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Unintentional drug overdose deaths involving cocaine among middle-aged and older adults in New York City

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A B S T R A C T

Background: Cocaine is commonly involved in unintentional drug poisoning (overdose) deaths, accounting for 46% of overdose deaths in New York City (NYC) in 2016. However, little research exists regarding cocaine use by middle-aged and older adults, who are more likely than younger individuals to have underlying cardiovascular disease (CVD) and therefore, may be at increased risk for the adverse health consequences of cocaine.
Methods: We conducted a retrospective analysis of unintentional drug overdose deaths of middle-aged and older NYC residents age 45–84 from 2000 to 2016 using two linked sources, NYC death certificates and toxicology results from the Office of the Chief Medical Examiner.
Results: From 2000 to 2016, there were 6061 unintentional drug overdose deaths among New Yorkers age 45–84. Of those, cocaine was involved in 53% (n = 3183). Co-occurring opioid involvement (fentanyl, heroin, methadone, or opioid analgesics) among deaths involving cocaine was common (58%). Compared to decedents of non-cocaine involved overdose, decedents of cocaine-involved overdose were more likely to be male and non-Latino Black. Multivariable analysis showed that adults age 45–54 (adjusted odds ratio [AOR] = 1.34, 95% 1.05, 1.70), males (AOR = 1.30, 95% CI 1.15, 1.46), Bronx residence (AOR = 1.29, 95% CI 1.08, 1.54), and non-Latino black race/ethnicity (AOR = 2.37, 95% CI 2.07, 2.72) were independently associated with cocaine-involved overdose.
Conclusion: Characteristics of decedents of cocaine-involved overdose overlap with populations with high CVD burden in NYC. Studies are needed to better understand the risks of cocaine among adults with underlying CVD.

1. Introduction

Cocaine is involved in increasing numbers of overdose deaths in the United States (US) and is the most common cause of drug-related emergency department visits (Substance Abuse and Mental Health Services Administration [SAMHSA], 2013). The number of overdose deaths involving cocaine in the US increased 3.5-fold increase from 2010 to 2017 (National Institute on Drug Abuse [NIDA], 2018). Nationally, cocaine was responsible for over 13,000 hospitalizations and over 6000 emergency department visits in 2014 (Centers for Disease Control [CDC], 2018) and in New York City (NYC) 46% of all unintentional drug overdose deaths involved cocaine in 2016 (New York City Department of Health and Mental Hygiene [NYCDOHMH], 2017a).

Cocaine is associated with severe medical complications that can acutely and chronically affect the cardiovascular, respiratory, central nervous, and renal systems (Glauser and Queen, 2007; Pozner et al.,

2005; White and Lambe, 2003). Middle-aged and older adults, due to the physiological changes of aging and associated chronic conditions, may be particularly vulnerable to the adverse effects of cocaine use, particularly on the cardiovascular and cerebrovascular systems (Pozner et al., 2005). The toxicities of cocaine include cardiac arrhythmias, myocardial and cerebrovascular ischemia, accelerated atherosclerosis, vascular vasospasm, and hematological abnormalities. These contribute both to cocaine-related chronic disease as well as acute cardiac death (Afonso et al., 2007; Bhattacharya et al., 2011; Pozner et al., 2005; Rezkalla and Kloner, 2007; Sanchez et al., 2013).

Although the need for substance use disorder treatment is increasing among middle-aged and older adults (Fahmy et al., 2012; Han, 2018; Lofwall et al., 2008), in part due to the aging Baby Boomer generation (Gfroerer et al., 2003), there are few studies of drug use by this population. In fact, the rate of drug overdose deaths was highest among adults 45–54 years of age (34.0 per 100,000) followed by adults 55–64
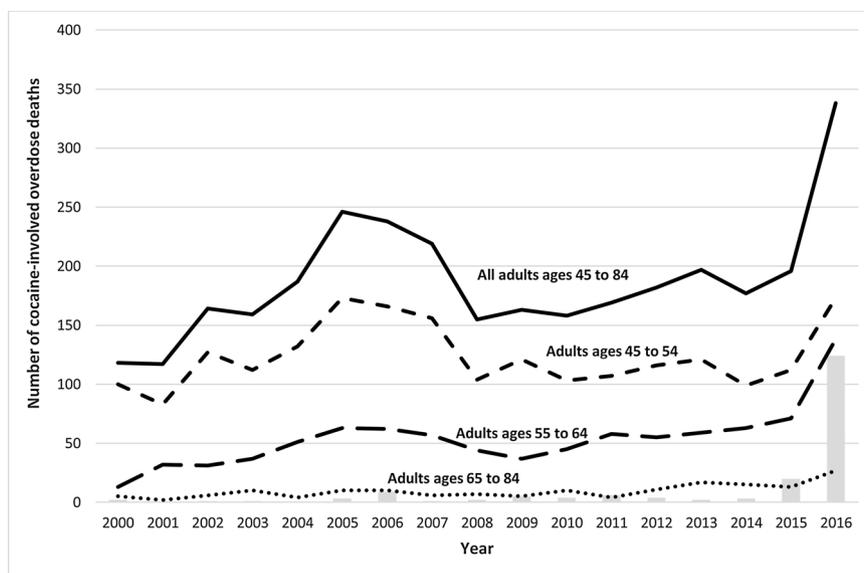

Fig. 1. Cocaine involved overdose deaths by age range, New York City, 2000–2016.
*Vertical bars represent the number of deaths in which cocaine was found in combination with fentanyl for adults ages 45–84.

years of age (29.9 per 100,000) in NYC in 2016 (NYCDOHMH, 2017a). Despite the rising cocaine-involved overdose deaths and a consistent proportion among adults born in 1946–1964, and adults age 45–54 with the highest rate of cocaine-involved overdose deaths compared to younger adults (NYCDOHMH, 2015), no studies have examined the characteristics of and contribution of cocaine to overdose deaths among middle-aged and older adults. Given the higher rates of drug overdose death including cocaine among middle-aged adults and the lack of data on patterns of and factors associated with cocaine-involved overdose among older adults, we performed a retrospective analysis of unintentional drug overdose deaths of adults age 45–84 in NYC from 2000 to 2016 to compare demographic characteristics of cocaine and non-cocaine-involved overdoses.

2. Methods

2.1. Study sample and data source

The sample included all unintentional drug overdose deaths among adults with known NYC residence age 45–84 from January 1, 2000, to December 31, 2016. Data on adults age 85 and older are generally suppressed by the Bureau of Alcohol and Drug Use Prevention, Care and Treatment at the NYC Department of Health and Mental Hygiene due to the typically low number of drug overdoses among adults ≥85, and therefore not included in this analysis. The sample was drawn from NYC death certificates from NYC Vital Statistics and linked to toxicology results and case files from the Office of the Chief Medical Examiner (OCME). Decedents with a non-NYC or missing zip code information were excluded.

2.2. Variables

Demographic variables included gender, race/ethnicity, age, borough of residence, borough of death, and neighborhood poverty. Race/ethnicity was classified as non-Latino white, non-Latino black, Latino, and non-Latino other, which collapsed other race and ethnicities. Age was categorized as 45–54, 55–64, and 65–84. Neighborhood poverty was defined from zip code of residence as the percent of residents with incomes below 100% of the federal poverty level per American Community Survey and Census 2000. Neighborhood poverty was categorized into four groups: low (< 10% of residents below poverty),

medium (10% to < 20% below poverty), high (20% to < 30% below poverty), and very high (≥ 30% below poverty).

Drugs and drug metabolites were abstracted from toxicology reports of medical examiner files and included alcohol, benzodiazepines, cocaine, fentanyl, methadone, heroin, and opioid analgesics. Drugs were not mutually exclusive; a decedent's toxicology could be positive for more than one drug.

2.3. Statistical analysis

We performed descriptive and bivariate analyses of demographic characteristics with toxicology results of decedents with cocaine-involved overdoses and decedents with non-cocaine-involved overdoses. Binary logistic regression models estimated the crude odds ratio (OR) of each covariate. Multivariable logistic regression was performed to give an adjusted OR (AOR) to determine associations between demographic characteristics and cocaine-involved overdoses adjusting for age, gender, race/ethnicity, borough of residence, and neighborhood poverty. We decided not to include drug type in the model due to the high number of concurrent substances in both the cocaine-involved and non-cocaine-involved deaths. Also, we did not include borough of death in the model due to high concordance with borough of residence (< 1% difference), and sensitivity analyses using borough of death instead of residence in the model did not significantly change the results. All data were analyzed using SAS 9.2 (SAS Institute, Cary, NC, USA). This study was exempted from institutional board review as it was considered routine public health overdose surveillance.

3. Results

From January 1, 2000, to December 31, 2016, we identified 6061 drug overdose deaths among New Yorkers age 45 and older with 3906 age 45–54, 1837 age 55–64, and 318 age 65–84. Cocaine was involved in 3183 of all drug overdose deaths (53%) with 2105 age 45–54 (66%), 916 age 55–64 (29%), and 162 age 65–84 (5%). Fig. 1 presents changes in the number of cocaine-involved overdose deaths over time by age range and includes the number of cocaine and fentanyl overdose deaths to highlight the recent rise in fentanyl-involved overdoses in NYC. Table 1 presents between-group demographic differences for decedents of cocaine-involved deaths versus non-cocaine-involved deaths and the results from the logistic regression models. The proportion of decedents

Table 1
Demographic characteristics of cocaine-involved overdose deaths versus non-cocaine overdose deaths comparison among middle-aged and older adults New York City, 2000−2016.

	Cocaine-involved overdose deaths (n = 3,183)		Non-cocaine involved overdose deaths (n = 2,878)		X^2 p-value	Adjusted OR[c]	(95% CI)	p-value
	n	%	n	%				
Mean age (years, sd)	52.87 (SD 6.20)		53.45 (SD 6.31)		0.31			
Age range (years)	45-82		45-84					
45 to 54	2105	66%	1801	63%		1.34	(1.05, 1.70)	0.02
55 to 64	916	29%	921	32%		1.04	(0.81, 1.34)	0.75
65 to 84	162	5%	156	5%		1.00		
Gender					0.003			
Male	2369	74%	2044	71%		1.30	(1.15, 1.46)	< 0.001
Female	814	26%	834	29%		1.00		
Race/Ethnicity[†]					< 0.001			
Black (non-Latino)	1486	47%	667	23%		2.37	(2.07, 2.72)	< 0.001
Latino	782	25%	801	28%		1.00		
White (non- Latino)	834	26%	1320	46%		0.68	(0.58, 0.78)	< 0.001
Other	81	3%	90	3%		0.90	(0.66, 1.24)	0.52
Borough of Residence[†]					< 0.001			
Bronx	772	24%	571	20%		1.29	(1.08, 1.54)	0.006
Brooklyn	901	28%	759	26%		1.04	(0.86, 1.27)	0.69
Manhattan	881	28%	789	27%		0.97	(0.81, 1.16)	0.75
Queens	485	15%	531	18%		1.00		
Staten Island	144	5%	228	8%		0.88	(0.68, 1.13)	0.32
Borough of Death					< 0.001			
Bronx	829	26%	631	22%				
Brooklyn	882	28%	729	25%				
Manhattan	874	27%	790	27%				
Queens	454	14%	509	18%				
Staten Island	144	5%	219	8%				
Neighborhood Poverty[†,a]					< 0.001			
Low (wealthiest)	355	11%	486	17%		1.00		
Medium	819	26%	846	29%		1.03	(0.86, 1.24)	0.75
High	949	30%	709	25%		1.09	(0.89, 1.32)	0.41
Very High	1060	33%	837	29%		1.04	(0.84, 1.30)	0.71

[a]OR adjusted for age, gender, race/ethnicity, borough of residence, and neighborhood poverty.
[b]Percentage of deaths within subgroups are calculated among categories presented.
[c]Neighborhood poverty (based on ZIP code) was defined as percent of residents with incomes below 100% of the federal poverty level (Census 2000), separated into four groups: low (< 10%), medium (10%- < 20%), high (20%- < 30%) and very high (≥30%).

by age group did not differ for cocaine-involved overdose deaths and non-cocaine-involved overdose deaths. Decedents of cocaine-involved deaths were more like to be male, non-Latino Black, and to have lived in neighborhoods with high or very high poverty.

Table 2 presents between-group differences in other substances involved in overdose between cocaine-involved and non-cocaine-involved deaths. Among cocaine-involved deaths, 17% did not have any of the following substances – alcohol, benzodiazepine, or any opioid - present on toxicology. More than half had concurrent presence of an opioid (58%) or alcohol (53%). Heroin was the most common opioid

involved (39%), followed by methadone (22%), and opioid analgesics excluding fentanyl (16%). The number of overdoses involving both cocaine and fentanyl increased dramatically from 2013 (3 deaths) to 2016 (124 deaths). Benzodiazepines were present in 17% of cocaine-involved overdose deaths. Most non-cocaine-involved overdose deaths were opioid related (82%), with higher proportions of heroin-involved (54%). The next most common substances in non-cocaine drug overdose deaths were alcohol (found in 36%), and benzodiazepines (37%). In our unadjusted model, alcohol was more likely to be involved in cocaine-involved deaths (unadjusted OR 2.02 [1.82–2.23]), while

Table 2
Odds of cocaine-involved overdose death versus non-cocaine overdose deaths among middle-aged and older adults, by co-occurring drugs involved in overdose, New York City, 2000–2016.

	Cocaine involved overdose deaths (n = 3,183)		Non-cocaine involved overdose deaths (n = 2,878)		X^2 p-value	Crude OR	(95% CI)	p-value
	n	%	n	%				
Substance involved in overdose[a]								
No other substance (cocaine only)	544	17%	NA	NA	NA			
Alcohol	1,697	53%	1040	36%	< 0.001	2.02	(1.82, 2.23)	< 0.001
Benzodiazepines	552	17%	1057	37%	< 0.001	0.36	(0.32, 0.41)	< 0.001
Heroin	1228	39%	1566	54%	< 0.001	0.53	(0.48, 0.58)	< 0.001
Methadone	686	22%	905	31%	< 0.001	0.60	(0.53, 0.67)	< 0.001
Fentanyl	187	6%	258	9%	< 0.001	0.63	(0.52, 0.77)	< 0.001
Fentanyl + Heroin	96	3%	139	5%	< 0.001	0.61	(0.47, 0.80)	< 0.001
Opioid Analgesics	495	16%	778	27%	< 0.001	0.50	(0.44, 0.56)	< 0.001
Opiates (any)	1861	58%	2396	82%	< 0.001	0.28	(0.25, 0.32)	< 0.001

[a] Substance Type, not mutually exclusive; percent will not equal 100%.

opioids and benzodiazepines were more likely to be present in non-cocaine-involved deaths.

In our adjusted model, decedents with cocaine-involved overdoses were more likely to be age 45–54 compared to 65–84 year olds [AOR 1.34 (95% CI 1.05–1.70); p = 0.02], male [AOR 1.30 (95% CI 1.15–1.46); *p* < 0.001], non-Latino black compared to Latinos [AOR 2.37 (95% CI 2.07–2.72); *p* < 0.001], and residents of the Bronx compared to Queens [AOR 1.29 (95% CI 1.08–1.54); *p* = 0.01] (see Table 1).

4. Discussion

This retrospective analysis of cocaine-involved overdose deaths among middle-aged and older NYC residents indicates that cocaine was involved in over half of unintentional drug overdose deaths from 2000–2016. While there is now recognition that substance use among older adults is increasing (Fahmy et al., 2012; Han, 2018; Lofwall et al., 2008), and that more older adults need treatment for substance use disorder (Gfroerer et al., 2003), most studies of overdose drug deaths among those middle-aged and older have focused on opioids (Clausen et al., 2009; Larney et al., 2014). To our knowledge, our study is the first to describe the prevalence of drug overdose deaths that involve cocaine among middle-aged and older adults, and identify demographic characteristics associated with cocaine involved deaths compared to non-cocaine-related deaths for these age groups. Cocaine-involved overdose deaths are commonly overlooked, especially in the setting of the opioid epidemic, but with high drug overdose mortality among adults 45 years of age and older, this has important public health implications.

In our study, cocaine-involved decedents compared to non-cocaine-involved decedents were more likely to be male, non-Latino black, and live in the Bronx. A recent study also found a high death rate of cocaine-related overdose among non-Latino black persons age 20–64, comparable to death rates of opioids among non-Latino whites (Shiels et al., 2018). National data reports a higher prevalence of past-year cocaine use and cocaine use disorder among non-Latino blacks compared to non-Latino whites and Latinos (John and Wu, 2017), and therefore the higher prevalence of cocaine use could explain the higher cocaine-involved overdoses in this population. Another important factor to consider for why cocaine-related overdose deaths are higher among non-Latino blacks and males may be related to the high prevalence of hypertension and underlying cardiovascular disease in this population in NYC (NYCDOHMH, 2017b; New York State Department of Health, 2000). Recent data show high rates of premature heart disease and stroke deaths among black males in New York City ages 18–65 with high rates in several neighborhoods in the Bronx (NYCDOHMH, 2017c). Given cocaine's association with myocardial injury and vascular events, including coronary plaque progression (Sandfort et al., 2017), it is not surprising to find high rates of cocaine involved overdoses in populations with high rates of underlying cardiovascular and cerebrovascular disease. However, this study cannot delineate the role of underlying cardiovascular diseases among the decedents of this study, especially in the setting of other substances present on toxicology.

In our study, we found that opioids, alcohol, and benzodiazepines were also present along with cocaine for many overdose deaths. It is difficult to distinguish what role cocaine had in these overdose deaths. Undoubtedly in some of the cases the other substances, such as opioids (especially fentanyl), are the main triggers of the overdose death as national data show the co-use of heroin and synthetic opioids is driving the increase in cocaine-involved overdose deaths in the United States (McCall Jones et al., 2017). However, if an individual also had cardiovascular disease the role of cocaine could be the main contributor to death despite the presence of other drugs or alcohol. It is also important to note the recent rise in overdose deaths involving fentanyl for this population reflecting the recent presence of fentanyl in cocaine and heroin products and driving the increase in overdose deaths in NYC

from 2014 to 2016 (NYCDOHMH, 2017a). Another important substance to note is the large proportion of cocaine-involved overdose deaths that also involved alcohol. The concurrent use of cocaine and alcohol is dangerous as cocaine is metabolized to cocaethylene. This active metabolite has a longer half-life than other cocaine metabolites and found to be cardiotoxic in animal models (DeMott et al., 2010; Xu et al., 1994). This may explain the additive effect on heart rate of co-use of alcohol and cocaine compared to either use alone (Pennings et al., 2002). This could place individuals who concurrently use alcohol and cocaine at higher risk for overdose. Finally, with over 80% of decedents of cocaine-involved overdoses analyzed in this study having another substance present at death, the co-use of substances in this population has important public health implications. However, there exists limited research on polysubstance use among older adults or adults with chronic diseases and this should be a research priority.

Providers and public health messaging must inform patients of the possible cardiovascular risks of cocaine use, and the risks of concurrent use with alcohol and other drugs. All patients with known cardiovascular disease should be screened for and counseled on cocaine use as patients may not be aware of their high risk for further cardiovascular injury or sudden death even with one-time use (Rezkalla and Kloner, 2007; Sanchez et al., 2013). And in general, providers should consider screening older adults and adults with chronic medical conditions for unhealthy substance use given the potential for adverse events of drug use with specific underlying medical disease (Han et al., 2018).

Our study has several limitations that are common in studies that rely on data from death certificates and toxicology reports. Data from the Office of the Chief Medical Examiner often relies on individual judgment in classifying deaths and what the underlying causes were. There also may be inaccuracies or delays in the collection of toxicology specimens that could affect the detection of drugs on autopsy. Another major limitation is our study was limited to NYC residents and may not be generalizable to other parts of the country. Another key limitation is the lack of important medical information for the decedents that may have contributed to their death, particularly since older adults are more likely to have chronic cardiovascular and other diseases. Future studies that include autopsy information could inform underlying cardiovascular disease status among decedents of cocaine-involved overdoses. In addition, since we do not have reliable prevalence estimates for cocaine use in this population, we, therefore, cannot determine the relative risk of death from cocaine use, especially among adults with underlying cardiovascular disease. Finally, this study is restricted to known NYC residents and decedents with a non-NYC or missing zip codes were excluded. This inadvertently may have removed some individuals who were homeless and did not have a known zip code, and therefore this study may not fully capture all NYC residents. Taken together, the lack of information regarding health and social conditions (i.e., homelessness) limits our analysis of who may be vulnerable to cocaine-involved overdose.

5. Conclusions

Cocaine was involved in over half of unintentional drug overdose deaths among NYC residents age 45–84 from 2000–2016. Studies are needed to better understand the risks of cocaine use among middle-aged and older adults, especially adults with underlying cardiovascular disease.

Contributors

All authors are responsible for this reported research. B. Han, E. Tuazon, and S. Mantha, conceptualized and designed the study, conducted the statistical analyses, helped interpret results, drafted the initial manuscript, and revised the manuscript. D. Paone conceptualized and designed the study, helped interpret results, critically reviewed and edited the manuscript. H. Kunins helped interpret results, critically

reviewed and edited the manuscript. All authors read and approved the final manuscript

Role of funding source

Conflict of interest

No conflict declared.

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