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Incarceration and Health Outcomes in HIV-Infected Patients: The Impact of Substance Use, Primary Care Engagement, and Antiretroviral Adherence

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Abstract

Background and Objectives—One in seven HIV-infected individuals is incarcerated each year. We used data from the Veterans Aging Cohort Study (VACS) to explore the relationship between incarceration and HIV disease outcomes and evaluate potential mediators of this relationship.

Methods—HIV disease outcomes included: low CD4 counts (<200 cells/mL), detectable viral RNA loads (>500 copies/mL), and the VACS Index score. We performed a mediation analysis among 1,591 HIV-infected patients to examine whether unhealthy alcohol use, drug use, primary care engagement, or antiretroviral adherence mediated observed associations.

Results—Among 1,591 HIV-infected patients, 47% reported having a history of incarceration. In multivariate analyses, a history of incarceration was associated with a higher VACS Index score (β 2.47, 95% CI 0.52–4.43). Mediation analysis revealed that recent drug use attenuated the association by 22% (β 1.93, 95% CI –0.06, 3.91) while other proposed mediators did not.

Conclusions and Scientific Significance—Improving access to drug treatment when incarcerated and upon release may be an important target to improving the health of HIV-infected individuals with a history of incarceration.

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Declaration of Interest

The authors report no conflicts of interest. The authors alone are responsible for the content and writing of this paper.

INTRODUCTION

An estimated 15% of all persons living with HIV in the United States (US) pass through a correctional facility annually.¹ Recent incarceration is a risk factor for worse HIV disease control, defined as CD4 count <200 cells/mL or viral RNA load >500 copies/mL.² Studies show that when effective combination active antiretroviral therapy (ART) is prescribed in US correctional settings, patients with HIV can achieve complete suppression of their viral load.^{2–5} These patients, however, experience deterioration in their health upon release to the community.^{2–5} Recently released inmates also have an increased risk for HIV mortality compared to the general population.^{6,7} Thus, one of the most pressing issues facing both the correctional and community healthcare systems is to understand the factors that are driving this decline in health upon release.

One plausible mechanism for worse HIV morbidity and mortality upon release is relapse to substance use since incarceration permits less access to alcohol, drugs, and substance abuse treatment than the community.^{8,9} Numerous studies have found that the leading cause of death for recently released individuals is drug overdose.^{6,7} Other plausible mechanisms include decreased adherence to HIV medications and limited engagement in medical care.^{6,10–12} While substance abuse undoubtedly affects HIV disease, what remains unknown is the interplay between substance use, primary care utilization, and ART adherence for individuals with a history of incarceration.¹³

To address these gaps, we used data from the multicenter Veterans Aging Cohort Study (VACS) to examine the association between incarceration and HIV outcomes and to determine how substance use, primary care engagement, and ART adherence mediate these associations. We hypothesized that in healthcare settings including the Veterans Health Administration (VHA), which provide access to primary care, pharmacy benefits, and a national reentry program integrated into the primary care system,^{14,15} substance abuse would be the primary mediator of worse HIV outcomes.

METHODS

Sample and Setting

We analyzed data from 1,591 HIV-infected participants who completed the VACS follow-up survey between October 1, 2009 and September 30, 2010 and had complete data for incarceration and available laboratory data for at least one HIV outcome. The VACS is an observational cohort of HIV-infected patients that began in 2002 and was designed to examine the role of alcohol and drug use and comorbid medical and psychiatric disease in determining clinical outcomes in HIV infection. A full description of the study and measures collected are described elsewhere.¹⁶ Briefly, VACS assesses patient data using a combination of self-reported, administrative, and clinical data from eight VHA infectious disease clinics (Atlanta, GA; Baltimore, MD; Bronx, NY; New York City, NY; Houston, TX; Los Angeles, CA; Pittsburg, PA; and Washington, DC). Overall, 58% of HIV-infected patients at the eight sites completed the 2009–2010 survey, with only 9% of those approached refusing to participate. Data collected include measures of patients' sociodemographics, comorbidities, and habits, including unhealthy alcohol use and drug use,

and health behaviors. The institutional review boards at all locations approved the study, and all participants provided written informed consent prior to enrollment.

Incarceration Exposure

All participants who completed the follow-up survey were asked the following question: “Have you ever spent any time in a jail, prison, detention center, or juvenile correctional facility?” Those who responded affirmatively were categorized as having a history of incarceration. Those who refused to answer or responded “don’t know” were not included in this analysis ($N=70$).

Clinical Outcomes

For each participant, the CD4 cell count and HIV-1 RNA level closest to the date of their follow-up survey between 2009 and 2010 were used and taken from VHA laboratory data. Poor HIV outcomes were low CD4 count, defined by CD4 counts <200 cells/ μ L, or detectable viral load, as indicated by a HIV-1 RNA >500 copies/mL. Because viral load assays of varying sensitivity were used across the VACS sites, we chose the cut off of the least sensitive type of test performed, which was 500 copies/mL. We also used the VACS Index score as a third health outcome, a validated index of overall medical health that is predictive of morbidity and mortality and incorporates both HIV and non-HIV biomarkers.^{17,18} It is calculated using the patient’s age, CD4 cell count, HIV RNA and hemoglobin levels, renal and hepatic function, and Hepatitis C virus serostatus.^{17,18} Possible VACS Index scores range from 0 to 164 points with higher scores indicating greater burden of disease and higher risk of morbidity and mortality (each additional 5 points indicates approximately 20% increased risk of 5-year mortality).^{18,19} VACS Index scores were calculated based on available laboratory results closest to the survey date.

Confounders

Covariates for the study included age (continuous), gender (male vs. female), race/ethnicity (white vs. black vs. Latino vs. other), income ($<\$12,000$ /year vs. $\$12,000$ /year), education ($<$ high school graduation vs. high school graduation and beyond), marital status (married or living with partner vs. single), employment status (yes vs. no), hepatitis C infection (yes vs. no), and recent homelessness (past 4 weeks, yes vs. no). We used a score of 10 or higher on the Patient Health Questionnaire-9 (PHQ-9) to indicate active depressive symptoms.²⁰

Potential Mediators

We measured current alcohol consumption using the 3-item Alcohol Use Disorders Identification Test–Consumption (AUDIT-C).²¹ Persons were classified as having unhealthy alcohol use if their total score on the AUDIT-C was greater than four or they reported heavy episodic or binge drinking (more than six drinks in one sitting at least once a month).²² Recent drug use was considered any self-reported use of cocaine, stimulants, heroin, non-medical use of prescription opioids, or injection of intravenous drugs in the past year. We measured primary care engagement using data from the VHA administrative database, defined according to HIV quality of care metrics: two or more visits at least 90 days apart to a primary medical clinic (HIV or general medicine) in the 12 months prior to the follow-up

examination.^{23,24} To measure ART adherence, we used the algorithm of Steiner and colleagues to estimate the percentage of days without ART based upon pharmacy refill data from the Veterans Affairs National Pharmacy Managements Benefits Services database.^{25,26} Among those on ART, we averaged adherence to all antiretroviral medications to yield a summary adherence measure during the study period from October 1, 2009 to September 30, 2010. The Steiner algorithm has previously been validated by demonstrating that its estimates were highly correlated with drug plasma levels.²⁶

Analyses

We compared HIV-infected participants with and without a history of incarceration compared by sociodemographic, clinical characteristics, and potential mediators of clinical outcomes (unhealthy alcohol use, drug use, primary care engagement, and ART adherence) using *t*-tests and chi-square tests as appropriate. Then we tested for bivariate association between history of incarceration and HIV outcomes using *t*-test for continuous versions of all outcomes and chi-square test for low CD4 count and detectable viral load. Using multivariable logistic regression, we next examined the independent association between having a history of incarceration and poor HIV outcomes, low CD4 count, and detectable viral load, by adjusting for covariates associated with poor HIV-outcomes with $p < .20$ in bivariate analyses. We also examined the independent association between having a history of incarceration and the VACS Index score using multivariable linear regression, but did not include age or hepatitis C infection as a covariate because they are part of the outcome measure. *P*-values $< .05$ were considered statistically significant. To determine the role of unhealthy alcohol use, drug use, primary care engagement, and ART adherence in influencing the relationship between incarceration and HIV outcomes, we used Baron and Kenny mediation analysis.²⁷ This is a three-step process to determine whether (1) incarceration is associated with poor HIV outcomes; (2) incarceration is associated with the potential mediators; and (3) the association between incarceration and poor HIV outcomes is attenuated, after adjustment for the potential mediators.²⁷

RESULTS

Among 1,591 HIV-infected participants, 47% reported having a history of incarceration (Table 1). Participants who had a history of incarceration were more likely to be black, have less than high school education, have low income, and be recently homeless compared with those never incarcerated. Former inmates were more likely to meet criteria for unhealthy alcohol use (19% vs. 13%, $p < .001$) and recent drug use (39% vs. 20%, $p < .001$) compared with those without a history of incarceration. Those with a history of incarceration were equally likely to have engaged in primary medical care in the past 12 months as those never incarcerated (81% vs. 81%, $p = .91$). Former inmates were less adherent (without their ART medications more often) than those never incarcerated (% of time out of medicine, 21% vs. 18%, $p = .002$).

Individuals with a history of incarceration had similar mean CD4 counts (496.9 vs. 522.4, $p = .10$) and viral loads (10,095 vs. 9,807, $p = .91$) compared with those never incarcerated, respectively (Table 2). Former inmates were more likely to have a CD4 count < 200

cells/mL (15% vs. 11%, $p=.019$) or viral load >500 copies/mL (18% vs. 14%, $p=.027$). They also had a higher mean VACS Index score compared with those never incarcerated (33.8 vs. 29.5, $p<.001$).

Compared with participants never incarcerated, those with a history of incarceration were more likely to have worse HIV outcomes—low CD4 count (odds ratio [OR] 1.42 [95% confidence interval [CI] 1.06, 1.90]), a detectable viral load (OR 1.35 [95% CI 1.03, 1.77]), and a higher VACS Index score (β 4.18 [95% CI 2.25, 6.11]; Table 3). After adjustment for covariates associated with low CD4 count (including age, race, income, homelessness in the past 4 weeks) a history of incarceration was no longer associated with low CD4 count (adjusted odds ratio [AOR] 1.24 [95% CI 0.92, 1.68]). Similarly, after adjustment for the same covariates, a history of incarceration was no longer associated with a detectable viral load (AOR 1.18 [95% CI 0.89, 1.56]). In contrast, after adjustment for sex, race, education, marital status, income, and recent homelessness, incarceration was still significantly associated with an increased VACS Index score (adjusted β 2.47 [95% CI 0.52, 4.43]).

After adjusting for recent drug use, the effect of incarceration on the VACS Index score was lessened, indicating that drug use plays a mediating role (adjusted β 1.93 [95% CI -0.06, 3.91]). There was no evidence that the other potential mediators played a role in the association between incarceration and VACS Index score, as the effect of incarceration on the VACS Index score was not substantially changed by adjustment for recent unhealthy alcohol use (adjusted β 2.84 [95% CI 0.88, 4.79]), primary care engagement (adjusted β 2.50 [95% CI 0.55, 4.42]), and ART adherence (adjusted β 2.23 [95% CI 0.03, 4.42]).

DISCUSSION

In a large multisite study of HIV-infected patients, we found that 47% of participants had a history of incarceration and that having been incarcerated was independently associated with a 4.2-point higher VACS Index score, equivalent to approximately 15% higher risk of mortality in 5 years. Our findings confirm those of past studies where individuals with a history of incarceration have a higher risk for mortality compared with those never incarcerated, given a higher burden of other chronic medical conditions, including high rates of hepatitis C infection,²⁸ including a study of Veterans with a history of incarceration.¹⁴ Past studies have found similarly high rates of incarceration among HIV-infected populations, though this is among the first explorations of the experience of incarceration among HIV-infected veterans and its impact on their health. Nationally, the Bureau of Justice Statistics reports that the number of veterans incarcerated is decreasing from 20% in 1986 to 10% in 2004^{15,29} though whether this is the case for HIV-infected veterans is unknown.

We also found that the VACS Index reflected greater effects of incarceration than did CD4 count or HIV-1 RNA alone; we did not find an independent association between history of incarceration and low CD4 count or detectable viral load. One plausible reason is that all study participants are engaged in healthcare in the VHA and thus have access to primary care and ART medications. This result is consistent with prior studies of the VACS Index and suggests that physiologic harms of incarceration extend beyond conventional measures

of HIV disease to include general organ system injury.¹⁸ Some of this injury is likely due to the ongoing inflammation from chronic HIV-infection and some may reflect comorbid diseases including hepatitis C infection. Notably, we did not include hepatitis C as a covariate in the multivariate model given concerns of over-adjusting since it is part of the VACS Index score.

Among the potential mediators explored, we found that recent drug use mediates the association between incarceration and the VACS Index score. Individuals with a history of incarceration were more likely to be engaging in drug use and this accounted for 22% of the association between incarceration and the VACS Index score. There is, however, a complex relationship between timing of drug use and incarceration, which we were unable to capture in this analysis because we did not have the specific dates of incarceration episodes. Nonetheless, this finding raises the possibility that limited access to drug treatment when incarcerated and upon release may be an important target to improving the health of HIV-infected individuals with a history of incarceration. While the VHA provides patients routine access to drug treatment especially following release from a correctional facility through the national Health Care for Reentry Veterans program,³⁰ there are national data suggesting that drug treatment is less available for veterans compared with the need for treatment.³¹ Future studies are needed to explore the role of drug treatment and its impact on the health outcomes of HIV-infected patients with a history of incarceration. We did not find that hazardous alcohol use was a mediator in the relationship between incarceration and VACS Index score, in spite of higher use among participants with a history of incarceration compared with those never incarcerated. It is possible that this level of drinking among those who have been incarcerated is not associated with increased morbidity and mortality, though this warrants further investigation. Alcohol, tobacco, and drug use do not occur in isolation making it difficult to determine primary versus secondary effects of these behaviors on health. Drug users are much more likely to smoke and to drink alcohol, often heavily. In our analyses, drug use was the only significant mediator, but future work is needed to determine how multisubstance use influences health outcomes among those experiencing incarceration.

Consistent with our hypothesis, we did not find any impact of primary care engagement or ART adherence on the association between incarceration and HIV outcomes. There were no differences in the rates of engagement in primary care comparing those with and without a history of incarceration. Approximately 80% of individuals with a history of incarceration visited a primary care provider at least twice in the year of the study. In contrast, nearly all studies of formerly incarcerated individuals have shown that former inmates are less likely to engage in primary care compared with those never incarcerated.³² Consistent with prior studies, we found that former inmates were less adherent to ART medications compared with those never incarcerated, but more than half of individuals with a history of incarceration had their ART medications filled about 80% of their time.^{9,33} Typically, former inmates face barriers to obtaining their medications following release, including barriers to applying for AIDS Drug Assistance Programs or obtaining reinstatement of VHA, Medicaid or Medicare benefits.^{9,34} Our findings may reflect the outreach efforts of the national Health Care for Reentry Veterans program and/or relative ease of reinstatement of VHA benefits compared to other entitlement programs.

One explanation for the difference in findings from past studies may be that the VHA represents a template scenario for health systems caring for communities with high rates of incarceration. To that end, while several studies have demonstrated positive associations between recent incarceration and poor HIV outcomes,^{2–5} we only found the VACS Index to be associated with a history of incarceration. It is important to note that in contrast to past studies, we used a measure of lifetime incarceration and we studied this association among participants who are ostensibly less disenfranchised than previously studied populations (those sampled based on homelessness or drug use). Those reasons aside, we speculate the primary reason that we did not find an association between history of incarceration and either low CD4 count or detectable viral load was that this study was conducted among patients who were engaged in ongoing medical care.

There are several important limitations to this study. No conclusions about cause and effect can be made from this study due to its cross-sectional design. We were not able to collect specific dates of incarceration episodes related to HIV measures and thus cannot make any associations about the temporal relationship between incarceration and HIV outcomes, which are essential to determining how best to design interventions to improve the health of those recently released from correctional facilities. Further, there were too few individuals who self-reported recent (within the last year) incarceration for meaningful comparisons when incarceration was categorized as recent, past, or never, particularly after adjustment for covariates. Data on incarceration, unhealthy alcohol use, and drug use were self-reported so social desirability bias may be present. Individuals who receive their health care through the VHA may have higher levels of access to medical care than other individuals with a history of incarceration which make generalizing these data to all individuals with a history of incarceration limited; still yet, VACS is one of the few cohorts that captures incarceration history and individuals with a history of incarceration still had worse health outcomes compared with those without this history even in a setting with higher access to medical care. Notwithstanding these limitations, these data come from clinical, pharmacologic, and administrative databases and provide accurate information on the health outcomes and potential mediators of individuals released from prison.

In this large, multisite study, having a history of incarceration was independently associated with higher VACS Index score in HIV-infected patients – connoting greater mortality risk. Recent drug use mediated the observed association. Longitudinal studies with temporal measures of incarceration are needed to better understand the relationships between incarceration, substance use, primary care engagement, ART adherence, and HIV outcomes to inform specific interventions for HIV-infected patients who have experienced incarceration.

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TABLE 1

Characteristics of study sample

Characteristics	Never incarcerated (N=840,53%)		Ever incarcerated (N=751,47%)		p-value
	N	%	N	%	
Age (years; Mean, Std)	57	9	56	7	.071
Sex					
Male	813	97	734	98	.25
Female	27	3	17	2	
Race/Ethnicity					
White	202	24	99	13	<.001
Black	518	62	568	76	
Latino	83	10	63	8	
Other	37	4	21	3	
Education					
<High school	37	4	56	7	.030
High school	795	95	690	92	
Missing	8	1	5	1	
Married or living with partner					
Yes	206	25	176	23	.59
No	625	74	563	75	
Missing	9	1	12	2	
Low income (<\$12,000/year)					
Yes	335	40	424	56	<.001
No	489	58	297	40	
Missing	16	2	30	4	
Ever homeless					
Yes	232	28	422	56	<.001
No	604	72	325	43	
Missing	4	0	4	1	
Recent homelessness (past 4 weeks)					
Yes	69	8	113	15	<.001

Characteristics	Never incarcerated (N=840, 53%)		Ever incarcerated (N=751, 47%)		p-value
	N	%	N	%	
No	762	91	632	84	
Missing	9	1	6	1	
Hepatitis C					
Yes	297	35	445	59	<.001
No	543	65	306	41	
Depression (PMD > 10)					
Yes	123	15	163	22	.001
No	711	85	581	77	
Missing	6	1	7	1	
Receiving combination antiretroviral treatment					
Yes	650	77	579	77	.89
No	190	23	172	23	
Potential mediators					
Unhealthy alcohol use (AUDIT-C 4)					
Yes	113	13	140	19	.001
No	644	77	566	75	
Missing	83	10	45	6	
Drug use in past year (cocaine, stimulant, heroin, non-prescription opioid use, or IV drug use in past year)					
Yes	170	20	291	39	<.001
No	653	78	451	60	
Missing	17	2	9	1	
Primary care engagement (2 primary care visits in past year)					
Yes	678	81	608	81	.90
No	162	19	143	19	
Antiretroviral adherence (% time out of medicine; Mean, Std)*	18	18	21	20	.002

* Only includes 1,201 subjects.

TABLE 2

Clinical outcomes stratified by history of incarceration

Outcomes	Never incarcerated	Ever incarcerated	<i>p</i> -value
CD4 count (mean, std)	522.4 (311.6)	496.9 (309.8)	.10
Low CD4 count (<200 cells/ μ L; <i>N</i> , %)	94 (11%)	114 (15%)	.019
HIV-1 RNA viral load (mean, std)	9,807 (53,872)	10,095 (52,330)	.91
Detectable HIV-1 RNA viral load (>500 copies/mL; <i>N</i> , %)	119 (14%)	137 (18%)	.027
VACS Index score (mean, std)	29.5 (19.6)	33.8 (19.6)	<.001

TABLE 3

Association between history of incarceration and HIV outcomes with potential mediators

	Outcome		
	Low CD4 count	Detectable viral load	VACS Index score
Preliminary estimates	Odds ratio (95% CI)		β (95% CI)
Unadjusted model	1.42(1.06–1.90)	1.35 (1.03–1.77)	4.18 (2.25–6.11)
Adjusted model*	1.24(0.92–1.68)	1.18 (0.89–1.56)	2.47 (0.52–4.43)
Assess potential mediators			
Unhealthy alcohol use			2.84 (0.88–4.79)
Recent drug use			1.93 (–0.06–3.91)
Primary care engagement	Not applicable because association not significant in adjusted model		2.50 (0.55–4.46)
Antiretroviral adherence**			2.23 (0.03–4.42)

* Low CD4 count and detectable viral load models adjusted for age, race, income, and recent homelessness. VACS Index score models adjusted for sex, race, education, marital status, income, recent homelessness;

** Model only includes 1201 subjects.