HHS Public Access

Author manuscript

J Neurovirol. Author manuscript; available in PMC 2024 April 30.

Published in final edited form as:

J Neurovirol. 2023 June ; 29(3): 331–336. doi:10.1007/s13365-022-01100-4.

HIV viremia contributes to neurocognitive impairments in persons who use cocaine

Kareem Al-Khalil[1,*], **Sheri L. Towe**[1], **Taylor P. Ikner**[2], **Christina S. Meade**[1]

[1]Department of Psychiatry and Behavioral Sciences, School of Medicine, Duke University, Durham, NC, USA.

[2]College of Liberal and Professional Studies, University of Pennsylvania, Philadelphia, PA, USA.

Abstract

Persons with HIV (PWH) who use illicit drugs are at elevated risk for neurocognitive impairment (NCI). This study investigated the effects of HIV disease and HIV viremia on NCI among adults who use cocaine. PWH who were not virologically suppressed showed greater global deficits compared to participants with HIV viral suppression and HIV-negative participants, but no differences emerged between the latter two groups. These findings highlight the adverse effects of poorly-controlled HIV disease on NCI, beyond the independent effects of cocaine on cognition, and underscore the importance of strengthening the HIV care continuum for persons who use cocaine.

Keywords

Viral load; viral suppression; HIV; cocaine use; neuropsychological impairment

INTRODUCTION

Neurological complications of HIV disease are a persistent clinical problem, and the resulting neurocognitive impairment (NCI) can adversely impact daily living, including employment, driving, and medication adherence (Anand et al. 2010; Cattie et al. 2012; Laverick et al. 2017). Even with highly effective combination antiretroviral therapy (cART), up to half of patients will experience NCI (Gates & Cysique, 2016; Saylor et al. 2016). In 2019, the United States launched its *Ending the HIV Epidemic* plan, an ambitious initiative to reduce the burden of HIV in high incidence areas (Fauci et al. 2019). Despite the widespread availability of cART, an estimated 35% of people with HIV (PWH) in the United States do not achieve sustained viral suppression (VS) (CDC, 2020). The HIV care continuum consists of several steps to achieve VS, including HIV diagnosis, linkage to and retention in HIV care, and consistent use of cART (Gardner et al. 2011; Cheever, 2007). Although cognitive deficits remain in PWH who have sustained VS, likely due to persistent

*Corresponding Author: kareem.alkhalil@duke.edu, 919-681-9289.

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

low-grade immune activation (Gott et al. 2017), poorly controlled HIV disease may increase the risk of NCI (Heaton et al. 2015).

Cocaine use is prevalent in PWH (Shiau et al. 2017). Persons who use cocaine are more likely to fall out of each step of the HIV care continuum (Parsons et al. 2014; Gwadz et al. 2016; Wechsberg et al. 2017), and are susceptible to virologic failure (Rasbach et al. 2013; Tolson et al. 2018). Chronic cocaine use is associated with deficits in many cognitive domains, including working memory, psychomotor performance, and executive function (Potvin et al. 2014; Spronk et al. 2013). Prior research has also documented the additive effects of HIV disease and cocaine use on cognitive function (Meade et al. 2015). However, these studies did not differentiate the role of unsuppressed HIV viremia independent of underlying effects of cocaine use on cognition, which may be a driver of observed disparities.

The present study investigated the effects of HIV disease on NCI in persons who use cocaine. Comparisons of neurocognitive functioning were made between PWH with (COC+HIV+VS+) and without (COC+HIV+VS-) VS and an HIV-negative comparison group (COC+HIV-). To increase the representativeness of the sample, we utilized community-based recruitment strategies, including peer referral, to reach PWH irrespective of current engagement in HIV care. Our primary hypothesis was that HIV disease would be associated with cognitive deficits, and that these deficits would be greatest in COC+HIV+VS-. A secondary goal was to characterize COC+HIV+VS- to identify potential contributors that could be targeted in interventions to improve HIV clinical outcomes.

METHODS

The sample included 197 adults with and without HIV who were 18–64 years old, had a history of regular cocaine use for >1 year, and used cocaine in the past 90 days. HIV-negative status was verified via an OraQuick® rapid HIV test conducted at the screening, and HIV-positive status was verified by medical record review (to ensure confirmatory testing). Exclusion criteria were: English non-fluency or illiteracy, serious neurological conditions (including opportunistic brain infections), physical disabilities impeding participation, and inability to provide informed consent.

Participants were recruited from the Raleigh-Durham area of North Carolina, USA between October 2016 and December 2018 via flyers posted in community-based organizations and infectious diseases clinics, a contact repository, and participant referrals. After clearing a brief prescreening interview, interested individuals were invited for a comprehensive in-person screening that included clinical interviews, computerized questionnaires, and a urine toxicology screen. Eligible participants returned on another day to complete neuropsychological testing, additional clinical interviews and questionnaires, and another urine drug test. Participants were paid $60 for the screening and $65 for the assessment visit. Study procedures were approved by the institutional review board at Duke University Health System, and participants provided written informed consent.

Screening measures.

The Addiction Severity Index-Lite assessed lifetime substance use and associated impairments (McLellan et al. 1992). Timeline follow-back methodology was used to assess frequency of substance use in the past 90 days (Robinson et al. 2014; Sobell & Sobell, 1992). Self-report of recent drug use was corroborated with an 11-panel urine toxicology screen for cannabis, cocaine, opioids, methamphetamine, amphetamine, benzodiazepines, barbiturates, methadone, oxycodone, buprenorphine, and ecstasy. Module E of the Structured Clinical Interview for DSM-5 was administered to identify substance use disorders in the past 12 months (First et al. 2015). For cocaine use disorder (CUD), the total number of symptoms endorsed, ranging from 0 to 11, was summed to indicate severity. The Word Reading subtest of the Wide Range Achievement Test-4 was used as a screen for literacy (Wilkinson & Robertson, 2006). PWH reported HIV diagnosis dates, acquisition routes, and current antiretroviral (ARV) treatment. Adherence to ARV medications in the past 30 days was assessed using a visual analogue scale (VAS) of 0–100% (Giordano et al. 2004), and a cutoff of ≥90% was used for adherence (Garofalo et al. 2016). Finally, demographics and medical histories were obtained from computerized surveys.

Neuropsychological testing.

Participants completed the following neuropsychological tests:

1. Grooved Pegboard Test, dominant hand – number of seconds to completion (Klove 1963).
2. Trail Making Test, Part A – number of seconds to completion (Reitan and Wolfson 1993).
3. Hopkins Verbal Learning Test – Revised (HVLT-R) –number of words recalled on trials 1–3 (Brandt and Benedict 2001).
4. Stroop Color and Word Test, interference score – difference between actual and predicted score on the Color-Word trial (Golden 1978).
5. FAS letter fluency – number of words generated (Benton et al. 1983).
6. Paced Auditory Serial Addition Task-50 – number correct (Diehr et al. 2003).

Although brief to minimize burden on participants, the chosen neuropsychological battery covers the primary domains affected by HIV, including executive function, information processing speed, and motor skills (Reger et al., 2002; Heaton et al., 2004). Using up-to-date published norms, raw scores were converted to demographically corrected T-scores (M=50, SD=10) (Diehr et al. 2003; Heaton et al. 2004; Stern and White 2009). Each case was scored by two research assistants with any discrepancies resolved by a third research assistant re-scoring the case. T-scores were converted to deficit scores using a 0–5 rating, with 0 reflecting no impairment and 5 reflecting severe impairment (T ≥40 = 0, 35–39 = 1, 30–34 = 2, 25–29 = 3, 20–24 = 4, and <20 = 5). By assigning a zero-point value to T-scores within or above one standard deviation of the mean, deficit scores give less weight to performances that are within normal limits and provide a more accurate characterization of impairment. Global deficit scores (GDS) were computed by averaging the deficit scores for each assessment, and then normalized with square-root transformations.

Medical record review.

Participants provided a release for us to obtain copies of their healthcare records. This information was used to confirm no exclusionary conditions, and to abstract relevant data, including HIV disease characteristics, such as VL and CD4 T-cell counts. VS was defined as <200 copies/mL (Phillips 2020). Additionally, Veterans Aging Cohort Study (VACS) Index 2.0 scores were calculated using relevant measures from the medical records, with higher scores indicating greater mortality risks in PWH (Tate et al. 2019).

Data analysis.

To characterize the sample and identify potential confounding variables, we compared the groups using one-way Analysis of Variance (ANOVA) and chi square for continuous and categorical variables, respectively. Due to the zero-inflation, cognitive deficit scores were analyzed using Tobit models in R Studio (R: Tobit Regression [r-project.org]). Using left-censoring of zeros, a Tobit regression was conducted with GDS as the dependent variable and group as the independent variable with COC+HIV+VS− as the reference. Post-hoc analyses were also conducted to compare COC+HIV+VS+ with COC+HIV-. Age, CUD symptoms, and days of cocaine use were added as covariates because these variables significantly differed between groups.

RESULTS

Sample characteristics (Table 1).

The sample consisted of 197 participants (56% men, 93% African American) with a mean age of 48.2 years (SD=9.6) and education of 11.9 years (SD=2.1). The groups were similar in race, education, years of regular cocaine use, route of cocaine administration, and current use of other substances. However, there were group differences on age, biological sex, frequency of current cocaine use, and CUD symptoms. Post-hoc t-tests revealed that the COC+HIV+VS+ group was significantly older than the COC+HIV+VS− group, $t(194) = 2.77$, $p < 0.05$, and that they had a greater proportion of men compared to COC+HIV− group, $\chi^2(1) = 6.70$, $p < 0.05$. COC+HIV+VS+ also endorsed fewer CUD symptoms, $t(194) = 2.92$, $p < 0.05$, and less frequent cocaine use, $t(194) = 3.19$, $p < 0.01$, compared to COC+HIV-.

Neurocognitive deficits (Table 1).

Overall, cognitive impairment was quite high in our sample (untransformed GDS: Mean = 0.65; SD = 0.52). Tobit regression results revealed significantly higher GDS in COC+HIV+VS− relative to both COC+HIV+VS+, B (SE) = 0.30 (0.11), $p < 0.01$, and COC+HIV-, B (SE) = 0.22 (0.10), $p < 0.05$. Post-hoc comparisons revealed no differences in cognitive deficit scores between the COC+HIV+VS+ and COC+HIV− groups, B (SE) = −0.07 (0.07), p=0.27. Furthermore, GDS were not significantly associated with cocaine use, (B (SE) = −0.002 (0.001), p=0.17), or with CUD symptoms, (B (SE) = 0.008 (0.011), p=0.49).

HIV characteristics (Table 1).

The PWH in the current sample had been diagnosed with HIV for a median of 15 years, and many had a history of severe immuno-suppression (median nadir CD4 = 193 count/μL; 50.6% <200), but most were currently asymptomatic (median current CD4: 662 count/μL; 93% currently taking cART). There were no group differences in proportion of CD4 nadir < 200, years of HIV diagnosis, or routes of HIV acquisition. As expected, ARV prescription and adherence rates were higher in COC+HIV+VS+ than COC+HIV+VS-, as was current CD4 count. VACS Index 2.0 scores were significantly higher in COC+HIV+VS− compared to COC+HIV+VS+, but these differences were not significant when scores were calculated without viral load.

DISCUSSION

Our primary finding is that VS among PWH who use cocaine may protect against additional cognitive impairment related to HIV disease, independent of deficits related to ongoing cocaine use. PWH who use cocaine and other drugs are more likely to fall out of each step of the HIV care continuum (Gwadz et al. 2016; Wechsberg et al. 2017), resulting in poorer HIV clinical outcomes (Arnsten et al. 2002; Lucas et al. 2002; Baum et al. 2009). Differences in VACS scores between COC+HIV+VS+ and COC+HIV+VS− were driven by viral load differences. Even though cognitive impairment was quite prevalent among our participants, as consistent with their prolonged cocaine use (median lifetime use = 17 years), the current study supports the importance of achieving and maintaining VS among persons who use drugs to protect against additional cognitive impairment.

While abstinence from cocaine and other illicit drugs is recommended to minimize adverse health outcomes, many people continue to use drugs for a variety of reasons, including limited access to substance use treatment (Foster et al. 2010; Priester et al. 2016), high relapse rates (Dutra et al. 2008), and desire to use. Our results demonstrate that many people who use cocaine and other drugs do achieve VS despite ongoing use. In this sample, the majority of PWH (77%) had VS; these participants were more likely to be on cART and to adhere to their medications. Achieving optimal HIV clinical outcomes does not necessitate abstinence from substance use, but interventions focusing on HIV care retention are critical (Pan et al. 2019; Metsch et al. 2016; Stitzer et al. 2017). For example, contingency management strategies, which are effective in supporting abstinence from drugs of abuse, have also been found successful in achieving VS in PWH (Burch et al., 2017). Our results suggest that such interventions may be particularly indicated for younger PWH with more severe CUD.

Research has linked plasma markers of immune activation, inflammation, and dysregulated metabolism with HIV-related NCI (Zayyad & Spludich, 2015; Lentz et al., 2011). Further, cocaine use has detrimental effects on neuro-inflammatory markers in PWH, and consequent HIV-related NCI (Cai et al., 2016; Cisneros et al., 2018) even among those with VS (Chilunda et al., 2019). Indeed, there may some residual impact of cocaine use on immune dysregulation in the COC+HIV+VS+ that could further amplify the risk for NCI.

The urgency to promote treatment access and sustained VS in PWH who use cocaine cannot be overstated. This work provides additional evidence that PWH who use stimulants can achieve VS, they are likely to do so more slowly (Chilunda et al., 2019; Cisneros et al., 2018; Cai et al., 2016) and remain at higher risk for virologic rebound compared to PWH without substance use (Boucoiran et al., 2017). As such, PWH who use cocaine need more intensive intervention to improve linkage and retention to care in order to ensure sustained VS despite ongoing substance use.

A key strength of this study was the use of community-based recruitment strategies to reach a more representative sample of people irrespective of engagement in HIV care. At the same time, the current study is limited by its cross-sectional design, which cannot ascertain the temporal relationship between HIV disease and cognitive deficits. This study also did not include a comparison group of participants who did not use cocaine as the effects of cocaine on cognition are well documented. Another limitation is the small number of COC+HIV+VS+ participants in the current sample, which warrants replication studies.

In sum, among adults with regular cocaine use, PWH who have achieved VS performed equivalently to HIV-negative counterparts on a neurocognitive assessment battery, underscoring the importance of adherence to cART. However, PWH who had unsuppressed viremia did evidence greater cognitive deficits, despite their relatively younger age. Future studies should investigate longitudinal effects of HIV viremia and illicit drug use on cognitive functioning to ascertain more explanatory relationships between these variables.

Acknowledgements:

The authors thank all the individuals who participated in this study.

Funding:

This study was funded by the National Institute of Health.

REFERENCES

Anand P, Springer SA, Copenhaver MM, Altice FL. (2010). Neurocognitive impairment and HIV risk factors: A reciprocal relationship. AIDS and Behavior, 14(6), 1213–1226. [PubMed: 20232242]

Arnsten JH, Demas PA, Grant RW, Gourevitch MN, Farzadegran H, Howard AA, Schoenbaum EE. (2002). Impact of active drug use on antiretroviral therapy adherence and viral suppression in HIV-infected drug users. Journal of General Internal Medicine, 17(5), 377–381. [PubMed: 12047736]

Baum MK, Rafie C, Lai S, Sales S, Page B, Campa A (2009). Crack-cocaine use accelerates HIV disease progression in a cohort of HIV-positive drug users. J Acquir Immune Defic Syndr, 50, 93–99. [PubMed: 19295339]

Benton A, Hamsher K, Sivan A (1983). Multilingual Aphasia Examination, third ed. AJA Associates, Iowa City, IA.

Boucoiran I, Albert A, Tulloch K, Wagner EC, Pick N, van Schalkwyk J, Harrigan PR, & Money D (2017). Human Immunodeficiency Virus Viral Load Rebound Near Delivery in Previously Suppressed, Combination Antiretroviral Therapy-Treated Pregnant Women. Obstetrics and gynecology, 130(3), 497–501. 10.1097/AOG.0000000000002133 [PubMed: 28796673]

Brandt J, Benedict RHB (2001). Hopkins Verbal Learning Test — Revised Professional Manual. Psychological Assessment Resources, Inc, Lutz, FL.

Burch AE, Rash CJ, Petry NM (2017). Cocaine-using substance abuse treatment patients with and without HIV respond well to contingency management treatment. Journal of substance abuse treatment, 77, 21–25. 10.1016/j.jsat.2017.03.001 [PubMed: 28476266]

Cai Y, Yang L, Callen S, & Buch S (2016). Multiple Faceted Roles of Cocaine in Potentiation of HAND. Current HIV research, 14(5), 412–416. 10.2174/1570162x14666160324125158 [PubMed: 27009095]

Cattie JE, Doyle K, Weber E, Grant I, Woods SP (2012). Planning deficits in HIV-associated neurocognitive disorders: component processes, cognitive correlates, and implications for everyday functioning. Journal of Clinical and Experimental Neuropsychology, 34(9), 906–918. [PubMed: 22731608]

Centers for Disease Control and Prevention. (2020). Monitoring selected national HIV prevention and care objectives by using HIV surveillance data—United States and 6 dependent areas, 2018. HIV Surveillance Supplemental Report, 25(2). http://www.cdc.gov/hiv/library/reports/hiv-surveillance.html. Accessed September, 2021.

Cheever LW. (2007) Engaging HIV-infected patients in care: their lives depend on it. Clinical Infectious Diseases, 44, 1500–1502. [PubMed: 17479949]

Chilunda V, Calderon TM, Martinez-Aguado P, & Berman JW (2019). The impact of substance abuse on HIV-mediated neuropathogenesis in the current ART era. Brain research, 1724, 146426. 10.1016/j.brainres.2019.146426 [PubMed: 31473221]

Cisneros IE, Erdenizmenli M, Cunningham KA, Paessler S, & Dineley KT (2018). Cocaine evokes a profile of oxidative stress and impacts innate antiviral response pathways in astrocytes. Neuropharmacology, 135, 431–443. 10.1016/j.neuropharm.2018.03.019 [PubMed: 29578037]

Diehr MC, Cherner M, Wolfson TJ, Miller SW, Grant I, Heaton RK (2003). The 50 and 100 item short forms of the Paced Auditory Serial Addition Task (PASAT): demographically corrected norms and comparisons with the full PASAT in normal and clinical samples. J.Clin.Exp.Neuropsychol 25,571–585, 10.1076/jcen.25.4.571.13876. [PubMed: 12911108]

Dutra L, Stathopoulou G, Basden SL, Leyro TM, Powers MB, Otto MW (2008). A meta-analytic review of psychosocial interventions for substance use disorders. The American journal of psychiatry, 165, 179–187. [PubMed: 18198270]

Fauci AS, Redfield RR, Sigounas G, Weahkee MD, Giroir BP (2019). Ending the HIV epidemic: a plan for the United States. JAMA, 321(9), 844–845. [PubMed: 30730529]

First MB, Williams JBW, Karg RS, Spitzer RL (2015). Structured Clinical Interview for DSM-5—Research Version (SCID-5 for DSM-5, Research Version; SCID-5-RV). Arlington, VA: American Psychiatric Association.

Foster S, LeFauve C, Kresky-Wolff M, Rickards L (2010). Services and supports for individuals with co-occurring disorders and long-term homelessness. Journal of Behavioral Health Services Research;37(2):239–251. [PubMed: 19768552]

Gardner EM, McLees MP, Steiner JF, Del Rio C, Burman WJ. (2011). The spectrum of engagement in HIV care and its relevance to test-and-treat strategies for prevention of HIV infection. Clinical Infectious Diseases, 52, 793–800. doi:10.1093/cid/ciq243. [PubMed: 21367734]

Garofalo R, Kuhns LM, Hotton A, Johnson A, Muldoon A, Rice D (2016). A Randomized Controlled Trial of Personalized Text Message Reminders to Promote Medication Adherence Among HIV-Positive Adolescents and Young Adults. AIDS and behavior, 20(5), 1049–1059. [PubMed: 26362167]

Gates TM, Cysique LA (2016). The chronicity of HIV infection should drive the research strategy of neuroHIV treatment studies: a critical review. Central Nervous System Drugs, 30(1), 53–69.

Giordano TP, Guzman D, Clark R, Charlebois ED, Bangsberg DR (2004). Measuring adherence to antiretroviral therapy in a diverse population using a visual analogue scale. HIV Clin Trials, 5(2):74–79. [PubMed: 15116282]

Golden CJ (1978). Stroop Color and Word Test. Stoelting, Chicago, IL.

Gott C, Gates T, Dermody N, Brew BJ, Cysique LA (2017). Cognitive change trajectories in virally suppressed HIV-infected individuals indicate high prevalence of disease activity. PLoS ONE, 12(3), e0171887. [PubMed: 28264037]

Gwadz M, de Guzman R, Freeman R, Kutnick A, Silverman E, Leonard NR, Ritchie AS, Munoz-Plaza C, Salomon D, Wolfe H, Hilliard C, Cleland CM, Honig S (2016). Exploring how substance use impedes engagement along the HIV Care Continuum: A qualitative study. Frontiers Public Health, 4:62.

Heaton RK, Franklin DR Jr., Deutsch R, Letendre S, Ellis RJ, Casaletto K, Marquine M, Woods S, Vaida F, Atkinson J, Marcotte T, McCutchan J, Collier A, Marra C, Clifford D, Gelman B, Sacktor N, Morgello S, Simpson D, Abransom I, Gamst A, Fennema-Notestine C, Smith D, Grant I (2015). Neurocognitive change in the era of HIV combination antiretroviral therapy: the longitudinal CHARTER study. Clinical Infectious Diseases, 60(3), 473–480. [PubMed: 25362201]

Heaton RK, Marcotte TD, Mindt MR, Sadek J, Moore DJ, Bentley H, … Grant I(2004). The impact of HIV-associated neuropsychological impairment on everyday functioning. Journal of the International Neuropsychological Society, 10(3), 317–331. [PubMed: 15147590]

Klove H (1963). Grooved Pegboard. Lafayette Instruments, Lafayette, IN.

Laverick R, Haddow L, Daskalopoulou M, Lampe F, Gilson R, Speakman A, … Rodger A (2017). Self-reported decline in everyday function, cognitive symptoms, and cognitive function in people with HIV. Journal of Acquired Immune Deficiency Syndromes, 76(3), e74–e83. [PubMed: 29016449]

Lentz MR, Kim WK, Kim H, Soulas C, Lee V, Venna N, Halpern EF, Rosenberg ES, Williams K, & González RG (2011). Alterations in brain metabolism during the first year of HIV infection. Journal of neurovirology, 17(3), 220–229. 10.1007/s13365-011-0030-9 [PubMed: 21494901]

Lucas GM, Gebo KA, Chaisson RE, Moore RD (2002). Longitudinal assessment of the effects of drug and alcohol abuse on HIV-1 treatment outcomes in an urban clinic. AIDS, 16(5), 767–774. [PubMed: 11964533]

McLellan AT, Alterman AI, Cacciola J, Metzger D, O'Brien CP (1992). A new measure of substance abuse treatment. Initial studies of the treatment services review. J Nerv Ment Dis, 180(2), 101–110. [PubMed: 1737971]

Meade CS, Towe SL, Skalski LM, Robertson KR. (2015). Independent effects of HIV infection and cocaine dependence on neurocognitive impairment in a community sample living in the southern United States. Drug and Alcohol Dependence, 149, 128–135. [PubMed: 25697913]

Metsch LR, Feaster DJ, Gooden L, Matheson T, Stitzer M, Das M, Jain MK, Rodriguez AE, Armstrong WS, Lucas GM, Nijhawan AE, Drainoni ML, Herrera P, Vergara-Rodriguez P, Jacobson JM, Mugavero MJ, Sullivan M, Daar ES, McMahon DK, Ferris DC, … del Rio C (2016). Effect of Patient Navigation With or Without Financial Incentives on Viral Suppression Among Hospitalized Patients With HIV Infection and Substance Use: A Randomized Clinical Trial. JAMA, 316(2), 156–170. 10.1001/jama.2016.8914 [PubMed: 27404184]

Pan Y, Metsch LR, Gooden LK, Philbin MM, Daar ES, Douaihy A, Jacobs P, Del Rio C, Rodriguez AE, & Feaster DJ (2019). Viral suppression and HIV transmission behaviors among hospitalized patients living with HIV. International journal of STD & AIDS, 30(9), 891–901. 10.1177/0956462419846726 [PubMed: 31159715]

Parsons JT, Starks TJ, Millar BM, Boonrai K, Marcotte D (2014). Patterns of substance use among HIV-positive adults over 50: Implications for treatment and medication adherence. Drug and Alcohol Dependence, 139, 33–40. [PubMed: 24745475]

Phillps J (2020). What you need to know about the 6 EHE indicators: The AHEAD Dashboard. What You Need to Know About the 6 EHE Indicators: The AHEAD Dashboard | HIV.gov

Potvin S, Stavro K, Rizkallah E, Pelletier J (2014). Cocaine and cognition: A systematic quantitative review. Journal of Addiction Medicine, 8(5), 368–376. [PubMed: 25187977]

Priester MA, Browne T, Iachini A, Clone S, DeHart D, Seay KD (2016). Treatment Access Barriers and Disparities Among Individuals with Co-Occurring Mental Health and Substance Use Disorders: An Integrative Literature Review. Journal of substance abuse treatment, 61, 47–59. [PubMed: 26531892]

Rasbach DA, Desruisseau AJ, Kipp AM, Stinnette S, Kheshti A, Shepherd BE, … Qian HZ (2013). Active cocaine use is associated with lack of HIV-1 virologic suppression independent of nonadherence to antiretroviral therapy: use of a rapid screening tool during routine clinic visits. AIDS Care, 25(1), 109–117. [PubMed: 22670566]

Reger M, Welsh R, Razani J, Martin DJ, & Boone KB (2002). A meta-analysis of the neuropsychological sequelae of HIV infection. Journal of the International Neuropsychological Society: JINS, 8(3), 410–424. 10.1017/s1355617702813212. [PubMed: 11939699]

Reitan RM, Wolfson D (1993). The Halstead–Reitan Neuropsychological Test Battery: Theory and Clinical Interpretation, second ed. Neuropsycholgy Press, Tucson, AZ.

Robinson SM, Sobell LC, Sobell MB, Leo GI. (2014). Reliability of the Timeline Followback for cocaine, cannabis, and cigarette use. Psychol Addict Behav, 28(1), 154–162. [PubMed: 23276315]

Saylor D, Dickens AM, Sacktor N, Haughey N, Slusher B, Pletnikov M, … McArthur JC (2016). HIV-associated neurocognitive disorder - pathogenesis and prospects for treatment. Nature Reviews Neurology, 12(5), 309.

Shiau S, Arpadi SM, Yin MT, Martins SS (2017). Patterns of drug use and HIV infection among adults in a nationally representative sample. Addictive Behaviors, 68, 39–44. [PubMed: 28088742]

Sobell LC, Sobell MB. (1992). Timeline Follow-back: A technique for assessing self-reported ethanol consumption. In Allen J Litten RZ (Eds.), Measuring Alcohol Consumption: Psychosocial and Biological Methods (pp. 41–72). Totowa, NJ: Humana Press.

Spronk DB, van Wel JHP, Ramaekers JG, Verkes RJ (2013). Characterizing the cognitive effects of cocaine: A comprehensive review. Neuroscience Biobehavioral Reviews, 37(8), 1838–1859. [PubMed: 23876288]

Stern RA, White T (2009). NAB Digits Forward/Digits Backward Test: Professional Manual. Psychological Assessment Resources,Inc. Lutz,FL.

Stitzer M, Matheson T, Cunningham C, Sorensen JL, Feaster DJ, Gooden L, Hammond AS, Fitzsimons H, & Metsch LR (2017). Enhancing patient navigation to improve intervention session attendance and viral load suppression of persons with HIV and substance use: a secondary post hoc analysis of the Project HOPE study. Addiction science & clinical practice, 12(1), 16. 10.1186/s13722-017-0081-1 [PubMed: 28651612]

Tate JP, Sterne JAC, Justice AC; Veterans Aging Cohort Study (VACS) and the Antiretroviral Therapy Cohort Collaboration (ART-CC) (2019). Albumin, white blood cell count, and body mass index improve discrimination of mortality in HIV-positive individuals. AIDS, 33, 903–912. doi: 10.1097/QAD.0000000000002140. [PubMed: 30649058]

Tolson C, Richey LE, Zhao Y, Korte JE, Brady K, Haynes L, Meissner EG (2018). Association of substance use with hospitalization and virologic suppression in a southern academic HIV clinic. The American Journal of the Medical Sciences, 355(6), 553–558. [PubMed: 29891038]

Wechsberg WM, van der Horst C, Ndirangu J, Doherty IA, Kline T, Browne FA, Belus JM, Nance R, & Zule WA (2017). Seek, test, treat: substance-using women in the HIV treatment cascade in South Africa. Addiction science & clinical practice, 12(1), 12. 10.1186/s13722-017-0077-x [PubMed: 28441975]

Wilkinson GS, Robertson GJ. (2006). Wide Range Achievement Test–4 (WRAT-4). Lutz, FL: Psychological Assessment Resources.

Zayyad Z, & Spudich S (2015). Neuropathogenesis of HIV: from initial neuroinvasion to HIV-associated neurocognitive disorder (HAND). Current HIV/AIDS Reports, 12(1), 16–24. doi:10.1007/s11904-014-0255-3 [PubMed: 25604237]

Table 1.

Sample characteristics by study grouping.

	COC+HIV− (n=116)	COC+HIV+VS+ (n=62)	COC+HIV+VS− (n=19)	Statistics	p-value
Sample characteristics					
Age, M (SD)	48.01 (9.56)	50.16 (8.82)	43.32 (10.62)	F(2,194)=3.90	0.022[c]
Male, n (%)	59 (51%)	44 (71%)	9 (47%)	$\chi(2)^2$=7.43	0.024[a]
African American, n (%)	107 (92%)	58 (94%)	18 (95%)	FET=0.14	1.000
Education in years, M (SD)	12.00 (1.98)	11.82 (2.15)	11.32 (2.21)	F(2,194)=0.94	0.394
Cocaine use characteristics					
Route of administration, n (%)				FET=1.120	0.568
Nasal	22 (19%)	16 (26%)	4 (21%)		
Smoking	94 (81%)	46 (74%)	15 (79%)		
Cocaine use disorder symptoms, M (SD)	7.05 (2.59)	5.77 (2.99)	6.26 (3.25)	F(2,194)=4.38	0.014[a]
Years of regular cocaine use, M (SD)	18.12 (9.66)	18.23 (11.13)	16.21 (9.52)	F(2,194)=0.32	0.727
Days of cocaine use in past 90, M (SD)	38.95 (27.86)	25.58 (23.80)	35.89 (27.48)	F(2,194)=5.13	0.007[a]
Positive UDS, n (%)	95 (82%)	49 (79%)	16 (89%)	FET=0.76	0.694
Days of other substance use (past 90)					
Alcohol use, M (SD)	37.34 (31.89)	32.89 (29.62)	26.32 (29.30)	F(2,194)=1.22	0.297
Marijuana use, M (SD)	21.59 (33.11)	29.19 (35.14)	23.41 (34.68)	F(2,194)=1.02	0.362
Opioid, M (SD)	5.91 (17.05)	2.15 (11.02)	1.11 (2.31)	F(2,194)=1.86	0.159
Neurocognitive Functioning					
Global Deficit Score, M (SD)	0.63 (0.45)	0.58 (0.53)	1.0 (0.72)	$\chi^2(2)$ = 8.79	0.012[b,c]
HIV Characteristics					
Years since HIV diagnosis, Median (IQR)	N/A	15.00 (15)	13.50 (17)	U = 501.00	0.718
HIV acquisition route, N (%)	N/A			FET = 1.98	0.568
MSM		23 (41%)	5 (31%)		
Heterosexual sex		27 (48%)	10 (63%)		
Injection drug use		4 (7%)	0 (0%)		
Other		2 (4%)	1 (6%)		

	COC+HIV− (n=116)	COC+HIV+VS+ (n=62)	COC+HIV+VS− (n=19)	Statistics	p-value
Nadir CD4 count, Median (IQR)	N/A	196 (322)	193 (435)	U = 576.50	0.889
Proportion with Nadir CD4 < 200, N (%)	N/A	31 (50%)	10 (52.6%)	$\chi^2(1) = 0.40$	0.841
Current CD4 count, Median (IQR)	N/A	695 (454)	469 (589)	U = 280.50	<0.001
Currently taking ARVs, N (%)	N/A	62 (100%)	13 (68%)	$\chi^2(1) = 21.15$	<0.001
≥90% adherence to ARV, N (%)[1]	N/A	50 (81%)	5 (39%)	$\chi^2(1) = 9.80$	0.002
VACS Index 2.0 score, Median (IQR)	N/A	46.04 (19.69)	60.93 (24.73)	U = 913	<0.001
VACS without VL, Median (IQR)	N/A	49.97 (15.81)	57.36 (23.66)	U=754	0.066

Pairwise differences from post-hoc tests:

[a] COC+HIV− ≠ COC+HIV+VS+;

[b] COC+HIV− ≠ COC+HIV+VS−;

[c] COC+HIV+VS+ ≠ COC+HIV+VS−

[1] Restricted to participants on ART