Published in final edited form as:

Qual Life Res. 2010 November ; 19(9): 1295–1302. doi:10.1007/s11136-010-9701-x.

HIV and COPD: impact of risk behaviors and diseases on quality of life

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Abstract

Purpose—Smoking worsens quality of life among HIV-infected individuals, but it remains unclear if this association is related simply to smoking or to chronic obstructive pulmonary disease (COPD), the end-organ disease caused by smoking.

Methods—Using cross-sectional data from the AIDS Linked to the Intravenous Experience study, we determined the independent effects of smoking, HIV and COPD assessed using the Medical Outcome Studies-HIV questionnaire.

Results—Of 973 participants, 287 (29.5%) were HIV infected and 151 (15.5%) had spirometry-defined obstruction. Eight hundred and thirty-four (85.7%) were current smokers with 23.3 mean pack-years history. HIV infection was independently associated with reduced physical and mental health. COPD was associated with a trend toward worse physical health (−1.48 units; 95%CI −3.33 to 0.38; $p = 0.12$) and was independently associated with worse mental health (−2.43 units; 95%CI −4.22 to −0.64; $p < 0.01$). After accounting for COPD and other covariates, smoking was not associated with changes in physical or mental health.

Conclusions—The presence of COPD, rather than smoking, is associated with worse quality of life independent of HIV infection. Diagnosis and management of COPD in former or current smokers with or at risk for HIV may further improve quality of life.

Keywords

Quality of life; Chronic obstructive pulmonary disease; Human immunodeficiency virus; Injection drug use; Smoking; Tobacco use

Introduction

The advancement of highly active anti-retroviral therapies (HAART) has led to prolonged survival with HIV infection [1]. Despite increased survival, HIV infection is still associated with significant worsening of quality of life [2–4]. As survival with HIV improves, HIV-infected individuals are frequently diagnosed with other co-morbidities which may further impact quality of life [5–8]. Chronic obstructive pulmonary disease (COPD), the fourth leading cause of death in the United States, is a smoking-related lung disease characterized by gradual decline in lung function which can have a substantial negative impact on quality of life [9–13]. Smoking is substantially more prevalent among HIV-infected persons [14], and recent reports have demonstrated that COPD is commonly observed among HIV-infected individuals [15–17]. While several studies have reported on the negative impact of smoking on quality of life in HIV [18–20], little is known regarding the influence of COPD on quality of life among HIV-infected individuals. Moreover, it remains unclear whether the risk behavior (cigarette smoking) or the end-organ disease associated with that behavior (COPD) is responsible for decrements in quality of life.

The AIDS Linked to the Intravenous Experience (ALIVE) study has prospectively observed a cohort of injection drug users (IDUs) in Baltimore, Maryland since 1988. Clinical, laboratory, spirometric and quality of life data have been collected in this cohort of individuals infected with or at risk for HIV [21]. We have previously described that cigarette smoking is near ubiquitous among this population [6, 22]. Further, we have observed a substantial prevalence of obstructive lung disease within this population. In the current

study, we sought to evaluate the independent effects of cigarette smoking, COPD and HIV infection on both physical and mental quality of life in a large inner-city population.

Methods

Study cohort

At study entry, ALIVE participants were required to be ≥ 18 years of age and have a history of injecting drugs. Initially, HIV-infected patients with AIDS were excluded. However, this exclusion was lifted following availability of HAART. As part of a lung disease sub-study, ALIVE participants completed a respiratory questionnaire and underwent spirometry testing. Cross-sectional data collected concurrent with the initial lung sub-study evaluation from January 9, 2007 to September 28, 2008 were included in the current analysis. This study was approved by Institutional Review Board of the Johns Hopkins University and has therefore been conducted in accordance with the ethical standards of the 1964 Declaration of Helsinki. All participants provided written informed consent.

Data collection

Smoking status and duration, injection drug use in the last 6 months, anti-retroviral and bronchodilator therapy were determined by self-report. Medical conditions such as respiratory infections or clinical AIDS events occurring in the last 6 months were identified through self-report and confirmed through standardized medical record abstraction. An interviewer administered Medical Outcomes Study-Human Immunodeficiency Virus (MOS-HIV) questionnaire was conducted at the time of spirometry. While typically self-administered, the MOS-HIV is written at the 8th grade literacy level. Because some ALIVE participants are functionally illiterate or perform below the 8th grade level, a specially trained interviewer administered the questionnaire. The MOS-HIV questionnaire is a 35-item survey that assesses ten dimensions of health to measure functional status and well-being in persons with HIV [23]. Physical health and mental health summary scores are generated using regression-based weights of individual domains [24]. The summary scores are standardized with a mean of 50 and a standard deviation of 10 (i.e., *T*-scores), with higher scores indicating better health status. The MOS-HIV has good psychometric properties and has demonstrated responsiveness in many HIV-infected populations [25]. The physical and mental health summary scores have been shown to correlate with survival in longitudinal studies of HIV infection [26]. The internal consistency and construct validity of the MOS-HIV has been demonstrated in numerous clinical trials [23, 27–31]. Spirometry was performed using a KOKO® (Pulmonary Data Services, Inc., Louisville, CO) pneumotach in accordance with American Thoracic Society guidelines [32]. Percent predicted values were calculated using standard formulas [33]. COPD was defined as a ratio of the forced expiratory volume in 1 s (FEV1) to forced vital capacity (FVC) of < 70%.

Statistical analysis

Clinical and demographic characteristics between groups were compared using the t-test for normally distributed continuous variables and Mann–Whitney test for skewed data. All data are presented as mean (standard deviation) for normally distributed data and median (interquartile range [IQR]) for non-normally distributed data. Categorical variables were

compared with Pearson's chi-squared and Fisher's exact tests. Multivariable linear regression models were generated to explore combinations of variables associated with summary scores. Covariates were evaluated based upon known relevance from clinical literature review and/or inspection of exploratory data analyses. Stata version 10.0 (Stata Corp, College Station, TX), was used for statistical analysis.

Results

Participant characteristics

Of the 1,052 participants evaluated in the ALIVE lung sub-study, 973 participants had complete spirometric and MOS-HIV questionnaire data. Overall, the mean age of participants was 48 years, two-thirds were male and 90% were black (Table 1). A total of 834 (85.7%) were current smokers while 287 (29.5%) were HIV-infected. The median CD4 count of HIV-infected participants was 320 cells/mm³ (IQR, 177–502 cells/mm³), 155 (54.8%) were receiving HAART and 131 (45.6%) had HIV RNA levels below 400 copies/mL. Spirometry-defined obstruction was observed in 151 (15.5%) of participants and did not differ by HIV status (15.7% vs. 15.5% for HIV-infected compared to HIV-uninfected). The FEV1/FVC ratio of the cohort was 76.8 ± 8.1 with a mean FEV1% predicted of 91.9 ± 18.1 %. For participants with spirometry-defined obstruction, the mean FEV1/FVC ratio was 62.7 ± 7.2 with a mean FEV1% predicted of 71.6 ± 18.9 %. When comparing the demographic characteristics of the 79 excluded participants to the 973 included in this sample, the body mass index of excluded participants was lower (24.7 ± 5.9 kg/m² vs. 26.5 ± 6.1 ; $p = 0.01$). As well, excluded participants had a higher proportion of never-smokers (12.6% vs. 4.9%; $p = 0.02$). There was no difference in the proportion of HIV-infected individuals in the excluded participants.

MOS-HIV scores by HIV and COPD status

When comparing MOS-HIV scores among HIV-uninfected ($n = 686$) to HIV-infected individuals ($n = 287$), several subdomains were lower in the presence of HIV (Table 2). Specifically, general health perception, role function, social function and cognitive function scores were significantly lower in HIV-infected individuals compared to the HIV-uninfected participants. The physical health summary score was lower in HIV-infected individuals compared to HIV-uninfected participants (45.2 ± 11.0 vs. 46.8 ± 11.2 ; $p = 0.04$). The six remaining dimension specific scores and mental health summary score did not significantly differ between participants stratified by HIV infection status.

When defining the study cohort by the presence of COPD, decrements were observed in the subdomains of general health perception, role function and cognitive function in the presence of COPD (Table 3). Additionally, the energy/fatigue and health distress subdomains were lower when COPD was present. COPD was associated with a lowering of both the physical health summary score (44.3 ± 11.4 vs. 46.7 ± 11.1 ; $p = 0.02$) and mental health summary score (47.4 ± 11.0 vs. 50.3 ± 10.6 ; $p < 0.01$).

Unadjusted and adjusted associations of MOS-HIV summary scores

Because demographic and clinical factors are known to impact MOS-HIV summary scores [34], we sought to examine the impact of HIV and COPD on physical and mental health summary scores while accounting for potential confounding effects. In univariate analysis older age, female gender, HIV infection and COPD were associated with reduced physical health summary scores while race, high school education, current IDU status and smoking status were not associated with a difference in physical health summary scores (Table 4). A multivariate model incorporating these eight covariates was generated to assess the independent impact of COPD and HIV on the MOS-HIV physical health summary score. Older age and female gender were independently associated with a lower physical health summary score (Table 4). Black race and high school education were associated with a positive effect on the physical health summary score. While injection drug use was not independently associated with a change in the physical health summary score (-0.80 ; 95%CI -2.18 to 0.58 ; $p = 0.26$), the presence of HIV was associated with a decrease in the physical health summary score (-2.06 ; 95%CI -3.55 to -0.58 ; $p < 0.01$). Neither smoking status (current/former versus never) nor the presence of COPD was independently associated with a change in the physical health summary score (0.34 ; 95%CI -2.78 to 3.46 ; $p = 0.83$ and -1.48 ; 95%CI -3.33 to 0.38 ; $p = 0.12$, respectively). Modeling smoking status in different ways (current versus former/never, per 10 pack-years, <40 pack-years versus ≥ 40 pack-years) did not substantially alter the effect of COPD on physical health summary scores.

Regarding the mental health summary score, in univariate modeling female gender, presence of COPD and current injection drug use were associated with a lower summary score (Table 5). An improvement in the mental health summary score was observed with black race and the presence of high school education. Age, HIV status and smoking status were not associated with a change in mental health summary scores in univariate analysis. In multivariate modeling incorporating all eight variables, a similar impact of age, gender, race and high school education were observed in the mental health summary score as seen in the physical health summary score (Table 5). Both injection drug use and HIV were associated with a lower mental health summary score (-3.66 ; 95%CI -4.99 to -2.33 ; $p < 0.01$ and -1.51 ; 95%CI -2.94 to -0.08 ; $p = 0.04$, respectively). Smoking status was not associated with a change in the mental health summary score (2.16 ; 95%CI -0.85 to 5.16 ; $p = 0.16$) while COPD was associated with a substantial reduction in the mental health summary score (-2.43 ; 95%CI -4.22 to -0.64 ; $p < 0.01$). Interestingly, the magnitude of effect of COPD on mental health summary scores appeared at least equivalent and likely greater than the decrease seen with HIV infection. In the presence of HIV, the mental health summary score was lowered by -1.51 units (95%CI -2.94 to -0.08), while COPD lowered the summary score by -2.43 units (95%CI -4.22 to -0.64). Similarly, different models of smoking history (current versus former/never, per 10 pack-years, <40 pack-years versus ≥ 40 pack-years) did not substantially alter the effect of COPD on mental health summary scores.

Discussion

Our analysis of factors impacting quality of life in a large cohort of injection drug users at risk for HIV and COPD has several key findings. As expected, HIV infection was associated

with lower physical and mental health; however, we also identified that COPD was primarily associated with reduced mental health. In contrast to other studies of smoking and quality of life among HIV-infected persons, neither physical nor mental health scores were impacted by smoking habits within our IDU population after accounting for HIV, COPD and other covariates. HIV and COPD had similar effects on most subdomains of the MOS-HIV questionnaire, although only COPD had a significant impact on energy/fatigue and health distress measures.

While our results confirm the impact of HIV on quality of life measures, this analysis expands the current understanding of the effect of cigarette smoking and COPD on quality of life outcomes in those living with or at risk for HIV. Prior studies have examined the effect of cigarette smoking on quality of life measures in HIV [18, 35, 36]. These studies have shown that cigarette smoking adversely affects quality of life among HIV-infected individuals. What is unclear is whether these prior studies were capturing the quality of life effect of smoking or its end-organ disease COPD. To our knowledge, the data presented here is the first to evaluate the impact of spirometry-defined COPD while adjusting for smoking habits. In our analysis, it is the presence of COPD, not smoking habits, that is associated with worse physical and mental health. This observation highlights the importance of early spirometric screening in individuals with a history of remote or current smoking, as diagnosis and management of COPD has the potential for improving the quality of life in individuals at risk or with HIV.

The physical and mental health summary scores have been shown in prior studies to be practical tools for the monitoring of health status [23, 24, 37] and are able to discriminate between HIV-infected groups stratified by disease severity [38]. Our analysis demonstrates that the presence of COPD was associated with a 2.43-unit decrease in the mental health summary score. Prior studies have reported that each one point decrease in baseline physical or mental health summary score was associated with a 4% increase in the likelihood of death [26, 39]. Thus, the magnitude of effect of COPD on the summary scores we report (approximately 2 units) is within a clinically meaningful range. Whereas prior studies have demonstrated that tobacco use is associated with mortality [18, 40], our analysis provides evidence that COPD, the end-organ disease related to smoking, adversely affects quality of life and potentially mortality, even after controlling for HIV infection.

While the magnitudes of effect of COPD and HIV on the physical health summary score were similar, COPD was associated with a potentially stronger negative effect on mental health summary score than HIV. It is known that individuals with COPD acclimate to an inactive lifestyle [41]. Such an effect could contribute to a substantial decrement in mental health while having a less substantial impact on physical health status. This is supported by our observation that COPD negatively impacts general health perception, energy/fatigue and cognitive function subdomains but not pain or physical function subdomains. Additionally, the MOS-HIV summary scores may be capturing non-specific effects of chronic disease, rather than HIV-specific effects. Some controversy exists as to the most appropriate instrument to use for measuring quality of life in HIV-positive patients [42, 43]. The Short Form-36 may be more useful than the MOS-HIV because of the presence of national

normative data, less ceiling and floor effects, and prior use in a wide variety of patient populations.

This study has some limitations which should be addressed. The study population for this analysis is a relatively homogeneous inner-city population. The relevance of our results to individuals without a history of intravenous drug use is not known. While this may limit the generalizability of our findings to other populations, the demographics of our study cohort are similar to those at risk for HIV and COPD [44–47]. The large size of our cohort makes us susceptible to detection of statistically but not clinically relevant differences in scores between study groups. However, by examining the magnitude of change in the context of prior studies, we are able to make meaningful clinical conclusions. It is possible that unmeasured chronic illnesses related to injection drug use (such as viral hepatitis or end-stage kidney disease) may contribute to decrements in quality of life independent of HIV infection. The cross-sectional nature of our analysis prevents us from making conclusions regarding the correlation of MOS-HIV scores with longitudinal outcomes such as mortality. Although the low prevalence of never-smokers potentially limits conclusions regarding the independent associations between history of smoking and COPD on quality of life, when modeling smoking exposure and duration several different ways we observed a persistent effect of COPD, but not smoking, on quality of life. Despite these limitations, our analysis provides a comprehensive study of the impact of COPD on MOS-HIV sub-domains and summary scores in individuals at risk or with HIV.

In summary, employing the MOS-HIV questionnaire in a large cohort of individual at risk for HIV and COPD, we have shown that COPD, but not smoking habits, worsen quality of life measures independent of HIV effects. Moreover, the effect of COPD on quality of life was at least equivalent in magnitude to that of HIV. With the efficacy of HAART, life expectancy of HIV-infected individuals has extended such that they are susceptible to development of chronic debilitating diseases including COPD. Health care providers of HIV-infected individuals should screen for undiagnosed COPD as management of this disease may lead to improved quality of life.

Acknowledgments

Financial support This study was funded in part by grants from the NIH (RO1s HL090483, DA04334 and DA12568). MBD is supported by an Institute for Clinical and Translational Research (KL2) Mentored Career Development Award from the National Institutes of Health.

Abbreviations

ALIVE	AIDS Linked to the Intravenous Experience
BMI	Body mass index
CD4	CD4+ T-helper cells
CI	confidence interval
COPD	Chronic obstructive pulmonary disease
FEV1	Forced expiratory volume in 1 s

FVC	Forced vital capacity
HAART	Highly active antiretroviral therapy
HIV	Human immunodeficiency virus
IDU	Injection drug user
IQR	Interquartile range
MOS-HIV	Medical outcomes studies-human immunodeficiency virus
QOL	Quality of life

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Table 1

Participant characteristics

<i>N</i>	973
Age, year	48.3 (7.8)
Male, <i>n</i> (%)	642 (66.0)
Race/ethnicity, <i>n</i> (%)	
Black	874 (89.8)
BMI (kg/m ²)	25.4 (22.3–29.8)
Annual income, <i>n</i> (%)	
None	227 (24.0)
<\$5,000	482 (50.9)
\$5,000–\$10,000	159 (16.8)
>\$10,000	79 (8.3)
High school education, <i>n</i> (%)	404 (41.7)
Smoking status, <i>n</i> (%)	
Current	834 (85.7)
Former	91 (9.4)
Never	48 (4.9)
Smoking, pack-year	23.3 (16.3)
Current injector, <i>n</i> (%) ^a	392 (40.3)
HIV-infected, <i>n</i> (%)	287 (29.5)
CD4 count (cells/mm ³) ^b	320 (177–502)
HIV RNA undetectable, <i>n</i> (%) ^b	131 (45.6)
HIV RNA level ^c	20,350 (3,770–73,100)
Anti-retroviral use, <i>n</i> (%) ^d	155 (54.8)
Infection, <i>n</i> (%) ^a	
Pneumocystis	2 (0.2)
Any pneumonia	22 (2.3)
COPD, <i>n</i> (%)	151 (15.5)
FEV ₁ /FVC ratio	76.8 (8.1)
FEV ₁	
Absolute (L)	2.80 (0.78)
% Predicted	91.9 (18.1)
FVC	
Absolute (L)	3.64 (0.97)
% Predicted	96.1 (16.6)

Values presented as mean (S.D.) or median (IQR) unless indicated

BMI body mass index, *HIV* human immunodeficiency virus, *pack-year* number of packs smoked per day * years smoked, *IDU* injection drug use, *CD4* CD4+ T-helper cells, *COPD* chronic obstructive pulmonary disease, *FEV1* forced expiratory volume in 1 s, *FVC* forced vital capacity

^aIndicates exposure within prior 6 months

^b Among HIV-infected only

^c Among HIV-infected participants with detectable viral load only

Table 2

MOS-HIV questionnaire scores stratified by HIV status

	HIV–	HIV+	<i>P</i>
<i>N</i>	686	287	
General health perception	59.8 (24.0)	54.8 (24.9)	<0.01
Pain	73.3 (24.5)	73.0 (25.8)	0.85
Physical function	61.9 (31.1)	60.4 (29.2)	0.47
Role function, mean	69.1 (43.5)	61.0 (44.2)	<0.01
Role function, <i>n</i> (%)			
0	178 (26.0)	87 (30.3)	
50	68 (9.9)	50 (17.4)	
100	440 (64.1)	150 (52.3)	<0.01
Social function, mean	74.3 (31.3)	69.3 (31.6)	0.02
Social function, <i>n</i> (%)			
0	41 (6.0)	14 (4.9)	
20	58 (8.5)	37 (12.9)	
40	29 (4.2)	20 (7.0)	
60	117 (17.1)	53 (18.5)	
80	122 (17.8)	57 (19.9)	
100	319 (46.5)	106 (36.9)	0.03
Energy/fatigue	61.4 (19.9)	61.3 (21.3)	0.96
Mental health	70.6 (20.4)	69.5 (20.7)	0.47
Health distress	77.1 (25.0)	73.3 (27.5)	0.05
QOL, mean	66.4 (20.0)	68.6 (20.2)	0.12
QOL, <i>n</i> (%)			
0	8 (1.2)	5 (1.7)	
25	47 (6.9)	10 (3.5)	
50	190 (27.7)	80 (27.9)	
75	370 (53.9)	151 (52.6)	
100	71 (10.4)	41 (14.3)	0.13
Cognitive function	79.2 (22.4)	74.7 (25.5)	0.01
Summary scores			
Physical health	46.8 (11.2)	45.2 (11.0)	0.04
Mental health	50.2 (10.5)	49.1 (11.1)	0.16

Values presented as mean (S.D.) or *n* (%)*MOS-HIV* medical outcomes study-human immunodeficiency virus, *HIV* human immunodeficiency virus, *QOL* quality of life

Table 3

MOS-HIV questionnaire scores stratified by COPD status

	COPD–	COPD+	<i>P</i>
<i>N</i>	822	151	
General health perception	59.7 (24.0)	50.7 (25.0)	<0.01
Pain	73.2 (24.8)	73.1 (25.6)	0.97
Physical function	62.1 (30.6)	58.4 (30.1)	0.17
Role function, mean	68.3 (43.3)	57.9 (45.9)	0.01
Role function, <i>n</i> (%)			
0	212 (25.8)	53 (35.1)	
50	97 (11.8)	21 (13.9)	
100	513 (62.4)	77 (51.0)	0.03
Social function, mean	73.7 (31.1)	68.2 (33.0)	0.06
Social function, <i>n</i> (%)			
0	45 (5.5)	10 (6.6)	
20	75 (9.1)	20 (13.3)	
40	40 (4.9)	9 (6.0)	
60	143 (17.4)	27 (17.9)	
80	150 (18.3)	29 (19.2)	
100	369 (44.9)	56 (37.1)	0.46
Energy/fatigue	61.9 (20.1)	58.0 (21.2)	0.04
Mental health	70.7 (20.4)	67.8 (20.9)	0.11
Health distress	77.0 (25.5)	70.3 (26.8)	<0.01
QOL, mean	67.5 (19.8)	64.6 (21.5)	0.13
QOL, <i>n</i> (%)			
0	11 (1.3)	2 (1.3)	
25	43 (5.2)	14 (9.3)	
50	224 (27.3)	46 (30.5)	
75	449 (54.6)	72 (47.7)	
100	95 (11.6)	17 (11.3)	0.27
Cognitive function	78.8 (23.1)	72.9 (24.5)	<0.01
Summary scores			
Physical health	46.7 (11.1)	44.3 (11.4)	0.02
Mental health	50.3 (10.6)	47.4 (11.0)	<0.01

Values presented as mean (S.D.) or *n* (%)*MOS-HIV* medical outcomes study-human immunodeficiency virus, *COPD* chronic obstructive pulmonary disease, *QOL* quality of life

Table 4Associations with physical health summary score for entire cohort ($n = 973$)

Predictor	Unadjusted		Adjusted ^b	
	Mean difference (95%CI)	<i>p</i> -value	Mean difference (95%CI)	<i>p</i> -value
Age (per 10 years)	-2.74 (-3.62, -1.86)	<0.01	-4.18 (-5.12, -3.23)	<0.01
Gender (female vs. male)	-3.11 (-4.57, -1.64)	<0.01	-4.30 (-5.76, -2.85)	<0.01
Race (black vs. non-black)	2.17 (-0.15, 4.49)	0.07	6.16 (3.77, 8.54)	<0.01
High school education	1.38 (-0.04, 2.80)	0.06	1.53 (0.15, 2.91)	0.03
Current IDU	-0.13 (-1.56, 1.30)	0.85	-0.80 (-2.18, 0.58)	0.26
HIV status	-1.59 (-3.13, -0.06)	0.04	-2.06 (-3.55, -0.57)	<0.01
Smoking status ^a	-0.16 (-3.40, 3.08)	0.92	0.34 (-2.78, 3.46)	0.83
COPD status	-2.37 (-4.30, -0.44)	0.02	-1.48 (-3.33, 0.38)	0.12

MOS-HIV medical outcomes study-human immunodeficiency virus, *IDU* injection drug use, *HIV* human immunodeficiency virus, *COPD* chronic obstructive pulmonary disease

^a Current/former vs. never smoker

^b Individual covariates adjusted for the all other covariates listed in table

Table 5Associations with mental health summary score for entire cohort ($n = 973$)

Predictors	Unadjusted		Adjusted ^b	
	Mean difference (95%CI)	<i>p</i> -value	Mean difference (95%CI)	<i>p</i> -value
Age (per 10 years)	−0.04 (−0.91, 0.82)	0.92	−1.62 (−2.53, −0.71)	<0.01
Gender (female vs. male)	−2.49 (−3.90, −1.07)	<0.01	−2.95 (−4.35, −1.55)	<0.01
Race (black vs. non-black)	5.13 (2.92, 7.34)	<0.01	6.31 (4.01, 8.61)	<0.01
High school education	2.25 (0.89, 3.60)	<0.01	2.12 (0.80, 3.45)	<0.01
Current IDU	−3.65 (−5.01, −2.30)	<0.01	−3.66 (−4.99, −2.33)	<0.01
HIV status	−1.09 (−2.57, 0.39)	0.15	−1.51 (−2.94, −0.08)	0.04
Smoking status ^a	1.68 (−1.43, 4.79)	0.29	2.16 (−0.85, 5.16)	0.16
COPD status	−2.87 (−4.73, −1.02)	<0.01	−2.43 (−4.22, −0.64)	<0.01

^aCurrent/former vs. never smoker^bIndividual covariates adjusted all other covariates listed in table

MOS-HIV medical outcomes study-human immunodeficiency virus, *IDU* injection drug use, *HIV* human immunodeficiency virus, *COPD* chronic obstructive pulmonary disease