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Health Outcomes of HIV-Infected People with Mental Illness

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Abstract

Improving outcomes for people with HIV and mental illness will be critical to meeting the goals of the US *National HIV/AIDS Strategy*. In a retrospective analysis of the 2008–2010 cycles of the locally representative Philadelphia Medical Monitoring Project, we compared the proportions of HIV-infected adults with and without mental illness: (1) retained in care (≥2 primary HIV visits separated by ≥90 days in a 12-month period); (2) prescribed antiretroviral therapy (ART) at any point in a 12-month period; and (3) virally suppressed (HIV-1 RNA ≤200 copies/mL at the last measure in the 12-month period). Multivariable regression assessed associations between mental illness and the outcomes, adjusting for age, gender, race/ethnicity, insurance, alcohol abuse, injection drug use, CD4 count, and calendar year. Of 730 HIV-infected persons, representative of 9409 persons in care for HIV in Philadelphia, 49.0 % had mental illness. In adjusted analyses, there were no significant differences in retention (91.3 vs. 90.3 %; AOR 1.30, 95 % CI 0.63–2.56) and prescription of ART (83.2 vs. 88.7 %; AOR 0.79, 95 % CI 0.49–1.25) between those with and without mental illness. However, mentally ill patients were less likely to achieve viral suppression than those without mental illness (65.9 vs. 74.4 %; AOR 0.64, 95 % CI 0.46–0.90). These findings argue for the need to optimize ART adherence in this population.

Keywords

Mental illness; HIV; Viral suppression; Retention; Antiretroviral therapy; Outcomes

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Introduction

HIV infection and mental illness are closely intertwined conditions [1–7]. Between 5 and 23 % of persons with mental illness are infected with HIV, compared to 0.3–0.4 % of the general United States (US) population; and as many as half of people living with HIV (PLWH) have one or more psychiatric disorders [2–5, 8]. Psychiatric comorbidity may impact HIV outcomes, with prior studies noting decreased antiretroviral therapy (ART) adherence, higher rates of virologic failure, and increased mortality among HIV-infected people with mental illness [2, 9–11]. Among 765 HIV-infected adult women living in four urban cities, those with chronic depressive symptoms were twice as likely to die as women with limited to no depressive symptoms after adjusting for sociodemographics, CD4 cell count, HIV viral load, and use of ART [9]. Similarly, of 198 HIV-infected patients initiating ART, those with one or more psychiatric disorders had a slower rate of virologic suppression and a faster rate of virologic failure compared to individuals with no psychiatric diagnoses [11].

For these and other reasons, improving the care of HIV-infected persons with mental illness will be critical to meeting the goals of the *US National HIV/AIDS Strategy*— reduce new infections, increase access to care and improve health outcomes, reduce HIV-related health disparities. Moreover, focusing on PLWH and mental illness will be key to accelerating improvements along the HIV care continuum (HIV diagnosis, linkage to care, retention in care, ART prescription, and viral suppression) [2, 6, 12–14].

The treatment of HIV infection has changed dramatically since the studies described above were conducted more than 10 years ago. Novel drug classes, new-generation protease inhibitors, and fixed dose combination tablets have enhanced the safety and tolerability of regimens and improved patient adherence [15–20]. Thus, an updated analysis of the health outcomes of HIV-infected people with mental illness is needed. We compared differences in retention in care, prescription of ART, and HIV viral suppression (i.e. last three steps of the HIV care continuum) between PLWH with and without mental illness using data collected as part of a national HIV surveillance project.

Methods

Study Sample and Data Collection

Data were obtained from the Medical Monitoring Project (MMP), a surveillance project funded and coordinated by the Centers for Disease Control and Prevention (CDC). MMP uses a population-based sample of PLWH to monitor clinical outcomes, HIV medical care, and on-going risk factors for persons receiving HIV care. To select an annually representative sample of approximately 400 persons receiving primary HIV medical care in Philadelphia, MMP used a three-stage sampling process with a probability proportion-to-size sampling design, as has been described elsewhere [21, 22]. To be eligible, participants must have been: (1) diagnosed with HIV infection, (2) at least 18 years of age, (3) enrolled in care at the sampled facility, and (4) able to provide informed consent. All HIV-infected

adults who participated in either the 2008, 2009, or 2010 cycles of Philadelphia MMP were eligible for inclusion.

The study was approved by the Institutional Review Board (IRB) of the University of Pennsylvania. The IRB of the City of Philadelphia Department of Public Health determined the project was exempt from review as the MMP is considered part of routine HIV surveillance at both the local and national levels.

Definitions of Variables

Outcome Variables—Retention in care was based on the *US National HIV/AIDS Strategy* metric, which dichotomously defines retention as having two or more primary HIV medical visits separated by ≥90 days in a 12-month observation period [23]. Prescription of ART was defined as receiving a prescription for three or more antiretroviral drugs (excluding ritonavir) at any point during the 12-month observation period. HIV viral suppression was categorized as suppressed (plasma HIV-1 RNA ≤200 copies/mL) and not suppressed (plasma HIV-1 RNA >200 copies/mL) at the last measure of the 12-month observation period. Those with missing HIV-1 RNA values [0.05 % (n = 43) of the sample) were excluded from primary regression analyses.

Primary Exposure Variable—Persons with mental illness were defined as those with documented psychiatric disorders, bipolar disorder, depressive disorders, and/or anxiety disorders on medical record review. Furthermore, we adapted an algorithm to classify individuals into three categories based on the likely severity of their mental illness [7, 24]. We coded those with psychotic disorders as having the most severe mental illness; individuals with bipolar disease but without psychotic disorders as having the next most severe mental illness; and those with only depressive and/or anxiety disorders as having the least severe mental illness.

Sociodemographic and Clinical Variables—Sociodemographic variables, at the time of enrollment in the MMP, were defined according to CDC criteria [21]. Patients' age was divided into four groups: 18–29, 30–39, 40–49, and 50 years or older. Race/ethnicity was categorized as non-Hispanic White, non-Hispanic Black, Hispanic, and other/unknown. Health insurance coverage was categorized as private, Medicaid, Medicare (including persons with dual eligibility), uninsured, or other/unknown. Patients whose care was funded by Ryan White, those recorded as self-pay, and those covered by local governmental programs were classified as uninsured. First CD4 cell count during the 12-month observation period was grouped as ≤200, 201–350, 351–500,>500 cells/mm^3, and missing/unknown, based on differential indications for starting ART [25]. Patients with active or a history of injection drug use (IDU) and those with active or a history of alcohol abuse were distinguished from individuals without these conditions, respectively; IDU and alcohol abuse were *not* included in the definition of mental illness.

Statistical Analyses

Standard descriptive analyses of the sample were conducted. Multivariable logistic regression examined sociodemographic and clinical factors (age, gender, race/ ethnicity,

health insurance status, alcohol abuse, IDU, CD4 count) associated with having a mental illness. Weighted χ^2 tests were used to evaluate the unadjusted association between mental illness status (present vs. not present) and retention in care, prescription of ART, and HIV viral suppression. Multivariable logistic regression assessed the association between mental illness status (present vs. not present) and the outcomes, adjusting for age, gender, race/ethnicity, health insurance status, alcohol abuse, IDU, CD4 count, and calendar year of surveillance. In secondary analyses, we evaluated whether the association between mental illness and the outcomes differed by IDU status, by including an interaction term between mental illness and IDU. Similarly, we evaluated whether the association between mental illness and the outcomes differed by alcohol abuse status, by including an interaction term between mental illness and alcohol abuse. In exploratory analyses, the association of increasing mental illness severity with the outcomes was evaluated by multivariable logistic regression adjusting for the same confounders. In a sensitivity analysis, individuals with missing HIV-1 RNA measures were classified as "not suppressed"; as per previously published protocols [26]. All analyses incorporated weighting to account for the sampling strategy and non-response. Using survey weighting, each observation was weighted such that the resulting weighted sample reflected the population of persons in care for HIV in Philadelphia. Two-sided testing was used, with a p value of <0.05 considered significant. Analyses were conducted using SAS 9.3 (SAS Institute Inc., Cary, North Carolina).

Results

Between 2008 and 2010, 730 PLWH participated in the Philadelphia MMP representative of 9409 PLWH in Philadelphia (Table 1). Most people were male (66.4 %), ≥40 years old (69.0 %), racial/ethnic minorities (77.3 %), and had Medicaid insurance (52.1 %); 43.2 % had a first CD4 count >500 cells/mm^3. Approximately twenty percent of the population had active or a history of alcohol abuse, 12.3 % had active or a history of IDU, and 49.0 % had a mental health diagnosis. Individuals with mental illness were significantly ($p < 0.50$) more likely to be female, have Medicaid or Medicare insurance, actively use or have a history of alcohol abuse, and actively use or have a history of IDU (Table 1).

Overall, 90.8 % of the population was retained in care, 86.0 % prescribed ART, and 70.3 % virologically suppressed (Table 2). Among those virologically suppressed, the vast majority (97.5 %) were individuals on ART. In unadjusted analyses, the proportion retained in care was similar for individuals with and without mental illness (91.3 vs. 90.3 %; OR 1.13, 95 % CI 0.68–1.87). However, individuals with mental illness were less likely to be prescribed ART (83.2 vs. 88.7 %; OR 0.63, 95 % CI 0.42–0.95) and achieve viral suppression (65.9 vs. 74.4 %; OR 0.66, 95 % CI 0.49–0.90) than those without a mental health diagnosis.

Adjusting for sociodemographic and clinical factors, there was no significant difference in retention in care (AOR 1.30, 95 % CI 0.63–2.58) or prescription of ART (AOR 0.79, 95 % CI 0.49–1.25) between individuals with and without mental illness. However, persons with a mental health diagnosis were significantly less likely to achieve viral suppression than those without a mental health diagnosis (AOR 0.64, 95 % CI 0.46–0.90) (Table 3). This association was supported by a sensitivity analysis classifying all persons with missing viral load data as un-suppressed (AOR 0.70, 95 % CI 0.51–0.96) (Appendix Table 5). When

mental illness was grouped by severity, no significant differences in retention in care and prescription of ART were observed. However, compared to individuals without any mental illness, those with depressive/anxiety disorders were significantly less likely to achieve viral suppression (AOR 0.65, 95 % CI 0.47–0.91) (Table 4). Alcohol abuse and IDU did not significantly modify the association of mental illness with any of the outcomes. That is, the interaction between alcohol abuse and mental illness for the three outcomes was not significant (retention: AOR 0.66, 95 % CI 0.13–3.43; use of ART: AOR 1.71, 95 % CI 0.61–4.80; viral suppression AOR 1.16, 95 % CI 0.43–3.14). Similarly, the interaction between IDU and mental illness for the three outcomes was not significant (retention: AOR 1.36, 95 % CI 0.13–14.33; use of ART: AOR 0.56, 95 % CI 0.10–3.21; viral suppression: AOR 0.96, 95 % CI 0.30–3.05).

In multivariate analyses (Table 3), females and patients with higher CD4 cell counts were significantly ($p < 0.05$) less likely to be prescribed ART. Females and persons with black race/ethnicity (vs. white) were significantly ($p < 0.05$) less likely to be virologically suppressed. Older individuals were more commonly prescribed ART ($p < 0.05$) and virologically suppressed ($p < 0.05$).

Discussion

This study used population-based data, representative of PLWH receiving care in a major US city and demographically similar to the larger US HIV-infected population [27, 28], to compare HIV outcomes between PLWH with and without mental illness in the modern ART era. In our sample, mental illness was common, occurring in almost half of the population (49 %). Our finding is consistent with earlier studies, which document the prevalence of mental illness among PLWH to be between 48 and 54 % [2, 8]. In our population, people with mental illness were retained in care and prescribed ART at similar rates to those without mental illness. However, individuals with a mental health diagnosis were significantly less likely to achieve HIV viral suppression than those without mental illness, a problem that has persisted despite being highlighted by research conducted more than 10 years ago [2, 11, 29]. These findings contribute to the existing literature on HIV infection and mental health by providing new information on the HIV care continuum for people with mental illness and highlighting the continued disparity in viral suppression among this population.

Interestingly, retention in care and prescription of ART were similarly high among those with and without mental illness—90–91 % retained in care and 83–89 % prescribed ART. When mental illness was grouped by severity, no statistically significant differences in retention in care and prescription of ART between severity groups were identified. These findings should be extrapolated in the context of the study population evaluated. MMP specifically selects persons engaged in HIV medical care and excludes individuals with no medical visits during the sampling period [27]. However, evaluations of similarly engaged HIV-infected populations note comparable results, with retention rates between 82 and 89 % [30, 31]. Historically, patients with mental illness have been less likely to be prescribed ART [32–34]. A study of 190 PLWH evaluated time to first protease inhibitor prescription after the first elevated HIV viral load (≥10,000 copies/mL) and reported that patients with a

history of depression [hazard ratio (HR) of 1.49, 95 % CI 1.03–2.13] and IDU (HR 2.70, 95 % CI 1.35–5.56) experienced significant delays in use of protease inhibitors [33]. Early in the modern ART era, a survey of US physicians noted that providers equally weighted objective findings (e.g. CD4 count, opportunistic infections) and subjective findings in making treatment initiation decisions [35]. Specifically, the majority (60–80 % of physicians) were reluctant to initiate ART among patients with a history of drug use or mental illness as their perception of patient adherence in that group was low [35]. Since that time, new HIV therapies and changes in treatment guidelines have improved treatment efficacy, side effects, and encouraged physicians to prescribe ART for the vast majority of patients [16, 17, 19, 36]. These changes may account for the similar rates of prescription of ART in both people with and without mental illness observed in our study.

Despite adequate engagement in care and prescription of ART, people with mental health diagnoses had lower rates of viral suppression than those without such diagnoses. When mental illness was grouped by severity, those with depressive/anxiety disorders were significantly less likely to achieve viral suppression than individuals without any mental illness. This finding is consistent with other studies noting worse health outcomes (e.g. cardiovascular disease, diabetes) in individuals with depression disorders compared to those without these conditions [37, 38]. A recent systematic review evaluating the impact of mental health disorders on ART adherence noted mixed results: 32 out of 62 studies (52 %) showed decreased ART adherence among patients with a diagnosis of depression, while 30 out of 62 studies (48 %) demonstrated no significant difference between those with and without depression [39]. Two out of 10 studies (20 %) showed decreased ART adherence for patients with either psychosis, bipolar, or personality disorder, compared to 8 out of 10 studies (80 %) that noted no significant difference between groups [39]. Additional research is needed to assess differences in viral suppression between individuals with mental illness on treatment, individuals with mental illness not on treatment, and those without mental illness, as this information was unavailable in our dataset.

Untreated mental illness can lead to poor adherence, persistent HIV viral replication, viral resistance, treatment failure, progression to AIDS, and increased mortality [29]. Data suggests that treating mental illness leads to improved HIV outcomes [11, 40–42]. A small number of clinical trials and observational studies have demonstrated that psychotherapy-based interventions or the use of antidepressants increases ART adherence among PLWH with mental illness [11, 40–42]. Possible solutions to improve viral suppression include frequent assessment of barriers to medication adherence, integration of HIV and mental health services, and effective treatment of mental illness [11, 39]. Integration of HIV and mental health care may be accomplished by (1) increasing mental health screening and treatment in infectious diseases and HIV clinics; (2) incorporating HIV care into mental health clinics; and (3) developing specific sub-specialty clinics serving persons with both HIV and mental illness. Multiple studies evaluating the integration of HIV prevention and medical care into mental health and substance abuse treatment programs are currently ongoing, including several funded through the Substance Abuse and Mental Health Services Agency (SAMHSA) Primary Behavioral Health Care Integration grant program [43]. One potentially useful method for achieving integration of HIV and mental care is the behavioral health home model. This model, based on the chronic care model, identifies self-

management support, delivery system design, decision support, clinical information systems, and community linkages as necessary elements to forming a system that encourages high-quality behavioral health management [44]. Substance use (IDU and alcohol abuse) did not impact viral suppression in this study. The existing literature shows mixed results on the association between substance use and viral suppression with some studies showing increased virological failure and others showing no difference [11, 45, 46]. Additional investigations are needed to determine if the type of drug use (stimulant or depressant) mediate this effect.

The current analysis has several limitations. First, MMP does not include a comprehensive evaluation of all mental illnesses, thus adults classified as having no mental illness may have had undiagnosed psychiatric disorders or disorders other than the ones examined. This may have underestimated the effect of mental illness on the outcomes. In addition, the severity of mental illness or past and ongoing mental health treatment was not captured in our dataset. This decreases the applicability of our findings. Datasets capturing this important information and additional research examining how mental illness severity and treatment impact HIV outcomes are needed. Second, our cohort only included persons engaged in HIV medical care. Future studies evaluating the impact of mental illness on the early steps of the HIV care continuum and on disengagement in care are needed. Third, we focused on adult patients in one city, which may limit the applicability of our findings to other regions of the country. Lastly, additional data are needed to better understand specific barriers to retention in care, prescription of ART, and viral suppression among individuals with mental health conditions and in mental health settings.

In conclusion, PLWH commonly experience mental illness. People with a diagnosis of mental illness achieved similar rates of retention in care and ART prescription compared to those without mental illness; but were less likely to be virologically suppressed. These findings add to the growing literature on the HIV care continuum, highlighting opportunities for optimizing HIV viral suppression.

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Appendix

See Appendix Table 5.

Table 5

Sensitivity analysis for viral suppression (all subjects with missing HIV-1 RNA measures were classified as not suppressed

Characteristics	Total N = 730	Weighted total N = 9409	Weighed Viral suppression N = 6226 (%)[a]	AOR (95 % CI)
Mental illness				
No	372	4802	3359 (69.95)	1.0 (Ref)
Yes	358	4607	2867 (62.23)	**0.70 (0.51, 0.96)**
Age (years)				
18-29	108	1390	669 (48.15)	1.0 (Ref)
30-39	121	1530	836 (54.65)	1.93 (0.96, 3.90)
40-49	274	3536	2434 (68.83)	**3.07 (1.88, 5.02)**
>49	227	2954	2287 (77.42)	**3.76 (2.23, 6.31)**
Sex				
Male	484	6243	4458 (71.41)	1.0 (Ref)
Female	246	3166	1768 (55.84)	**0.54 (0.38, 0.76)**
Race/ethnicity				
White	122	1572	1305 (83.04)	1.0 (Ref)
Black	482	6209	3774 (60.79)	**0.44 (0.22, 0.90)**
Hispanic	81	1059	755 (71.30)	0.78 (0.34, 1.79)
Other/unknown	45	569	391 (68.74)	0.44 (0.14, 1.36)
Insurance				
Private	145	1878	1462 (77.87)	1.00 (Ref)
Medicaid	381	4902	2946 (60.10)	0.69 (0.38, 1.24)
Medicare	69	879	650 (73.89)	1.11 (0.58, 2.14)
Ryan white/uninsured	48	619	448 (72.36)	1.37 (0.56, 3.35)
Other/unknown	87	1132	721 (63.72)	0.75 (0.32, 1.76)
CD4 cell count				
<201 cell/mm^3	125	1611	743 (46.10)	1.00 (Ref)
201-350 cell/mm^3	128	1659	1213 (73.15)	**3.31 (1.85, 5.92)**
351-500 cell/mm^3	123	1590	1147 (72.15)	**3.38 (1.85, 5.75)**
>500 cell/mm^3	316	4064	3111 (76.56)	**4.31 (2.49, 7.47)**
Unknown	38	486	12 (2.44)	0.02 (0.00, 0.18)
Alcohol abuse				
No	587	7571	5080 (67.10)	1.00 (Ref)
Yes	143	1838	1146 (62.35)	0.79 (0.47, 1.32)
Injection drug use				
No	641	8252	5411 (65.93)	1.0 (Ref)
Yes	89	1157	786 (67.90)	0.96 (0.54, 1.72)

Bold values indicate statistical significance ($p < 0.05$)

AOR adjusted odds ratio, *CI* confidence interval

[a] Weighted row percentages shown

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Table 1

Demographics and clinical characteristics of the sample and factors associated with mental illness

Characteristics	Total N = 730	Weighted total N = 9409 (%)	Mental illness diagnosis		AOR (95 % CI)
			Weighted without Mental illness N = 4802 (%)	Weighted with Mental illness N = 4607 (%)	
Age (years)					
18-29	108	1390 (14.77)	806 (16.78)	584 (12.67)	1.00 (Ref)
30-39	121	1530 (16.25)	734 (15.29)	795 (17.26)	1.59 (0.81, 3.13)
40-49	274	3536 (37.58)	1601 (33.34)	1935 (41.99)	1.46 (0.92, 2.31)
>49	227	2954 (31.40)	1661 (34.59)	1294 (28.08)	0.97 (0.56, 1.67)
Sex					
Male	484	6243 (66.35)	3506 (73.01)	2737 (59.41)	1.00 (Ref)
Female	246	3166 (33.65)	1296 (26.99)	1870 (40.59)	**1.84 (1.31, 2.58)**
Race/ethnicity					
White	122	1572 (16.71)	738 (15.38)	833 (18.09)	1.00 (Ref)
Black	482	6209 (65.99)	3346 (69.67)	2863 (62.14)	0.45 (0.29, 0.71)
Hispanic	81	1059 (11.26)	364 (7.59)	695 (15.08)	1.16 (0.64, 2.11)
Other/unknown	45	569 (6.05)	353 (7.36)	216 (4.68)	0.37 (0.16, 0.82)
Insurance					
Private	145	1878 (19.96)	1243 (25.89)	635 (13.78)	1.00 (Ref)
Medicaid	381	4902 (52.10)	2018 (42.02)	2884 (62.59)	**2.74 (1.61, 4.66)**
Medicare	69	879 (9.35)	413 (8.61)	466 (10.11)	**2.27 (1.26, 4.08)**
Uninsured	48	619 (6.57)	395 (8.22)	224 (4.86)	1.16 (0.51, 2.63)
Other/unknown	87	1132 (12.03)	733 (15.26)	399 (8.66)	1.06 (0.58, 1.92)
CD4 cell count					
<201 cell/mm^3	125	1611 (17.12)	860 (17.91)	751 (16.30)	1.00 (Ref)
201-350 cell/mm^3	128	1659 (17.63)	942 (19.62)	716 (15.55)	1.14 (0.64, 2.01)
351-500 cell/mm^3	123	1590 (16.90)	806 (16.81)	783 (16.99)	1.35 (0.63, 2.89)
>500 cell/mm^3	316	4064 (43.19)	1983 (41.30)	2081 (45.16)	1.50 (0.91, 2.45)
Unknown	38	486 (5.17)	210 (4.36)	277 (6.00)	2.22 (0.85, 5.78)
Alcohol abuse					
No	587	7571 (80.47)	4171 (86.86)	3400 (73.80)	1.00 (Ref)
Yes	143	1838 (19.53)	631 (13.14)	1207 (26.20)	**2.20 (1.56, 3.10)**
Injection drug use					
No	641	8252 (87.70)	4462 (92.93)	3790 (82.26)	1.00 (Ref)
Yes	89	1157 (12.30)	339 (7.07)	817 (17.74)	**2.31 (1.37, 3.89)**

Bold values indicate statistical significance ($p < 0.05$)

AOR adjusted odds ratio, *ART* antiretroviral therapy, *CI* confidence interval

Table 2

Unadjusted proportion of the sample retained in care, on ART, and virologically suppressed

Characteristics	Total N = 730	Weighted total N = 9409	HIV outcomes		
			Weighted Retention in care N = 8453 (%)[a]	Weighted Use of ART N = 8089 (%)[a]	Weighted Viral suppression N = 6226 (%)[a]
Mental illness					
No	372	4802	4336 (90.30)	4258 (88.67)	3359 (74.40)
Yes	358	4607	4207 (91.31)	3831 (83.15)	2867 (65.86)
Depression/anxiety	283	3651	3355 (91.88)	3041 (83.30)	2309 (67.20)
Bipolar	42	537	473 (88.00)	472 (87.85)	344 (67.34)
Psychosis	33	419	379 (90.54)	318 (75.88)	213 (52.72)
Age (years)					
18-29	108	1390	1236 (88.97)	1018 (73.25)	669 (51.43)
30-39	121	1530	1310 (85.66)	1377 (90.02)	836 (59.65)
40-49	274	3536	3227 (91.25)	2988 (84.49)	2434 (73.09)
>49	227	2954	2770 (93.76)	2707 (91.63)	2287 (80.67)
Sex					
Male	484	6243	5634 (90.25)	5612 (89.89)	4458 (74.99)
Female	246	3166	2908 (91.86)	2477 (78.23)	1768 (60.51)
Race/ethnicity					
White	122	1572	1443 (91.78)	1420 (90.32)	1305 (85.78)
Black	482	6209	5600 (90.20)	5311 (85.53)	3774 (65.14)
Hispanic	81	1059	994 (93.80)	901 (85.06)	755 (75.08)
Other/unknown	45	569	506 (88.95)	458 (80.39)	391 (71.68)
Insurance					
Private	145	1878	1718 (91.50)	1684 (89.68)	1462 (81.36)
Medicaid	381	4902	4549 (92.81)	4107 (83.79)	2946 (62.95)
Medicare	69	879	817 (92.92)	842 (95.72)	650 (76.05)
Ryan white/uninsured	48	619	567 (91.63)	541 (87.48)	448 (80.91)
Other/unknown	87	1132	892 (78.79)	915 (80.85)	721 (73.34)
CD4 cell count					
<201 cell/mm^3	125	1611	1479 (91.82)	1536 (95.35)	743 (47.28)
201-350 cell/mm^3	128	1659	1527 (92.06)	1476 (88.99)	1213 (73.74)
351-500 cell/mm^3	123	1590	1550 (97.48)	1365 (85.88)	1147 (72.70)
>500 cell/mm^3	316	4064	3815 (93.88)	3414 (84.02)	3111 (77.27)
Unknown	38	486	172 (35.38)	297 (61.17)	12 (24.98)
Alcohol abuse					
No	587	7571	6901 (91.15)	6555 (86.58)	5080 (71.34)
Yes	143	1838	1642 (89.33)	1534 (83.45)	1146 (65.61)
Injection drug use					
No	641	8252	7453 (90.31)	7113 (86.19)	5411 (70.32)

Characteristics	Total N = 730	Weighted total N = 9409	HIV outcomes		
			Weighted Retention in care N = 8453 (%)[a]	Weighted Use of ART N = 8089 (%)[a]	Weighted Viral suppression N = 6226 (%)[a]
Yes	89	1157	1090 (94.23)	976 (84.40)	786 (69.51)

ART antiretroviral therapy

[a]Proportions represent row percentages

Table 3

Multivariable logistic regression models of patient characteristics associated with retention in care, use of ART, and viral suppression

Characteristics	Retained in care AOR (95 % CI)	Use of ART AOR (95 % CI)	Viral suppression AOR (95 % CI)
Mental illness			
No	1.00 (Ref)	1.00 (Ref)	1.00 (Ref)
Yes	1.30 (0.63, 2.56)	0.79 (0.49, 1.25)	**0.64 (0.46, 0.90)**
Age (years)			
18-29	1.00 (Ref)	1.00 (Ref)	1.00 (Ref)
30-39	0.86 (0.41, 1.83)	**3.70 (1.65, 8.31)**	**2.05 (1.01, 4.15)**
40-19	1.46 (0.64, 3.34)	**2.26 (1.24, 4.11)**	**3.26 (1.98, 5.38)**
>49	1.93 (0.86, 4.35)	**3.79 (1.76, 8.16)**	**4.06 (2.39, 6.90)**
Sex			
Male	1.00 (Ref)	1.00 (Ref)	1.00 (Ref)
Female	1.32 (0.68, 2.58)	**0.45 (0.30, 0.67)**	**0.56 (0.33, 0.80)**
Race/ethnicity			
White	1.00 (Ref)	1.00 (Ref)	1.00 (Ref)
Black	0.97 (0.45, 2.13)	0.90 (0.45, 1.77)	**0.45 (0.22, 0.93)**
Hispanic	1.02 (0.27, 3.85)	0.79 (0.29, 2.19)	0.86 (0.39, 1.91)
Other/unknown	0.93 (0.24, 3.70)	0.56 (0.18, 1.75)	0.43 (0.14, 1.37)
Insurance			
Private	1.00 (Ref)	1.00 (Ref)	1.00 (Ref)
Medicaid	1.10 (0.53, 2.29)	0.88 (0.44, 1.75)	0.73 (0.40, 1.35)
Medicare	1.51 (0.51, 4.48)	2.69 (0.69, 10.46)	1.07 (0.57, 2.03)
Ryan white/uninsured	2.13 (0.52, 8.74)	1.06 (0.38, 2.97)	1.66 (0.62, 4.41)
Other/unknown	0.49 (0.22, 1.08)	0.65 (0.24, 1.76)	0.80 (0.32, 1.96)
CD4 cell count			
<201 cell/mm^3	1.00 (Ref)	1.00 (Ref)	1.00 (Ref)
201-350 cell/mm^3	1.08 (0.51, 2.29)	0.41 (0.15, 1.07)	**3.37 (1.89, 6.02)**
351-500 cell/mm^3	**3.52 (1.23, 10.13)**	**0.34 (0.14, 0.83)**	**3.37 (1.95, 5.83)**
>500 cell/mm^3	1.35 (0.59, 3.07)	**0.27 (0.11, 0.65)**	**4.40 (2.47, 7.83)**
Unknown	**0.06 (0.02, 0.14)**	**0.08 (0.03, 0.23)**	0.38 (0.06, 2.31)
Alcohol abuse			
No	1.00 (Ref)	1.00 (Ref)	1.00 (Ref)
Yes	0.72 (0.28, 1.85)	0.76 (0.40, 1.45)	0.75 (0.44, 1.27)
Injection drug use			
No	1.00 (Ref)	1.00 (Ref)	1.00 (Ref)
Yes	1.28 (0.48, 3.46)	0.73 (0.35, 1.54)	0.95 (0.53, 1.69)

Bold values indicate statistical significance ($p < 0.05$)

AOR adjusted odds ratio, *ART* antiretroviral therapy, *CI* confidence interval

Table 4

Multivariable logistic regression models of patient characteristics (using Mental Illness Severity Groups) associated with retention in care, use of ART, and viral suppression

Characteristics	Retained in care AOR (95 % CI)	Use of ART AOR (95 % CI)	Viral suppression AOR (95 % CI)
Mental illness			
No mental illness	1.00 (Ref)	1.00 (Ref)	1.00 (Ref)
Psychosis	1.28 (0.27, 5.98)	0.44 (0.12, 1.67)	0.38 (0.13, 1.07)
Bipolar	0.86 (0.23, 3.20)	1.28 (0.40, 4.05)	0.95 (0.41, 2.21)
Depression/anxiety	1.38 (0.70, 2.73)	0.81 (0.52, 1.25)	**0.65 (0.47, 0.91)**
Age (years)			
18-29	1.00 (Ref)	1.00 (Ref)	1.00 (Ref)
30-39	0.88 (0.42, 1.85)	**3.83 (1.71, 8.58)**	**2.09 (1.00, 4.37)**
40-19	1.50 (0.64, 3.52)	**2.27 (1.25, 4.12)**	**3.27 (1.98, 5.38)**
>49	1.93 (0.85, 4.36)	**3.89 (1.81, 8.39)**	**4.10 (2.42, 6.96)**
Sex			
Male	1.00 (Ref)	1.00 (Ref)	1.00 (Ref)
Female	1.32 (0.68, 2.58)	**0.43 (0.29, 0.66)**	**0.55 (0.38, 0.79)**
Race/ethnicity			
White	1.00 (Ref)	1.00 (Ref)	1.00 (Ref)
Black	0.95 (0.43, 2.09)	0.92 (0.46, 1.86)	**0.45 (0.22, 0.92)**
Hispanic	0.97 (0.26, 3.57)	0.80 (0.29, 2.22)	0.85 (0.39, 1.85)
Other/unknown	0.92 (0.24, 3.59)	0.57 (0.17, 1.87)	0.44 (0.13, 1.42)
Insurance			
Private	1.00 (Ref)	1.00 (Ref)	1.00 (Ref)
Medicaid	1.13 (0.53, 2.39)	0.89 (0.45, 1.78)	0.73 (0.40, 1.36)
Medicare	1.60 (0.55, 4.66)	2.62 (0.65, 10.63)	1.07 (0.56, 2.06)
Ryan white/uninsured	2.12 (0.52, 8.71)	1.08 (0.38, 3.05)	1.68 (0.62, 4.51)
Other/unknown	0.49 (0.22, 1.06)	0.66 (0.25, 1.79)	0.81 (0.33, 2.00)
CD4 cell count			
<201 cell/mm^3	1.00 (Ref)	1.00 (Ref)	1.00 (Ref)
201-350 cell/mm^3	1.08 (0.51, 2.27)	0.41 (0.16, 1.08)	**3.42 (1.90, 6.13)**
351-500 cell/mm^3	**3.52 (1.24, 10.03)**	**0.34 (0.14, 0.82)**	**3.40 (1.96, 5.89)**
>500 cell/mm^3	1.34 (0.59, 3.05)	**0.28 (0.12, 0.66)**	**4.54 (2.53, 8.15)**
Unknown	**0.06 (0.02, 0.14)**	**0.08 (0.03, 0.23)**	0.35 (0.06, 2.26)
Alcohol abuse			
No	1.00 (Ref)	1.00 (Ref)	1.00 (Ref)
Yes	0.73 (0.28, 1.89)	0.78 (0.40, 1.52)	0.76 (0.45, 1.29)
Injection drug use			
No	1.00 (Ref)	1.00 (Ref)	1.00 (Ref)
Yes	1.32 (0.49, 3.55)	0.67 (0.31, 1.46)	0.89 (0.50, 1.61)

Bold values indicate statistical significance ($p < 0.05$)

AOR adjusted odds ratio, *ART* antiretroviral therapy, *CI* confidence interval