



Associations amongst form of cocaine used (powder vs crack vs both) and HIV-related outcomes

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ABSTRACT

Introduction: Cocaine (including powder and crack) use is common among people with HIV (PWH). We identified socio-demographic and behavioral factors associated with cocaine use (overall and various forms) among PWH; we also examined differences in HIV treatment outcomes across cocaine exposure groups.

Methods: The study sample (N = 1166) was derived from two cohorts of PWH in Florida between 2014 and 2020. Baseline data were linked to the Enhanced HIV/AIDS Reporting System (eHARS) which tracks HIV viral load. Socio-demographics and polysubstance use were compared by cocaine use and the three cocaine use groups (powder only n = 101, crack only n = 91, or both n = 65). The association between the three cocaine use groups, ART adherence, and HIV viral suppression (<200 copies/mL) in the following year was assessed by multivariate logistic regression.

Results: People who used cocaine had lower HIV treatment adherence and viral suppression than those who did not use. People who used powder cocaine only were more likely to be younger, Hispanic/Latinx, and employed than those who used crack only or both. Compared to people who used both powder and crack cocaine, those who used one form of cocaine had 3 + odds of having durable viral suppression in the following year.

Conclusion: The dual use of both powder and crack cocaine was associated with significantly worse HIV outcomes compared to use of only one form of cocaine. Screening for powder and crack cocaine use and timely intervention are needed to improve HIV treatment outcomes among this high-risk population.

1. Introduction

Cocaine is one of the most commonly used illicit drugs among people with HIV (PWH). In the United States (US), among PWH, the estimated prevalence of cocaine use in the past 12-months ranges from 9% to 50% (Cook et al., 2008; Dawson-Rose et al., 2017; Mimiaga et al., 2013; Skeer et al., 2012), which is much higher than the estimated national prevalence among the general population (2%) (Substance Abuse and Mental Health Services Administration, 2019). The use of cocaine has been associated with accelerated HIV disease progression and worse treatment outcomes (Baum et al., 2009; Cofrancesco et al., 2008; Pandhare et al., 2014), partly because people who use cocaine are a vulnerable population who are susceptible to poor access to care, and have reduced treatment adherence (Baum et al., 2009; Hayashi et al., 2016).

Moreover, cocaine could interact with HIV on CD4 T-cell apoptosis (Pandhare et al., 2014) and increase virus integration and replication (Addai et al., 2015; Buch et al., 2011). These mechanisms could further explain the association between cocaine use and poor HIV treatment outcomes from a biological perspective.

Past research has typically combined powder and crack cocaine together into a single variable or only focused on one of these forms of cocaine (França et al., 2018; Meade et al., 2010; Tyagi, Weber, Bukrinsky, & Simon, 2016). However, not all cocaine is the same. Powder cocaine is commonly used through snorting or injection, whereas crack is typically smoked. Different routes of administration influence the subjective feelings of cocaine use and are associated with different risks of cocaine use disorder (injection had the highest risk, snorting the lowest, and smoking in the middle) (Chen & Anthony, 2004; Gossop,

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Manning, & Ridge, 2006a; Kiluk, Babuscio, Nich, & Carroll, 2013). Crack and powder cocaine have a similar unit price (Caulkins, 1997); nevertheless, crack is often sold in smaller quantities relative to powder cocaine and, therefore, perceived as less expensive than powder cocaine. There is a “class” distinction between the two forms of cocaine use in the US, where powder cocaine users tend to have higher socioeconomic status relative to crack cocaine users (Palamar, Davies, Ompad, Cleland, & Weitzman, 2015). Moreover, some cocaine users use both forms of cocaine, and this population is often neglected in the literature. Some researchers have used non-mutually exclusive groups of powder and crack cocaine users (Pope, Falck, Carlson, Leukefeld, & Booth, 2011; Stewart, Fulton, & Barrett, 2014); others combined people who used both powder and crack with those who used crack only and compared them with those who only used powder (Chen & Anthony, 2004; Palamar et al., 2015) or excluded them in their comparisons (Gossop et al., 2006a; Gossop, Manning, & Ridge, 2006b; Miró et al., 2019).

When examined separately, both powder and crack cocaine use have been associated with worse HIV care and treatment outcomes than non-users with HIV (Cook et al., 2008; Liang et al., 2020; Socías et al., 2016). However, it is unclear whether different HIV treatment outcomes will be observed between people who use powder cocaine only, crack only, or both. One recent study has found that crack cocaine use was a significant predictor for higher HIV viral load, whereas powder cocaine use was not (Liang et al., 2020). However, this work did not directly compare powder cocaine users to crack cocaine users. Further, in line with the aforementioned literature on class differences between people who used different forms of cocaine, relative to powder cocaine users, crack cocaine users are more likely to be marginalized from the community, victimized by worse stigma, are homeless, and have higher involvement with violence and the criminal justice system (Cross, Johnson, Davis, & Liberty, 2001; Palamar et al., 2015; Stewart et al., 2014; Vaughn, Fu, Perron, Bohnert, & Howard, 2010). These factors may negatively impact their HIV care and treatment outcomes. Therefore, it can be hypothesized that poorer HIV care and treatment outcomes will be observed among crack cocaine users relative to powder cocaine users.

Using data collected from two cohorts of PWH in Florida, the third highest state in the US for new HIV diagnosis (Florida Department of Health, 2020), we examined the following objectives for the current investigation: (1) identify factors associated with cocaine use among PWH and replicate past findings on the association between cocaine use and worse HIV treatment outcomes; (2) examine if PWH who used powder cocaine present different socio-demographic and risks of other (non-cocaine) substance use compared with PWH who used crack cocaine or a combination of powder and crack; and (3) examine the associations between the three cocaine use groups and various HIV treatment and health outcomes.

2. Methods

2.1. Study population

The study sample was pooled from the baseline data of the Florida Cohort and the Marijuana Associated Planning and Long-term Effect (MAPLE) studies, two cohorts of PWH in Florida. The Florida Cohort study was conducted between 2014 and 2018. A total of 932 participants were recruited from a collaborative network of county health departments and community-based organizations/clinics. The eight recruitment sites (Gainesville, Tampa, Miami, Lake City, Orlando, Wildwood, Sanford, and Ft. Lauderdale) covered geographically diverse counties across north, central and south Florida in both rural and urban areas. Detailed study design for the Florida Cohort is described in Ibañez et al., 2020.

Between 2018 and March 2020, 300 participants were recruited into the ongoing MAPLE study from Gainesville, Tampa, and Miami. Both the MAPLE study and the Florida Cohort study recruited participants from clinical and community settings, with mostly similar eligibility criteria:

(1) confirmed HIV infection, (2) aged 18 or older, (3) planned to remain in Florida for the following 6 months, (4) English speaker (except Miami and Sanford sites of the Florida Cohort, individuals who spoke English or Spanish were eligible). The MAPLE study has one unique eligibility: for the user’s arm - used marijuana at least 4 times in the past month; for the non-user’s arm- did not use marijuana in the past 5 years and never used marijuana more than once per month in lifetime. Some of the MAPLE participants were recruited from the Florida Cohort registries. A total of 66 participants were enrolled in both Florida Cohort and MAPLE studies. To de-duplicate, only their responses in the MAPLE studies were included in the current analysis as they represent more recent data. After combining the two studies, 1166 PWH were included as the study sample (866 from Florida Cohort and 300 from MAPLE).

For both studies, the research team had established a Data Use Agreement with the Florida Department of Health (FDOH) who linked the study survey data with the state HIV surveillance database, including the enhanced HIV/AIDS Reporting System (eHARS). The matching was conducted at the FDOH twice a year with the latest match occurring in November 2020. Over 98% of all study participants were matched with eHARS and all their HIV viral load test results were extracted. The study was approved by the institutional review boards (IRBs) at the University of Florida, Florida International University, and the FDOH.

2.2. Measurement

A similar core survey was used in Florida Cohort and MAPLE studies covering socio-demographics, substance use, HIV treatment and care, and other HIV-related information. The survey was self-administered via paper and pen or computer. Detailed measures for the variables used in the current analysis are listed in Appendix Table 1. Socio-demographic factors included age, sex, race, ethnicity, education, marital status, employment status, annual household income, homelessness in the past 12 months (P12M), and being in jail in the P12M.

The use of powder cocaine and crack cocaine in the P12M were assessed separately. The use of powder cocaine use was measured by asking if participants ever injected powder cocaine, or speedball (heroin and cocaine together), or used cocaine as a non-injection drug (MAPLE)/injected cocaine or snorted cocaine (Florida Cohort) in the P12M. The use of crack cocaine was captured by asking if participants ever used crack as a non-injection drug (MAPLE)/smoked crack cocaine (Florida Cohort) in the P12M. The study sample was dichotomized into cocaine users ($n = 257$) and non-users ($n = 909$); among cocaine users, individuals were categorized into those who used powder only ($n = 101$), crack only ($n = 91$), and both powder and crack cocaine ($n = 65$). Additionally, we asked how often powder and crack cocaine were, respectively, used in the past 12 months with five different frequency options (less than once a month, 1–3 times a month, 1–3 times a week, 4–6 times a week or daily). If both powder and crack cocaine were used, the higher frequency was used in the current analysis. Other substance use measures included alcohol (any use, daily use, and heavy use: 4+ (female)/5+ (male) drinks on a typical day), marijuana, heroin, stimulants, prescription (Rx) opioids, and sedatives. For all substances except marijuana, both studies assessed any use in the P12M. For marijuana, the Florida Cohort study assessed the use in the past three months, while the MAPLE study assessed the use in the P12M.

The core survey for both studies asked if the participants are currently taking HIV antiretroviral medication (ART) with yes or no responses. ART adherence was defined as the proportion of days in the past 30 days participants did not miss any medication and categorized as optimal ($>90\%$) and suboptimal ($\leq 90\%$). Lab results on viral load were extracted from the eHARS. Viral suppression was defined as having a viral load <200 copies/mL. Results of all viral load tests that occurred 12 months before and after the date the survey was administered were used to calculate durable viral suppression in the P12M and the following 12 months. Durable viral suppression was defined as having all viral load <200 copies/mL during the time frame among people who

had at least one viral load test. People who did not have any viral load test in the given time frame were considered not to have durable viral suppression. A sensitivity analysis was conducted in which people who only had one viral load test in the given time frame were additionally considered not to have durable viral suppression and the main conclusions did not change. Additionally, the number of viral load tests performed during these two time frames was calculated.

2.3. Analysis

Before combining the two studies, we first conducted preliminary analyses in each study separately to examine heterogeneity in the direction of associations between factors examined and cocaine use groups. No significant inconsistency was found, and we pooled the two

studies together (after de-duplication) to increase the sample size.

Comparative analyses were conducted to characterize people who used cocaine and did not use cocaine in the P12M and those who used powder only, crack only, and both powder and crack cocaine on socio-demographics and polysubstance use. Then, differences in HIV treatment outcomes were examined. Primary HIV treatment outcomes of interest included currently on ART, ART adherence in the P12M, and durable viral suppression in the past and the following 12 months. Additionally, to rule out the impact of the number of viral load tests performed on the estimation of durable viral suppression, the number of viral load tests in the past and following 12 months were also included in the analysis. Pearson's chi-square or t-tests were used to examine differences between cocaine users and non-users. Pairwise comparisons were conducted to examine differences between people who used

Table 1

Comparative analysis examine the differences between people with and without cocaine use in the past 12 months (P12M) and between people who used power cocaine only, crack cocaine only, and both power and crack cocaine.

	Total sample n = 1166			Among cocaine users, n = 257			Significant (p < 0.05) pairwise comparisons ^{X1}
	Non-cocaine users n = 909 (%)	Cocaine users n = 257 (%)	p-value	powder only (a) n = 101 (%)	crack only (b) n = 91 (%)	powder and crack (c) n = 65 (%)	
Demographics							
Age: 45 or older	574 (63.2)	178 (69.3)	0.0705	59 (58.4)	69 (75.8)	50 (76.9)	a/b, a/c
Sex: Female	338 (37.3)	108 (42.0)	0.1661	42 (41.6)	36 (39.6)	30 (46.2)	none
Race: Black	527 (58.0)	188 (73.2)	<0.0001	70 (69.3)	72 (79.1)	46 (70.8)	none
Ethnicity: Hispanic/Latinx	187 (20.6)	36 (14.0)	0.0178	24 (23.8)	5 (5.6)	7 (10.8)	a/b, a/c
Social determinants of health							
Education: High school or below	530 (58.5)	168 (65.4)	0.0472	63 (62.4)	68 (74.7)	37 (56.9)	b/c
Marital status: Married or live with long term partner	181 (20.0)	46 (17.9)	0.4534	21 (20.8)	14 (15.4)	11 (16.9)	none
Unemployment	674 (73.8)	202 (78.6)	0.1187	69 (68.3)	76 (83.5)	57 (87.7)	a/b, a/c
Low household income (<10,000 annual)	498 (54.9)	161 (62.9)	0.0218	53 (53.0)	67 (73.6)	41 (63.1)	a/b
Being homeless in the P12M	100 (11.0)	68 (26.5)	<0.0001	19 (18.8)	28 (30.8)	21 (32.3)	a/c
In jail in the P12M	38 (4.2)	34 (13.2)	<0.0001	13 (12.9)	14 (15.4)	7 (10.8)	none
Frequency of cocaine use in the P12M							
Less than once a month	–	100 (39.1)	–	54 (54.0)	35 (38.5)	11 (16.9)	a/b, a/c, b/c
1 to 3 times a month	–	66 (25.8)	–	23 (23.0)	22 (24.2)	21 (32.3)	
1 to 3 times a week	–	37 (14.5)	–	15 (15.0)	13 (14.3)	9 (13.9)	
4 to 6 times a week	–	23 (9.0)	–	2 (2.0)	10 (11.0)	11 (16.9)	
Daily	–	30 (11.7)	–	6 (6.0)	11 (12.1)	13 (20.0)	
Polysubstance Use							
Any alcohol use in the P12M	612 (67.33)	225 (87.6)	<0.0001	93 (92.1)	74 (81.3)	58 (89.2)	a/b
Daily alcohol use in the P12M	68 (7.5)	55 (21.4)	<0.0001	14 (13.9)	22 (22.2)	19 (29.2)	a/c
Heavy alcohol use (4 + drinks on a typical day)	75 (8.3)	50 (13.5)	<0.0001	14 (13.9)	19 (20.9)	17 (26.2)	a/c
Marijuana use in the past 3 months ^{X2}	188 (26.9)	83 (50.0)	<0.0001	35 (70.0)	31 (40.3)	17 (43.6)	a/b, a/c
Marijuana use in the past 12 months ^{X3}	117 (56.0)	88 (96.7)	<0.0001	50 (98.0)	13 (92.9)	25 (96.2)	none
Heroin use in the P12M	2 (0.2)	22 (8.6)	<0.0001	4 (4.0)	6 (6.6)	12 (18.5)	a/c, b/c
Stimulant use in the P12M	31 (3.4)	39 (15.2)	<0.0001	13 (12.9)	7 (7.7)	19 (29.2)	a/c, b/c
Rx opioid use in the P12M	64 (7.0)	46 (17.9)	<0.0001	14 (13.9)	9 (9.9)	23 (35.4)	a/c, b/c
Sedative use in the P12M	63 (6.9)	45 (17.5)	<0.0001	14 (13.9)	10 (11.0)	21 (32.3)	a/c, b/c
HIV treatment and care							
Currently on ART	823 (91.4)	233 (91.7)	0.8845	92 (92.9)	80 (88.9)	61 (93.9)	none
Optimal ART adherence in the past 12 months ^{X4}	656 (82.5)	171 (76.7)	0.0097	69 (76.7)	59 (77.6)	43(75.4)	none
Durable viral suppression in the past 12 months ^{X5}	526 (60.6)	105 (44.3)	<0.0001	39 (42.9)	39 (45.4)	27 (45.0)	none
Durable viral suppression in the following 12 months ^{X5}	585 (64.4)	121 (47.1)	<0.0001	58 (57.4)	46 (50.6)	17 (26.2)	a/c, b/c
Number of viral load tests in the past 12 months (mean, SD)	2.8 (1.4)	2.8 (1.5)	0.8107	2.6 (1.5)	3.0 (1.5)	2.9 (1.6)	none
Number of viral load tests in the following 12 months (mean, SD)	2.6 (1.4)	2.3 (1.7)	0.0155	2.0 (1.7)	2.6 (1.5)	2.2 (1.8)	none

X1: Noting the significant paired comparison between powder only (a), crack only (b), powder and crack (c). e.g. "a/b" indicates significant difference between powder only and crack only; "none" indicates none of the three paired comparison are significant.

X2: Measured in the Florida Cohort, total n = 866, cocaine users n = 166.

X3: Measured in the MAPLE study, total n = 300, cocaine users n = 91.

X4: Conditional on currently on ART treatment.

X5: All viral load < 200 copies/mL in the past/following 12 months.

powder only, crack only, and both powder and crack cocaine.

Finally, multivariate logistic regressions were conducted for the HIV treatment outcomes that were found to be significantly different among the three cocaine use groups in univariate analysis, and any socio-demographic variables that were found to be significantly associated with the cocaine use groups were included in the model as covariates. Additionally, based on the bivariate analyses results, we suspected that the frequency of cocaine use (less than weekly, weekly or more) and polysubstance use (number of other substances used) might confound the observed associations. Therefore, analyses were conducted with these two factors additionally adjusted. $P < 0.05$ was considered statistically significant.

3. Results

The rate of any cocaine use (powder and/or crack) in the P12M observed in our study sample ($N = 1166$) was 22.0%. Among cocaine users ($n = 257$), 101 (39.3%) reported using powder cocaine only, 91 (35.4%) reported using crack cocaine only, and 65 (25.3%) reported using both. Among the 65 dual users, 53.9% reported the same frequency of their powder and crack cocaine use, 10.8% reported more frequent powder cocaine use than their crack cocaine use, and 35.4% reported the opposite.

3.1. Any cocaine use vs no use

As shown in Table 1, compared to non-users, people who used cocaine in the P12M were more likely to be Black, be non-Hispanic/Latinx, have low education, have low household income, be homeless, be recently incarcerated, and have a higher prevalence of alcohol (any, daily and heavy), marijuana, heroin, stimulant, opioid, or sedative use in the P12M. Around 90% of the sample were currently on ART; no significant difference was observed between cocaine users and non-users regarding the proportion on ART. Compared to non-cocaine users, cocaine users had significantly lower adherence to ART treatment (76.7% vs. 82.5%), lower number of HIV viral load tests in the following 12 months (2.6 vs. 2.3), and were less likely to be durably virally suppressed in the P12M (60.6% vs. 47.1%) and the following 12 months (54.4% vs. 47.1%; all $ps < 0.05$).

3.2. Heterogeneity in socio-demographics and polysubstance use by the use of powder only, crack only, and both forms of cocaine

The powder only group had a significantly higher proportion of being Hispanic/Latinx relative to the two other groups and a lower proportion of having low household income than the crack only group. Furthermore, the powder only group was more likely to be younger and more likely to be employed than the other two groups. The powder only group also had a significantly lower proportion of being homeless compared to those who used both forms of cocaine.

Among cocaine users, compared to the crack only group, the powder only group was significantly more likely to report any alcohol and marijuana use. Relative to people who used only one form of cocaine (i. e., mono-use group), significantly higher proportions of people who used both forms of cocaine reported P12M use of heroin, stimulants, Rx opioids, and sedatives, with no statistically significant differences between the two mono-use groups. The proportions of people who reported daily cocaine use were 6%, 12.1%, and 20%, respectively, among people who used powder only, crack only, and both.

3.3. Associations among forms and patterns of cocaine used and HIV treatment and care outcomes

Among cocaine users, no significant differences were observed in individuals who use powder only, crack only and both for receiving ART and ART treatment adherence. For viral load suppression, a similar

number (2–3) of viral load tests were performed across the three cocaine use groups in the past and following 12 months; no association was observed for concurrent (in the P12M) durable viral suppression. However, people who used both powder and crack cocaine were prospectively less likely to achieve durable viral suppression in the following 12 months (26.2%) compared to those who used powder only (57.4%, $p < 0.05$) or crack only (50.6%, $p < 0.05$). As shown in Table 2, after controlling for age, ethnicity, education, employment status, household income, and homelessness, those who used powder cocaine only and those who used crack only were 3.88 times (95%CI: 1.87–8.03) and 3.25 times (95 %CI: 1.56–6.74) as likely to have durable viral suppression in the following 12 months, compared to people who used both powder and crack cocaine. When frequency of cocaine use and polysubstance use were included in the multivariate model, the strengths and the significance level of the associations remained essentially the same.

4. Discussion

The current analyses linked baseline data from two studies conducted among PWH in Florida with the state HIV surveillance data (eHARS). Our findings help identify a high-risk population in need of tailored public health interventions to improve health outcomes for people who use cocaine and live with HIV.

Among our sample of PWH, being Black, non-Hispanic/Latinx, having low education attainment, low household income, and recent homelessness or incarceration experiences were significant factors correlated with P12M cocaine use among PWH. These associations are consistent with past research (John & Wu, 2017; North & Pollio, 2017; Zhao, Kim, Li, Hsiao, & Rice, 2018). A higher prevalence of P12M polysubstance use (including alcohol, marijuana, opioids, heroin, stimulants, and sedatives) was observed among cocaine users than non-users, supporting that polysubstance use is common among cocaine users (Liu, Elliott, Serdarevic, Leeman, & Cottler, 2019; Liu, Williamson, Setlow, Cottler, & Knackstedt, 2018). Additionally, our findings corroborated past research (Cook et al., 2008; Liang et al., 2020; Socías et al., 2016) and highlight that the use of cocaine is significantly associated with worse HIV treatment adherence and viral suppression outcomes.

We also explored the heterogeneity among those who used powder only, crack only, and both. In line with past research (Miró et al., 2019; Palamar et al., 2015), crack cocaine use was associated with older age, non-Hispanic/Latinx and lower socioeconomic status (education, employment, household income, and homelessness). Our findings were also different from some past research. Unlike one study which reported

Table 2

Multivariate logic regression examining the association between the use of powder only, crack only, powder and crack and durable viral suppression in the following 12 months.

Variables	OR	95 %CI	p value
Powder only	3.88	1.87–8.03	0.0003
Crack only	3.25	1.56–6.74	0.0016
Powder and crack	1		
Age (45 or older vs younger)	0.73	0.40–1.34	0.3112
Education (above high school vs high school or below)	1.67	0.94–2.98	0.0818
Unemployment (yes vs no)	1.11	0.56–2.19	0.7661
Low household income (yes vs no)	1.57	0.87–2.85	0.1347
Homeless (yes vs no)	0.28	0.14–0.55	0.0002
When polysubstance use and frequency of cocaine use were additionally adjusted X1			
Powder only	4.18	1.93–9.03	0.0003
Crack only	3.96	1.77–8.86	0.0008
Powder and crack	1		
Polysubstance use (number of other substances used)	1.22	0.95–1.56	0.1167
Frequency (daily/weekly vs less than weekly)	1.33	0.73–2.40	0.3501

X1: Age education, unemployment, household income and homelessness were included in the model.

that relative to powder cocaine users, crack users were more likely to be Black and have been arrested in the P12M (Palamar et al., 2015), we found that these factors were only associated with the use of cocaine in the P12M in general but not with the forms of cocaine used. Of note, although racial differences in cocaine use were observed, results do not indicate being Black has a causal effect on increased cocaine use risk. Previous research suggests that the racial differences in cocaine use were driven by systemic differences in socioeconomic and community-level factors like drug availability in the neighborhood (Lillie-Blanton, Anthony, & Schuster, 1993; Zhao et al., 2018). Additionally, we found that for most of the socio-demographic factors (e.g., age, employment, being homeless), people who used both powder and crack were more similar to those who used crack only than those who used powder only.

With regard to polysubstance use, differences were observed among the three cocaine use groups. For most of the measured substances, differences in use rates were observed between those who used both powder and crack cocaine vs. those who used either one form only. This may partially explain why past research with non-mutually exclusive groups found inconsistent polysubstance use rates between powder and crack users. For example, Stewart et al. (2014) reported that crack cocaine users were more likely to use opioids than powder cocaine users, whereas Miró et al. (2019) reported the opposite. Our findings indicate that the association in opioid, sedative, and stimulant use rates could be driven by the differences between dual-use vs. mono-use instead of the choice of powder or crack cocaine.

For HIV treatment outcomes, we found that people who used either powder or crack cocaine only shared similar viral suppression outcomes. A recent history of using both powder and crack cocaine predicted worse durable viral suppression in the next year relative to those who used either powder or crack cocaine only. Compared to those who used of a single form of cocaine, persons who used both forms of cocaine had a higher frequency of cocaine use and increased polysubstance use. However the association of cocaine use with viral suppression did not appear to be confounded or mediated by the frequency of cocaine use or polysubstance use. Moreover, this association was not likely to be affected by the receipt of ART, treatment adherence, number of viral load tests performed, or viral suppression observed in the P12M since these factors were evenly distributed in the three cocaine use groups. The current results support that it is worthwhile for HIV-related substance use screening and research to measure powder and crack cocaine use separately. Timely interventions for the identified high-risk population following screening have the potential to improve the viral suppression outcomes in the following year. Further investigation is needed to better understand the mechanisms with which how the use of particular drug types may impact PWH and viral suppression.

Furthermore, in our sample, around 90% of PWH were on ART at the time of interview regardless of their cocaine use status and forms of cocaine used. The finding suggested that among these cohorts of PWH in Florida, similar clinic-based interventions could be implemented to reduce the gaps in durable viral suppression outcomes across the three cocaine use groups because they are equally likely to be engaged in care. However, of note, our estimation of the prevalence of PWH who are currently on ART (91%) was higher than the state estimation of the proportion of PWH who were in care (79%) (Florida Department of Health, 2020). This may be because HIV clinics were used as recruitment sites for our studies, and PWH who are out of care may be under-represented in this study sample. The FDOH estimated 68% of PWH had a suppressed viral load (<200 copies/mL) on their latest test between January 2019 and March 2020 (Florida Department of Health, 2020). However, lower viral suppression rates were observed in our sample (64% among non-users; 43%–46% among cocaine users), which is concerning especially because most of the sample were on ART. Past research indicated relative to non-users, the use of crack cocaine elevated HIV viral load independent of ART and accelerated HIV disease progression by reducing treatment adherence among those on ART. This association was not found for the use of powder cocaine (Baum et al.,

2009); however, powder and crack cocaine users were not compared in this study, so results cannot be directly compared to ours. Future research could examine if these associations hold for dual cocaine forms users to better understand the mechanism behind the observed association in our analysis.

Our study has a few limitations. First, all participants were recruited in selected locations in Florida and it is not clear if the results can be generalized to other locations. Additionally, many participants were recruited from health care settings like the county health department and our sample may under-represent PWH who are out of care and those who do not seek care from those settings. Second, although less common than smoking crack, crack cocaine can also be used via injection (Lankenau, Clatts, Goldsamt, & Welle, 2004). However, we are unable to capture crack injection in our sample since the survey only asked the use of crack as a non-injection drug or use crack cocaine through smoking. Third, substance use measures used in the current analyses were based on self-reports and may be subject to recall bias. However, the MAPLE study collected urine samples to verify recent substance use, and the survey used in both studies was self-administrated, which may reduce desirability bias. Lastly, despite combining two studies to increase the sample size, we may be under-powered to detect small differences among the three cocaine use groups. Despite these limitations, to our knowledge, our analysis was the first to examine the association among powder only, crack only, and powder plus crack use and HIV viral load results concurrently and prospectively. The paired comparison between the three mutually exclusive cocaine use groups also supplemented previous research to better characterize the heterogeneity among cocaine using PWH.

5. Conclusion

Similar risk factors for cocaine use can be observed among PWH as studies conducted among the non-HIV specific population. Despite being associated with different socio-demographic factors, the powder cocaine only and crack-only groups shared similar risks of illicit drug use and HIV treatment outcomes. Dual use of powder and crack cocaine was associated with increased rates of polysubstance use. Identifying and intervening with individuals who use both powder and crack cocaine at HIV care visits may improve HIV treatment outcomes. Harm reduction efforts addressing substance use, including powder and crack cocaine use, should be a key component of HIV care. Future research is warranted to examine the mechanism behind observed associations in the current analysis and to identify actionable factors to design tailored interventions.

Declaration of Competing Interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

Appendix A. Supplementary material

Supplementary data to this article can be found online at <https://doi.org/10.1016/j.abrep.2021.100374>.

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