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Colombo Plan Bulletin

Trends in Toxic Adulterants in Street Drugs in the United States

cfsre
The Center for Forensic Science Research & Education

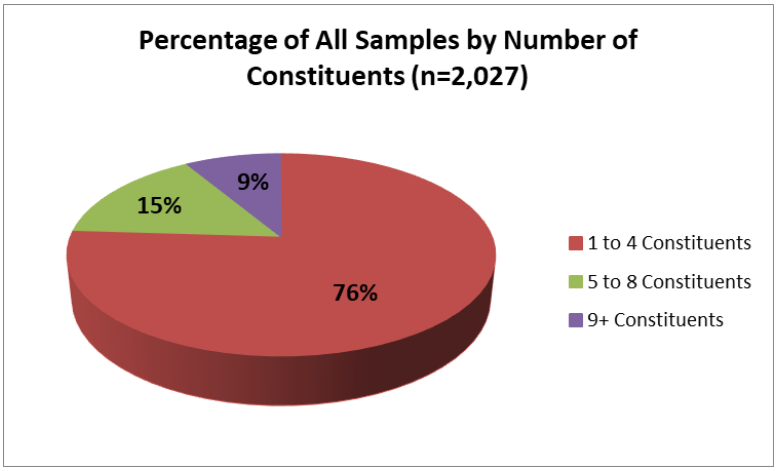
Project Overview: The objective of this project was to perform a survey of toxic adulterants in seized materials from across the United States.

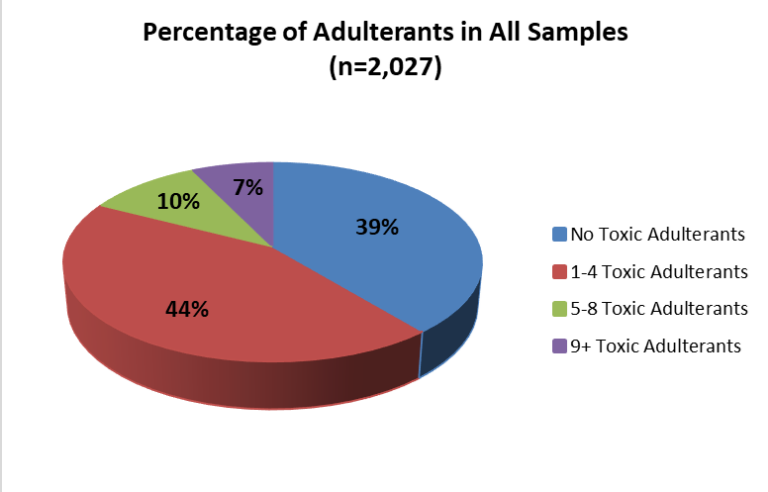
Study Design and Methods: A total of 2,031 seized drug extracts were submitted to the CFSRE for testing. Laboratories were contacted and requested to submit seized drug extracts suspected of containing opioids (heroin/fentanyl), methamphetamine and/or cocaine. Samples were analyzed using a using a Waters ACQUITY UPLC® I Class Waters Xevo® G2-S QTOF. Analytical separation was achieved using an ACQUITY UPLC® BEH C18 (2.1 mm x 150 mm, particle size 1.8 micron) column at 50˚C with a flow rate of 0.4 mL per minute and 5 µL injection. The Xevo® G2-S QTOF operated in positive electrospray ionization resolution mode (50-1000 m/z) with collision energy of 10-40 eV. Samples were processed against a library containing over 1100 drugs, adulterants and precursors/by-products. Criteria for calling a sample positive included: a clearly identifiable chromatograph peak within ±0.25 minutes of analyte in database, an observed mass of the molecular ion within ± 5ppm of mass in database, an observed mass of fragment ion within ± 2mDa, and a response greater than 800 (in the 3D data).

States Providing Samples	
Florida	Ohio
Georgia	Pennsylvania
Illinois	Texas
Indiana	Vermont
Kentucky	West Virginia
New Hampshire	-

Summary Data

Of the 2,031 samples analyzed, 2,027 returned positive results. There were four samples that were negative in the data set. Figure 1 shows the distribution of data by the number of constituents identified in the samples. Any identified drug, precursor or by-product was counted in the tabulations of the data. Most of the samples (76%) contained four or less total constituents. Fentanyl was identified in 899 samples, followed cocaine in 886 and methamphetamine in 785.





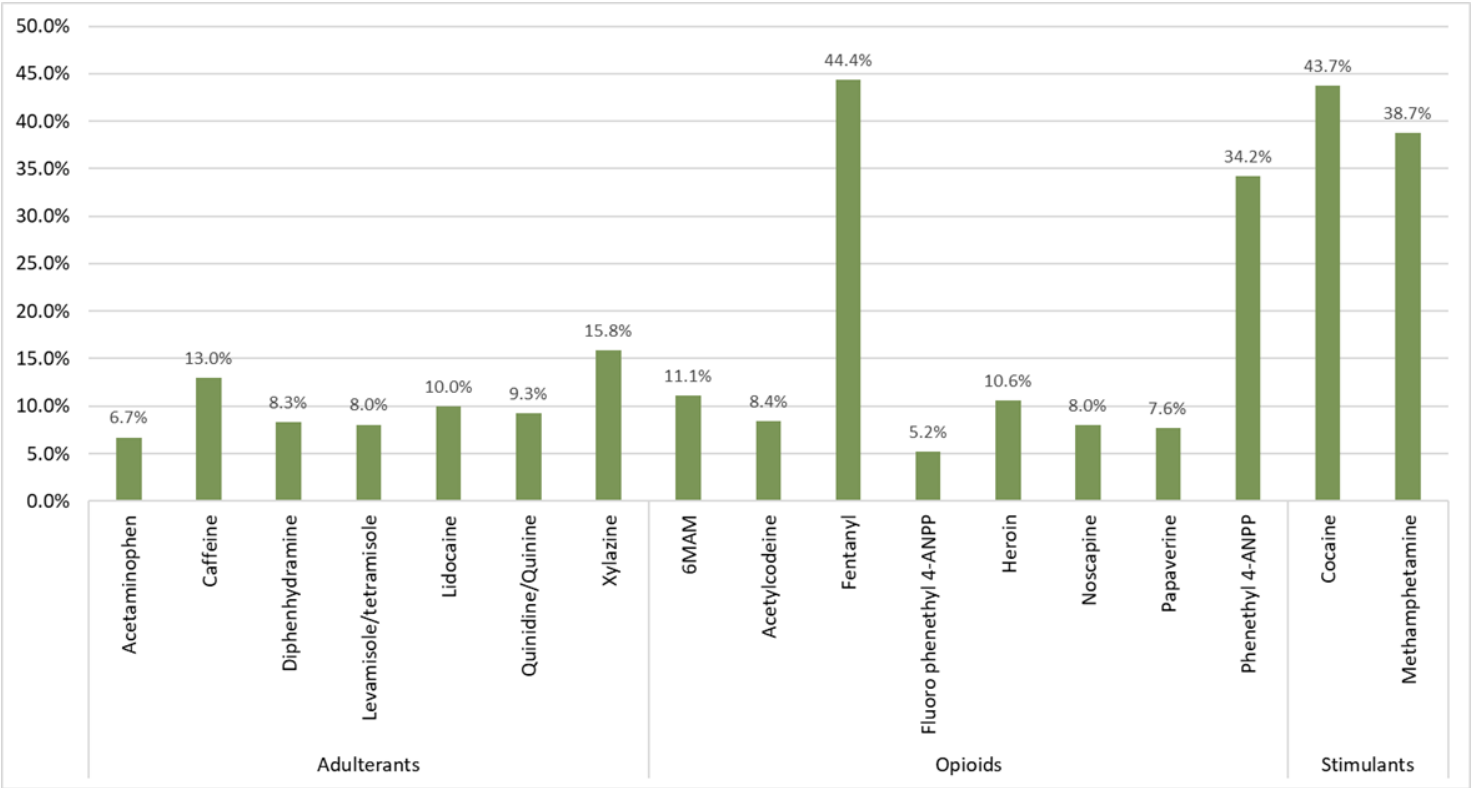
Adulterant Summary Data

Related to the adulterants found in the samples, 39% of the samples were unadulterated (Figure 2). Forty-four percent (44%) of the samples contained between 1 to 4 toxic adulterants. For the purposes of this analysis, any drug, adulterant or cutting agent that was identified in the sample that was not the peak in the sample with the greatest area was considered an adulterant. One sample contained 21 substances other than drug with the greatest peak area.

Drug Mixtures Observed in Seized Drug Samples

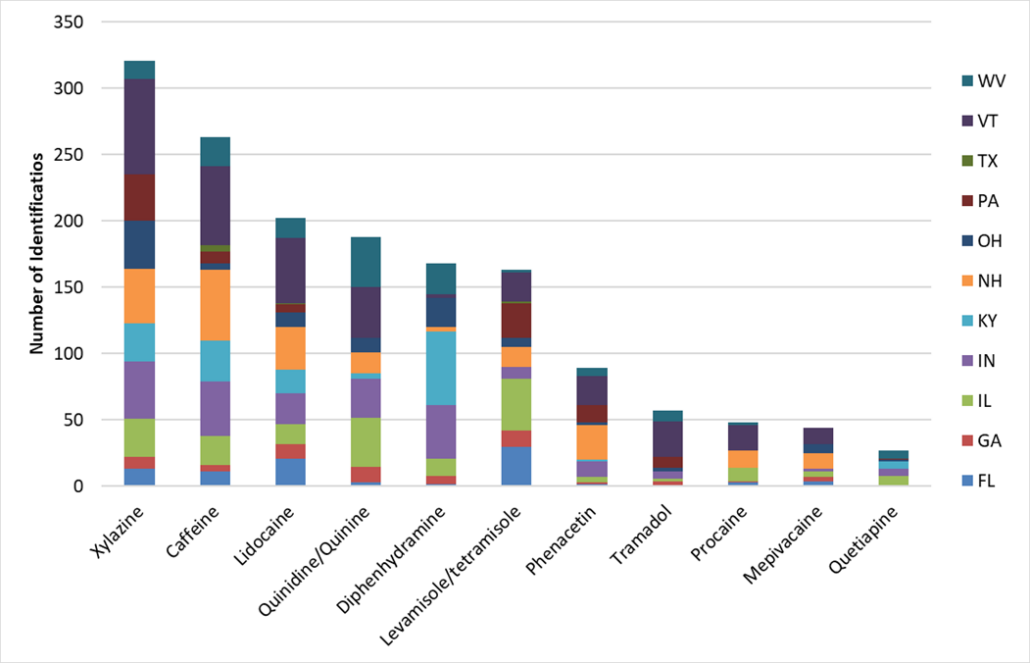
State	Identified Components
Illinois	Fentanyl, benzyl fentanyl, quinine/quinidine, cocaine, quetiapine, xylazine, 6-MAM, heroin, phenethyl-4ANPP, protonitazene, noscapine, clonazolam, acetylcodeine, hydroquinidine, papaverine, nicotinamide, fluoro phenethyl 4-ANPP, doxylamine, morphine, cinchonine, risperidone, and lidocaine
Vermont	Fentanyl, cocaine, lidocaine, heroin, phenethyl-4ANPP, dextro/levo methorphan, 6-MAM, tramadol, fluorofentanyl, phenacetin, noscapine, caffeine, papaverine, melatonin, morphine, xylazine, quinine/quinidine, diphenhydramine and acetaminophen
Illinois	Fentanyl, heroin, quinine/quinidine, phenethyl 4-ANPP, 6-MAM, acetylcodeine, papaverine, lidocaine, mitragynine, hydroquinindine, morphine, noscapine, codeine, xylazine, cocaine, oxycodone, cinchonine, NPP
Illinois	Fentanyl, heroin, fluoro phenethyl 4-ANPP, quinine/quinidine, quetiapine, xylazine, cocaine, 6-MAM, acetylcodeine, phenethyl 4-ANPP, hydroquinidine, papaverine, noscapine, cinchonine, acetaminophen, morphine, NPP
Ohio	Fentanyl, heroin, cocaine, phenethyl 4-ANPP, descholoretizolam, 6-MAM, acetylcodeine, fluoro phenethyl 4-ANPP, papaverine, quinine/quinidine, noscapine, lidocaine, diphenhydramine, mepivacaine, morphine, phenacetin, MeO-acetyl fentanyl, cinchonine

Percent Positivity by Drug Classification (n=2,027)



Data shown in the graph above shows the distribution for constituents identified with greater than 5% positivity. Fentanyl was identified in 44% of the samples, followed by cocaine in 43% and methamphetamine in 38%. Of the 790 cases that did not contain any other drug, adulterant or by-product, 453 (57%) were samples positive for methamphetamine only. Cocaine was found unadulterated in 274 (34%) and fentanyl was the only constituent identified in 18 (2.2%).

Overview of Adulterant Findings



Xylazine was the most frequently detected adulterant in the data set with a positivity rate of 15%, which is nearly double what is was in the previous round of data collection (8%). Quinine/quinidine was the next most frequently encountered adulterant detected in 188 (9.2%) of the cases analyzed, which is approximately half the positivity rate from the previous sample collection (18%). Diphenhydramine, levamisole and lidocaine positivity also significantly decreased in the most recent data collection going from 15% to 8%, 26% to 8% and 30% to 10%, respectively (See table below).

Detection Rates of Adulterants Over Time

Adulterant	2018 Round 1 (n=515)	Round 1 % Positivity	2019 Round 2 (n=1,031)	Round 2 % Positivity	2020-21 Round 3 (n=2,126)	Round 3 % Positivity	2022-23 Round 4 (n=2,027)	Round 4 % Positivity
Acetaminophen	26	5%	63	6%	320	15%	136	7%
Caffeine	177	34%	105	10%	570	27%	263	13%
Diphenhydramine	35	7%	17	2%	318	15%	168	8%
Levamisole	61	12%	112	11%	547	26%	163	8%
Lidocaine	64	12%	134	13%	646	30%	202	10%
Phenacetin	29	6%	78	8%	611	29%	89	4%
Procaine	70	14%	90	9%	150	7%	48	2%
Quinine/quinidine	123	24%	108	10%	381	18%	188	9%
Xylazine	8	2%	35	3%	160	8%	321	16%

Shown in the table above is select positivity for adulterants over time. The pilot study included 515 samples from Kentucky and Vermont that was completed in 2018. The second round covered the analysis of 1,031 drug exhibits from Pennsylvania, Texas, North Carolina, Virginia, New York, Georgia and Maryland, and it was completed in 2019. The third round of the project was completed in 2021 and covered the analysis of 2,126 samples from Ohio, Vermont, Illinois, Florida, Kentucky, New Hampshire, California, Pennsylvania, Texas and Washington DC. The most recent data was completed in 2023 and includes samples from Ohio, Vermont, Illinois, Florida, Kentucky, New Hampshire, Pennsylvania, Texas, West Virginia, Indiana and Georgia. Highlighted in the table above is the round in which the adulterants were seen with the greatest frequency. The diversity of adulterants used to cut illicit drugs continues to change over time along with the relative frequencies of detection in street samples. Due to the public health impacts and toxicity, these adulterants should continue to be monitored.

Drug Combinations

Principle Drug	In Combination With	Frequency of Combination within Principal Drug
Cocaine	Levamisole	31%
Cocaine	Lidocaine	19%
Cocaine	Phenacetin	14%
Fentanyl	Xylazine	36%
Fentanyl	Other Opioids	28%
Fentanyl	Caffeine	21%
Fentanyl	Quinine/Quinidine	20%
Fentanyl	Lidocaine	19%
Fentanyl	Diphenhydramine	18%
Fentanyl	Cocaine and Methamphetamine	9%
Fentanyl	Designer Benzodiazepines	4%
Fentanyl	Xylazine, Quinine/Quinidine, Caffeine, and Lidocaine	3%
Fentanyl	Heroin, Cocaine, and Methamphetamine	2%
Fentanyl	Nitazenes	1%
Heroin	Morphine and Codeine	10%
Methamphetamine	Caffeine	19%
Methamphetamine	Acetaminophen	4%

Cocaine, fentanyl, and methamphetamine positive samples were examined for combinations with other drugs and adulterants. When evaluating drug combinations, the principle drug was characterized as being the main component in the sample. Multiple substances under the "in combination with" column indicates that all substances listed were found in the sample together with the principal drug. The frequency listed was based on one or more of those drugs being identified along with the principal drug. In some instances, a drug category was listed due to positives for multiple different drugs from the same class, specifically the nitazenes, designer benzodiazepines, and other opioids categories. The nitazene category included the following drugs: metonitazene, n-desethyl isonitazene, etonitazepyne, and protonitazene. Designer benzodiazepines included bromazolam, clonazolam, deschloroetizolam, diclazepam, etizolam, flualprazolam, and flubromazolam. The other opioid category consisted of acetyl fentanyl, benzyl fentanyl, chlorofentanyl, fluorofentanyl, heroin, tramadol, and valeryl fentanyl.

Cocaine positive samples most commonly contained levamisole (31%), followed by lidocaine (19%), and phenacetin (14%). When fentanyl was identified as the primary drug, several different combinations were identified. Fentanyl was found with xylazine in 36% of the samples evaluated and other opioids in 28% of the cases. Methamphetamine positive samples were not normally adulterated, however, the most common combinations of adulterated methamphetamine samples contained caffeine (19%) or acetaminophen (4%).

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