470.
46. Stevens LA, Coresh J, Greene T, Levey AS. Assessing kidney function—measured and estimated glomerular filtration rate. *N Engl J Med*. 2006;354(23):2473-2483.
47. Crane H, Heckbert S, Drozd D, et al. Lessons learned from the design and implementation of myocardial infarction adjudication tailored for HIV clinical cohorts. *Am J Epidemiol*. 2014;179(8):996-1005.
48. Crane HM, Nance RM, Whitney BM, et al. Brief report: differences in types of myocardial infarctions among people aging with HIV. *J Acquir Immune Defic Syndr*. 2021;86(2):208-212.
49. Rastogi T, Jha P, Reddy K, et al. Bidi and cigarette smoking and risk of acute myocardial infarction among males in urban India. *Tob Control*. 2005;14(5):356-358.
50. Armani C, Landini L Jr, Leone A. Molecular and biochemical changes of the cardiovascular system due to smoking exposure. *Curr Pharm des*. 2009;15(10):1038-1053.

51. Benowitz NL. Cigarette smoking and cardiovascular disease: pathophysiology and implications for treatment. *Prog Cardiovasc Dis*. 2003;46(1):91-111.
52. Kimenai DM, Lindahl B, Chapman AR, et al. Sex differences in investigations and outcomes among patients with type 2 myocardial infarction. *Heart*. 2021;107(18):1480-1486.
53. Phreaner N, Daniels LB. *Sex differences in type 2 myocardial infarction: learning that we still have a lot to learn*. BMJ Publishing Group Ltd and British Cardiovascular Society; 2021:1444-1445.
54. Leong DP, Smyth A, Teo KK, et al. Patterns of alcohol consumption and myocardial infarction risk: observations from 52 countries in the INTERHEART case–control study. *Circulation*. 2014;130(5):390-398.
55. Mostofsky E, Chahal HS, Mukamal KJ, Rimm EB, Mittleman MA. Alcohol and immediate risk of cardiovascular events: a systematic review and dose–response meta-analysis. *Circulation*. 2016;133(10):979-987.
56. Mostofsky E, van der Bom JG, Mukamal KJ, et al. Risk of myocardial infarction immediately after alcohol consumption. *Epidemiology*. 2015;26(2):143-150.
57. Rimm EB, Williams P, Fosher K, Criqui M, Stampfer MJ. Moderate alcohol intake and lower risk of coronary heart disease: meta-analysis of effects on lipids and haemostatic factors. *BMJ*. 1999;319(7224):1523-1528.
58. Sierksma A, Patel H, Ouchi N, et al. Effect of moderate alcohol consumption on adiponectin, tumor necrosis factor-α, and insulin sensitivity. *Diabetes Care*. 2004;27(1):184-189.
59. Davies MJ, Baer DJ, Judd JT, Brown ED, Campbell WS, Taylor PR. Effects of moderate alcohol intake on fasting insulin and glucose concentrations and insulin sensitivity in postmenopausal women: a randomized controlled trial. *JAMA*. 2002;287(19):2559-2562.
60. Molina PE, Simon L, Amedee AM, Welsh DA, Ferguson TF. Impact of alcohol on HIV disease pathogenesis, comorbidities and aging: integrating preclinical and clinical findings. *Alcohol Alcohol*. 2018;53(4):439-447.
61. Ilomäki J, Hajat A, Kauhanen J, et al. Relationship between alcohol consumption and myocardial infarction among ageing men using a marginal structural model. *Eur J Public Health*. 2012;22(6):825-830.
62. Cheungpasitporn W, Thongprayoon C, Kittanamongkolchai W, et al. High alcohol consumption and the risk of renal damage: a systematic review and meta-analysis. *QJM*. 2015;108(7):539-548.
63. Jani BD, McQueenie R, Nicholl BI, et al. Association between patterns of alcohol consumption (beverage type, frequency and consumption with food) and risk of adverse health outcomes: a prospective cohort study. *BMC Med*. 2021;19(1):1-14.
64. Xi B, Veeranki SP, Zhao M, Ma C, Yan Y, Mi J. Relationship of alcohol consumption to all-cause, cardiovascular, and cancer-related mortality in US adults. *J Am Coll Cardiol*. 2017;70(8):913-922.
65. Rehm J, Gmel GE Sr, Gmel G, et al. The relationship between different dimensions of alcohol use and the burden of disease—an update. *Addiction*. 2017;112(6):968-1001.
66. Griswold MG, Fullman N, Hawley C, et al. Alcohol use and burden for 195 countries and territories, 1990–2016: a systematic analysis for the global burden of disease study 2016. *Lancet*. 2018;392(10152):1015-1035.
67. Bryant KJ. Expanding research on the role of alcohol consumption and related risks in the prevention and treatment of HIV_AIDS. *Subst Use Misuse*. 2006;41(10–12):1465-1507.
68. C ALGSTABCNEV. Alcohol consumption and acute myocardial infarction: a benefit of alcohol consumed with meals? *Epidemiology*. 2004;15(6):767-769.

SUPPORTING INFORMATION

Additional supporting information can be found online in the Supporting Information section at the end of this article.

How to cite this article: Drumright LN, Nance RM, Ruderman SA, et al. Associations between alcohol and cigarette use and type 1 and 2 myocardial infarction among people with HIV. *HIV Med*. 2023;24(6):703-715. doi:10.1111/hiv.13466