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## Understanding intentionality of fentanyl use and drug overdose risk: findings from a mixed methods study of people who inject drugs in New York City

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### Abstract

**Background**—As the proportion of drug overdose deaths involving fentanyl continues to increase in the US, monitoring exposure to and possible changes in intention to use fentanyl among people who use drugs (PWUD) is of great public health importance. This mixed methods study examines intentionality of fentanyl use among persons who inject drugs (PWID) in New York City during a period of unprecedentedly high rates of drug overdose mortality.

**Methods**—Between October 2021-December 2022, N=313 PWID were enrolled in a cross-sectional study that included a survey and urine toxicology screening. A subset of N=162 PWID also participated in an in-depth interview (IDI) examining drug use patterns, including fentanyl use, and experiences with drug overdose.

**Results**—83% of PWID were urine-toxicology positive for fentanyl, though only 18% reported recent intentional fentanyl use. Intentionality of fentanyl use was associated with being younger, white, increased drug use frequency, recent overdose (OD), recent stimulant use, among other characteristics. Qualitative findings suggest PWID tolerance to fentanyl may be increasing, which may be resulting in an increased preference for fentanyl. Concern about overdose was common with nearly all PWID using overdose prevention strategies to avoid it.

**Conclusion**—The findings from this study demonstrate a high prevalence of fentanyl use among PWID in NYC, despite an expressed preference for heroin. Our results suggest that the pervasiveness of fentanyl may be increasing fentanyl use and tolerance, which may contribute to

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**Ethics:**

The study was approved by the New York University School of Medicine Institutional Review Board

an increased risk for drug overdose. Expanding access to existing evidence-based interventions such as naloxone and medications for opioid use disorder is necessary to reduce overdose mortality. Further, exploring the implementation of additional novel strategies to reduce the risk of drug overdose should be considered, including other forms of opioid maintenance treatment and expansion and government support for overdose prevention centers.

### Keywords

fentanyl; heroin; drug overdose; COVID-19

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### Background

The United States (US) has been experiencing a drug overdose crisis for over two decades (Hedegaard H et al., 2021). In 2015, drug overdose mortality began to accelerate precipitously (Spencer et al., 2022) due to the increased proliferation of fentanyl, a synthetic opioid that is 50–100 times more potent than morphine (Suzuki & El-Haddad, 2017). Between 2015–2021 the rate of overdose deaths grew from 16.3 per 100,000 (Rudd et al., 2016) to an unprecedented 32.4 per 100,000 (Spencer et al., 2022). The primary driver of this increase was fentanyl which was involved in 66% of deaths in 2021 (Weiland & Sanger-Katz, 2022).

In New York City (NYC), drug overdose deaths have nearly tripled since 2015, increasing from 13.6 per 100,000 to a record 39.4 per 100,000 in 2021 (Askari MS et al., 2023). As deaths have increased, so has the proportion of overdose mortality involving fentanyl. Since 2017 fentanyl has been the most common drug identified in overdose deaths in NYC (Askari MS et al., 2023). Between 2017–2021, fentanyl involvement increased from 57% to 80% while heroin involvement decreased from 52% to 37% (Askari MS et al., 2023; M. Nolan et al., 2018).

Fentanyl has posed a particular threat to the safety of persons who use drugs (PWUD) due to both its high potency and visual similarity to heroin and other white powder drugs or pressed pills (Suzuki & El-Haddad, 2017). When fentanyl was introduced into the illicit drug supply in the US, it was initially and primarily mixed into heroin (Increases in Fentanyl Drug Confiscations and Fentanyl-Related Overdose Fatalities, 2015; Ciccarone, 2017; Prekupec et al., 2017) and opioid analgesics (Drug Enforcement Administration, 2021; Sutter et al., 2017; Tomassoni et al., 2017), but has also been found in cocaine (M. L. Nolan et al., 2019; Park et al., 2021; Tomassoni et al., 2017), methamphetamine (New York City Department of Health and Mental Hygiene, 2017; Park et al., 2021), amphetamines (Drug Enforcement Administration, 2021; Sundaram, 2022), and benzodiazepines (Drug Enforcement Administration, 2021; Sutter et al., 2017; Tomassoni et al., 2017). Prior research established that people using drugs containing fentanyl often did so unintentionally (Macmadu et al., 2017; Mars et al., 2017; Stogner, 2014). More recent research has found that many PWUD are aware of their fentanyl use (Buresh et al., 2019; Foglia et al., 2021; Hayashi et al., 2021; Rouhani et al., n.d.), though some studies suggest that fewer than half of PWUD know whether they are using fentanyl (Dezman et al., 2020; Ickowicz et al., 2021; Karamouzian et al., 2020; Martinez et al., 2021).

Since fentanyl has appeared in the illicit drug supply in the US, several studies have examined PWUDs' impression of fentanyl, including whether they prefer it to heroin and/or use it intentionally. Findings regarding fentanyl preference among PWUD have been mixed within and across studies, though most suggest that PWUD prefer either heroin or heroin mixed with fentanyl, with a small minority indicating PWUD prefer using fentanyl alone (Buresh et al., 2019; Carroll et al., 2017; Ciccarone et al., 2017; Daniulaityte et al., 2019; Gryczynski et al., 2019; Hochstatter et al., 2022; Mars et al., 2017; Morales et al., 2019). However, as the prevalence of fentanyl has grown, preference for it may be increasingly driven by market availability and increasing tolerance. In a recent study of PWUD in NYC, participants described their preferences for fentanyl, heroin or both in the context of the drugs' effects and availability. PWUD reported decreased consumer agency to choose heroin, as compared to fentanyl, suggesting that availability may have an outsized effect on preference (Urmanche et al., 2022). Mars et al further underscore the complexity of the concept of preference in their paper examining whether fentanyl is a supply-led or market-led product. As Mars et al describe, "There are hints that among some dependent heroin users, fentanyl's higher potency has increased their opioid tolerance, making regular heroin alone insufficient to satisfy the demands of their addiction, leading them to favor fentanyl over heroin regardless of their initial preference" (Mars et al., 2019).

A small number of studies have examined PWUD intention to use fentanyl, separate from preference. In studies of intentional fentanyl use, PWUD are typically asked whether they "intentionally used" or "sought to use" fentanyl. In a small study of people who use opioids (PWUO) who tested positive for fentanyl in NYC (N=33), 21% reported they had intentionally used fentanyl (Martinez et al., 2021). In a Massachusetts study of individuals in a methadone-assisted opioid withdrawal program, 70% reported having ever used fentanyl intentionally (Kenney et al., 2018). In a New Jersey study of PWUO who were enrolled in drug treatment, preference and intentionality of fentanyl use were assessed separately. Preference for fentanyl was reported by 52% of participants, yet 40% reported ever having intentionally used fentanyl, suggesting that not all individuals who preferred fentanyl had intentionally used it (Foglia et al., 2021).

Irrespective of preference for, intention to use, or ability to detect fentanyl, PWUD remain concerned about the increased risk of overdose it poses. In response, PWUD are utilizing a multitude of harm reduction strategies to mitigate overdose risk. Prior research has found these strategies to include using smaller "test" doses to gauge potency, using a trusted dealer to increase the likelihood of using a consistent product, using with or near others to increase the likelihood of resuscitation in the event of an overdose, using fentanyl test strips to determine whether fentanyl is present, keeping naloxone on hand to reverse an overdose, and using less risky methods of consumption including smoking or sniffing (Bardwell et al., 2019; Carroll et al., 2017; Mars et al., 2017, 2018; McKnight & des Jarlais, 2018; Rhodes et al., 2019; Rouhani et al., n.d.; Urmanche et al., 2022). While some of these strategies have been used by PWUD to avoid overdose prior to the proliferation of fentanyl (Heller & Stancliff, 2007; Neira-León et al., 2011), many of these strategies have been more widely implemented in response to the unpredictability of the drug supply due to fentanyl.

As the proportion of drug overdose mortality involving fentanyl continues to increase in the US, monitoring exposure to and possible changes in preference or intention to use fentanyl among PWUD is of great public health importance as they may expand our understanding of overdose risk as well as inform the development and implementation of more effective treatment options for people using fentanyl. Using a mixed methods approach, including survey data, urine toxicology screening, and qualitative interviews, this study examines the prevalence of fentanyl use and intentionality of fentanyl use among persons who inject drugs (PWID) in New York City during a period of unprecedentedly high rates of drug overdose mortality.

## Methods

### Recruitment

Persons who inject drugs were recruited between October 2021-December 2022 using an adapted version of respondent-driven sampling (RDS). Fourteen “seeds”, or individuals who served as initial study participants, were recruited from areas adjacent to syringe services programs (SSP) and methadone maintenance treatment programs (MMTP) in NYC. Study eligibility criteria included: being at least 18 years of age, injection of heroin, fentanyl, cocaine, crack or methamphetamine within the previous 30 days, fluent English speaker, ability to give informed consent and planning to reside in the NYC-metro area for the next six months. All study participants were screened for eligibility at the time of recruitment (for seeds) or at their first contact with the study team to set up an initial appointment (for referrals). Study eligibility was again confirmed when participants arrived for their first appointment.

At the completion of the initial study visit, study “seeds” were given three referral vouchers, or “coupons”, to provide to their drug using friends and acquaintances to participate in the study. Peer referral from seeds was initially slow and then interrupted for one month due to the Omicron surge of COVID-19. A variety of methods were employed to increase enrollment, including recruitment of additional seeds, increasing the number of referral coupons from three to six, and allowances for lost coupons.

### Data Collection

A total of N=313 eligible PWID were enrolled in this cross-sectional study which included a survey, urine toxicology screening and blood draw for HIV, HCV and SARS-CoV-2 testing. Computer-assisted structured interviews lasting ~30 minutes were conducted by experienced interviewers. Data were obtained on demographics, 30-day and lifetime self-reported drug use, including intentionality of fentanyl use which was assessed by asking “During the last 30 days, did you use fentanyl intentionally?”, drug use behaviors, overdose experiences, use of overdose prevention and response strategies, substance use treatment history, and other factors. Drug toxicology screening for alcohol, amphetamines, buprenorphine, benzodiazepines, cocaine, fentanyl, heroin, marijuana, methadone, methamphetamine, opiates, oxycodone and tramadol was conducted using the Premier Biotech 13 panel BioCup [disclosure of urine toxicology results to study participants was not permitted by the New York University School of Medicine Institutional Review Board (NYSOM IRB) because

the testing device was not approved by the Food and Drug Administration for diagnostic use]. Urine toxicology results for heroin reflect use of the drug within the previous two days (Cone EJ et al., 1991). The detection window for fentanyl can vary depending on the frequency of use, with detection evident among less frequent users up to three days since last use and up to two weeks among more frequent fentanyl users.(Huhn et al., 2020; Silverstein et al., 1993)

At the completion of the initial interview, all study participants enrolled between October 2021-February 2022 and June-August 2022 were invited to participate in an in-depth interview (IDI) about drug use patterns, including changes during COVID, fentanyl use, and experiences with drug overdose. A total of N=162 PWID opted to participate in the IDIs which lasted 30–45 minutes. All IDIs were audio-recorded for the purpose of transcription and transcribed by a professional transcription service. All names attributed in the qualitative quotes are pseudonyms.

Participants received \$30 for completing the initial interview, \$10 for each person, up to six, that they successfully recruited to the study, and an additional \$30 for the IDI. The study was approved by the NYUSOM IRB.

### Data Analysis

Using a convergent parallel design, quantitative and qualitative data were collected and analyzed simultaneously, but separately, and then compared. All quantitative analysis was conducted using R (R Foundation for Statistical Computing, 2023); coding, qualitative and mixed methods analysis were done using Dedoose (SocioCultural Research Consultants, 2023).

Descriptive statistics were tabulated to describe the demographic characteristics of the sample. To examine intentionality of recent fentanyl use, the sample was classified into three groups based on comparisons of urine toxicology (UT) results and self-reported (SR) drug use. The *Recent Intentional Fentanyl Use* Group (Group 1) included individuals who were SR+/UT+ for fentanyl; the *Recent Unintentional Fentanyl Use* Group (Group 2) included individuals who were SR-/UT+ for fentanyl; and the *No Recent Fentanyl Use* Group (Group 3) included individuals who were SR-/UT- for fentanyl. One participant who reported using fentanyl recently but had a negative urine toxicology test for fentanyl (SR+/UT-) was excluded from the analysis due to the small sample size of a potential fourth group.

Bivariate analysis was conducted to examine potential differences between the complete sample and the qualitative subset, the association between fentanyl use intentionality and demographic characteristics, and fentanyl use intentionality and past 30-day use of overdose prevention and response strategies. Wilcoxon rank sum test was used for continuous variables, and Pearson's Chi-squared test and Fisher's exact test for categorical variables. Significance level was set at  $\alpha=0.05$ .

Semi-structured IDIs were coded by two researchers independently using an a priori code list based on the interview guide. Open coding was also conducted to identify emergent codes. New codes and coding disagreements were discussed at weekly meetings and, if

necessary, resolved by the study PI (CM). Thematic analysis was used to identify and analyze themes related to the intersection of fentanyl and other drug use, drug overdose and overdose prevention and response strategies. Qualitative data were then stratified by the three quantitative groups of intentionality of fentanyl use. Once stratified, qualitative data were once again analyzed to identify themes within each stratum and compared to the quantitative data.

## Results

### Quantitative Results

The demographic characteristics of the complete sample (N=313) and qualitative subset (N=162) are presented in Table 1. Bivariate analysis determined there were no significant differences in the characteristics of these samples, thus only the complete sample findings are described below.

As shown in Table 1, all 313 study participants provided a urine sample for toxicology testing. Of these, 260 (83%) tested positive for fentanyl, yet only 56 (18%) reported intentional fentanyl use in the previous month. Urine toxicology testing also found 40% of samples were positive for heroin, but nearly all participants (99%) reported heroin use in the previous month. Among those who tested positive for fentanyl, 54% tested positive for fentanyl *without* heroin, and 46% tested positive for both fentanyl *and* heroin.

The mean age of participants was 49 years. Just over one-third (35%) of participants resided in Brooklyn, 26% in Manhattan, 12% in Queens, 10% in the Bronx, 4% in Staten Island and 13% resided in other areas, including New Jersey and Long Island. The majority (71%) of participants were male, 34% were Non-Hispanic Black, 31% were Non-Hispanic White, 27% were Hispanic, and 8% reported “Other” race or ethnicity. Housing instability was common, with 43% of participants reporting unstable housing or homelessness in the past six months, and 21% living with friends/relatives. Income sources over the previous six months included government benefits (70%), irregular employment or friend/relative’s income (12%), possible illegal income (10%), and regular employment (8%). Seventy percent of participants had a high school, GED, or higher level of education, and 65% reported experiencing food insecurity in the last 6 months.

Table 2 displays the results of bivariate analysis comparing the groups of intentionality of fentanyl use and several demographic and drug use characteristics. Compared to participants in the *Recent Unintentional Fentanyl Use* group, *Recent Intentional Fentanyl Use* group participants were significantly younger, began injecting drugs at a younger age, were more likely to be white, food insecure, experiencing serious psychological distress, have a severe substance use disorder, ever diagnosed with a psychiatric condition, previously received buprenorphine treatment, have a positive urine toxicology for stimulants, have overdosed one or more times in the previous six months, be HCV positive, report fentanyl as their main drug, and inject drugs more times per day.

Participants in the *Recent Unintentional Fentanyl Use* group were more likely to be experiencing moderate/minor psychological distress, currently in a methadone program,



report heroin as their main drug and inject drugs daily compared to those in the *No Recent Fentanyl Use* group.

Participants in the *Recent Intentional Fentanyl Use* group, compared to those in the *No Recent Fentanyl Use* group, were significantly younger, more likely to be white, ever diagnosed with a psychiatric condition, currently receiving methadone treatment, previously received buprenorphine treatment, have a positive urine toxicology for stimulants, have overdosed one or more times in the previous six months, HCV positive, report fentanyl as their main drug, inject drugs daily and inject more times per day.

Nearly one-quarter of all PWID had overdosed at least once in the previous six months, with 36% of PWID in the *Recent Intentional Fentanyl Use* group experiencing a recent overdose, compared to 21% in the *Recent Unintentional Fentanyl Use* group ( $p=0.02$ ), and 19% in the *No Recent Fentanyl Use* group ( $p=0.04$ ).

Table 3 presents the bivariate results comparing the groups of intentionality of fentanyl use and overdose prevention and response strategies used in the previous month. Among individuals in the *Recent Intentional Fentanyl Use* group, the following strategies were reported by the largest proportion of PWID: keeping naloxone nearby (57%), using smaller amounts of drugs (52%), and using drugs with or near other (38%). Among individuals in the *Recent Unintentional Fentanyl Use* group, keeping naloxone nearby (62%), using a trusted dealer (47%) and using smaller amounts of drugs (45%) were reported by the largest proportion. Among individuals in the *No Recent Fentanyl Use* group, using smaller amounts of drugs (54%), using a trusted dealer (43%) and using drugs with or near others (41%) were reported by the largest proportion.

Bivariate analysis determined that *Recent Unintentional Fentanyl Use* group participants were more likely to use “trusted” dealers ( $p=0.003$ ) and fentanyl test strips ( $p=0.044$ ) than *Recent Intentional Fentanyl Use* group participants, and more likely to keep naloxone nearby ( $p=0.001$ ) compared to *No Recent Fentanyl Use* group participants. Compared to *Recent Fentanyl Use* group participants, individuals in the *No Recent Fentanyl Use* group were more likely to use test shots ( $p=0.04$ ) and taste their drugs (by mouth) before using them ( $p=0.02$ ), but less likely to keep naloxone nearby ( $p=0.035$ ). A total of 15 PWID (4.8%) reported not using any strategy to prevent overdose in the last month, with no difference by intentionality of fentanyl use group assignment.

## Qualitative Results

Quantitative data indicate that most individuals who tested positive for fentanyl reported not intentionally using fentanyl in the previous month; however, these data do not provide a clear indication as to whether participants may have suspected that they used fentanyl recently. To explore suspected fentanyl use and other related themes, qualitative data were stratified using the three categories of fentanyl use intentionality, and themes were explored within and across these categories.

## Recent Intentional Fentanyl Use Group

All participants in the *Recent Intentional Fentanyl Use* group tested positive for fentanyl and reported intentionally using fentanyl in the last month, indicating that their recent use of fentanyl was intentional.

“Honestly, after fentanyl, the heroin’s like nothing.”

As the quantitative findings indicate, individuals in the *Recent Intentional Fentanyl Use* group were more likely than those in the other two groups to report fentanyl as their main drug, indicating a preference for fentanyl. However, the qualitative data indicate that preference within this context was multifaceted. For some PWID like Scott, a man in his 40s who began injecting twenty years ago, the main appeal of fentanyl is its potency. Here Scott explains the differences between heroin and fentanyl in terms of potency and why prefers fentanyl:

**Scott:** Honestly, after fentanyl, the heroin’s like nothing.

**Interviewer:** And how can you tell that there’s fentanyl in the heroin you buy?

**Scott:** How it hits you. It just totally is different. It hits you 50 times harder. It’s like when you first started doing dope, you get super high. And after a while you get a tolerance. You’ll get that after years. You’re just basically doing dope to stay well. But with the fentanyl, you’re getting high again.

**Interviewer:** Are you developing any tolerance to the fentanyl?

Yeah, everybody does. But I mean, it’s not something like with the heroin. It is always going to get you high.

For others, preference has less to do with pleasure and more to do with physical dependence due to increased tolerance over time. In the following excerpt Alicia, a woman in her 40s who began injecting six years ago, explains how she realized she preferred fentanyl to heroin:

**Interviewer:** Do you prefer fentanyl over heroin?

**Alicia:** Now, I do, yeah. If I see something too dark I’m like, “I don’t want it. I want the fentanyl.” Because I get sick...like, I could do dope and still get the sweats. When I first got sick I’m like, “Why am I getting sick, and I’m still doing it?” And then my friend’s like, “I think that’s fentanyl.” So I used to tell my boy, “Listen, I don’t want that crap. I want fentanyl.” And he’s like, “I don’t want to give that to you.” And I’m like, “you have to give it to me.”

As Alicia explains, her preference for fentanyl was developed by repeated, unknown exposure to it, which increased her tolerance, making heroin, and potentially heroin mixed with fentanyl an undesirable option. Alicia’s experience may be more common than we are aware given that heroin and fentanyl are usually mixed together but are typically sold as heroin. Further, as our urine toxicology results suggest, it is plausible that some drugs



sold as heroin do not contain heroin but instead are fentanyl. Because of this, when some PWID express having a current preference for fentanyl, they may be reflecting a need to use it because of tolerance. In the following quote by Doug, a man in his late 30s who began injecting nearly 20 years ago, the complexity of the concept of preference is described further:

**Interviewer:** What are your thoughts on fentanyl?

**Doug:** It's a demon. It sucks, but I guess it's just cheap heroin. It's not really heroin, but it's strong, but it wears off quick.

**Interviewer:** Do you ever use it intentionally?

Yeah. Because the heroin now is not really good, it's garbage. It doesn't even really work. But if you know you're getting fentanyl, you know you're going to feel it, you know you're going to get high.

As Doug describes, his opinion of fentanyl is complicated. While he dislikes it due to its short half-life, and generally prefers heroin, he needs to use fentanyl because he no longer feels the effects of heroin. While we do not know what caused him to shift to using fentanyl since he prefers heroin, given Alicia's experience and the proportion of PWID in this study who were unintentionally using fentanyl, it is possible that Doug was also unknowingly using fentanyl for a time, or some mix of heroin and fentanyl, when he thought he was using heroin. Like Alicia such consistent exposure could have increased his tolerance thus making heroin, or a mix of heroin and fentanyl less effective and less preferred.

"I'm going to do one bag or something first to see, to make sure."

Despite many PWID in the *Recent Intentional Fentanyl Use* group preferring fentanyl due to its potency and their increased tolerance, this did not necessarily mean they possessed a more cavalier attitude toward drug use and overdose. On the contrary, most were concerned about overdose and nearly all were taking precautions to try to avoid it. For June, a woman in her 30s who began injecting drugs in her 20s, fentanyl has been her drug of choice since she started using fentanyl patches over a decade ago. June reported having a high tolerance to street fentanyl as a result. Despite years of experience using fentanyl, as June describes, she is still very concerned about overdose:

I am concerned about it. You never know which one is going to be your last. You could test it. It can say it has fentanyl. You don't really know how much...you know what I mean? It's so dangerous.

June reported using naloxone as her main strategy for preventing a fatal overdose. However, as she describes in the following quote, she also tries to moderate the amount she uses, especially if she is using a new dealer:

I don't use a million... You know what I mean? I'm not an idiot. If I get something new from somebody, I'm not going to just fucking slam five bags. I'm going to do one bag or something first to see, to make sure. But that still could always be... there could be poison in that one bag.

The increased frequency of overdoses were a constant reminder of the lethality of the drug supply. It was a reality that nearly every participant discussed, often when reporting the number of times they had overdosed, the number of overdoses they had witnessed, and the number of family, friends, and acquaintances they had lost. For a few PWID, the regularity with which overdoses were occurring in NYC was like nothing they had ever experienced. For Ryan, a man in his 30s who began injecting a decade ago, his recent move to NYC from Florida had exposed him to far more overdoses than he witnessed in his lifetime in Florida. In the following quote, Ryan describes his experiences and why he always has Narcan on him:

**Ryan:** Prior to coming to New York, I'd only seen one overdose in Florida. But in the three or four months that I've been in the city, I've seen two or three deaths and probably 15 to 20 overdoses. [...] I think I've been pretty safe since I haven't overdosed, but you know, knock on wood. I keep Narcan in my bag but it's mainly for other people. I hope I never need it for myself, but if I do I have it on me.

**Interviewer:** Have you ever had to use it [Narcan] on somebody else?

**Ryan:** In the three months I've been here? I think I've supplied Narcan for at least eight overdoses. I've administered it myself probably three times. I did CPR two times. Yeah. It's pretty scary.

Attitudes towards fentanyl among participants in the *Recent Intentional Fentanyl Use* group varied. Though some preferred fentanyl to heroin, for several participants their fentanyl use began as unintentional and then shifted to intentional use as their tolerance increased. For others, the increased potency of fentanyl compared to heroin is appealing. However, even among individuals who reported enjoying its more potent effects, several also reported experiencing withdrawal more frequently, which continues to drive their intentional fentanyl use. Regardless, PWID remain concerned about overdose and their use of multiple overdose prevention strategies demonstrates their significant efforts to avoid it.

### Recent Unintentional Fentanyl Use Group

All participants in the *Recent Unintentional Fentanyl Use* group tested positive for fentanyl but reported they had not intentionally used fentanyl in the last month, indicating that their recent use of fentanyl was unintentional.

“Of course I'm concerned about [overdose], but that's why I deal with the same two guys”.

As the quantitative data indicate, using a trusted dealer was one of the most common strategies used by individuals in the *Recent Unintentional Fentanyl Use* group, and was more likely to be used by unintentional fentanyl users compared to people who had used fentanyl intentionally. Many participants in the *Recent Unintentional Fentanyl Use* group reported using a trusted dealer as their primary overdose prevention strategy. For Ocean, a man in his 30s who began injecting drugs four years prior, while he has used fentanyl in the past and enjoyed it, he is increasingly concerned about overdose because he typically uses drugs alone. To Ocean having a trusted dealer means he will be able to avoid fentanyl

because he believes his dealers both know and will inform him if the drugs they sell contain fentanyl. In this quote Ocean discusses his opinion of fentanyl and why he trusts that his dealers do not sell it:

I did like it [fentanyl]. It was five to ten times stronger than good heroin. Of course I'm concerned about it, but that's why I deal with the same two guys. These old timers, they would never have fentanyl in theirs. I don't deal with nobody else. I deal with the same two people, and I know I'm always getting what I want.

Ocean reported that he did not intentionally use fentanyl in the last month, and despite using dealers that he trusts to never sell drugs containing fentanyl, he tested positive for it. This was also true for several other participants in the *Recent Unintentional Fentanyl Use Group*.

Among some participants who had been injecting drugs for decades, the current unpredictability and lethality of the drug supply required them to change their approach to buying and using drugs. For Paul, a man in his 60s who began injecting drugs over forty years ago, he believed that having a trusted dealer was essential to helping him navigate the instability of the drug supply. Here Paul describes how his behavior related to buying drugs has changed since fentanyl became prevalent:

I'm being more careful because I started a long time ago and there wasn't no fentanyl when I started. Now there's fentanyl and you got to be careful. Now you got to get it from the same person that you know don't have no fentanyl. You can't bounce around and go to this guy, go to that guy because you don't know what they got. Twenty years ago, you can go here, you can go there because whatever they was cutting it with it was more or less safe, so you could go anywhere. But now, you got to find your guy and if he ain't got fentanyl you got to stick with your guy.

Similar to Ocean, Paul reported that he did not intentionally use fentanyl in the last month, but his urine toxicology was positive for fentanyl.

While some PWID relied on a single strategy to protect themselves from overdose, others utilized multiple methods at a time to try to stay safe. For Alex, a man in his 50s who began injecting drugs over twenty years ago, carrying naloxone and always using with another person were his go-to strategies. In the month prior to Alex's interview, he overdosed three times. One of the people Alex bought heroin from informed him that his dope contained fentanyl, but Alex was told it was the "absolute minimum amount." While having naloxone and a friend present helped keep Alex alive, as he explains here, these experiences have not changed his perception of the ubiquity of fentanyl or concern about overdose.

**Alex:** There was a period about a month ago where a lot of the stuff was coming up with fentanyl...I had the one, I overdosed, when I came to, I was like, "Well, I'm not getting that brand again". I'd go get a different brand and it would happen again. And I just basically stopped going down to the park for a brief period and came in the next week and everyone told me, "Oh, the fentanyl's gone. They've got good dope though." [...]

Right now, fortunately, I can get stuff that doesn't have it [fentanyl] in there, so I don't worry about it as much because when I do anything, I'll be with somebody and I'll go first or he'll go first, so there's always someone watching out.

**Interviewer:** Are you concerned about overdosing?

**Alex:** No, not right now, because it's [fentanyl] moved out and basically the dealers where I go have been avoiding it [fentanyl] now. They realized how bad it [fentanyl] was and everyone's still coming to them for regular dope. Now we don't have that problem with people going and getting Narcanned every day, thank God. [...]

**Interviewer:** Do you ever use fentanyl test strips?

**Alex:** No, because it requires you to use a little bit of your stuff and I'm getting only so much in a bag...and now I already know that it's [fentanyl] not happening where I am right now, with my dealers, so I don't feel a need to get the test strips.

Despite his belief that fentanyl was no longer in the drugs his dealers were selling, Alex tested positive for fentanyl, though he reported that he had not intentionally used fentanyl in the last month.

Among participants in the *Recent Unintentional Fentanyl Use* group, while most were aware that fentanyl was in the drug supply, several participants did not believe it was in *their* drug supply, particularly after taking active steps to avoid it. Qualitative interviews confirmed that for at least some individuals, their use of fentanyl was both unintentional and unsuspected. Overdose prevention and response strategies were being used by nearly all PWID, though most were using them inconsistently. Motivations and confidence in using these strategies varied among participants. Some participants took precautions to avoid fentanyl completely while others used strategies to prevent an overdose because of suspicion that fentanyl was in their drugs.

### No Recent Fentanyl Use Group

All participants in the *No Recent Fentanyl Use Group* tested negative for fentanyl and reported that they had not intentionally used fentanyl in the last month.

“I don't like to use fentanyl...I never used it intentionally. I don't like it...I don't want to die. I know so many people that died already.”

The qualitative findings for the *No Recent Fentanyl Use Group* supported the quantitative findings with respect to drug use frequency and not preferring fentanyl to heroin (as demonstrated by “main drug” data). For some people in the *No Recent Fentanyl Use Group*, their less frequent drug use was due to a negative experience that led them to reduce their use, whereas for others, fear of overdose led to a shift in the type or amount of drugs they used. Here Denise, a woman in her 50s who began injecting drugs as a teenager and has never overdosed, discusses why up until recently her drug of choice was heroin:

**Denise:** I use crack, weed, and coke. Just those three. I'm afraid of heroin, because of fentanyl, so I don't deal with that. I stopped about three, maybe four, months ago.

**Interviewer:** Before that, how often were you using heroin?

**Denise:** Every day.

**Interviewer:** Did something happen that made you decide to stop?

**Denise:** No, no, no. Just hearing about people dying and ODing, I was scared.

For Cassie, a woman in her 50s who began injecting drugs twenty years ago, having overdosed more than ten times in a span of a few years led her to initiate methadone treatment. Since the start of the COVID-19 pandemic, Cassie has restricted her heroin and cocaine use to a couple of times per month which she thought would help protect her from overdose. However, a recent overdose experience has made her very fearful, which has caused her to reduce her drug use further:

**Cassie:** Last time I used heroin, which was three weeks ago, I injected it and I overdosed. It was fentanyl, and I didn't know. [...]

I don't like to use fentanyl...I never used it intentionally. I don't like it...I don't want to die. I know so many people that died already.

**Interviewer:** Does that impact your drug use in any way?

**Cassie:** Yeah, it's had me slow down a lot...after the overdose, I've been really scared.

Using smaller amounts of drugs was the most common overdose prevention behavior reported by individuals in the *No Recent Fentanyl Use Group*. While using a smaller amount of drugs as a harm reduction strategy may help to mitigate overdose risk, the unpredictability of the drug supply could cause an overdose even on a small amount of drugs, especially for those with a lower tolerance to fentanyl. For Cole, a man in his late 50s who began injecting ten years ago, his recent heroin use has been relatively stable. He typically uses heroin twice a day, and while he prefers to inject it, he also sniffs it depending on where he is. As Cole explains here, despite his regular heroin use, he recently overdosed on a much smaller amount than he typically uses:

**Interviewer:** What are your general thoughts about fentanyl?

**Cole:** Fentanyl? Afraid of it. I almost died. Narcan saved me...I know four people who died from that, so I'm very afraid right now.

**Interviewer:** When was that?

**Cole:** The beginning of this month.

**Interviewer:** Were you taking anything else besides heroin...?

**Cole:** Not on that day...that's it. And it was just, I didn't even do a bag. I took three sniffs, and usually I could do a bag. I was sniffing and I was going to save the rest to shoot, but I went out...and thank God somebody had Narcan, otherwise I wouldn't be talking to you.

Our qualitative findings confirmed that many participants in the *No Recent Fentanyl Use Group* were using drugs less frequently and overwhelmingly disliked fentanyl, compared to individuals in the other two groups. Despite these differences, 19% of participants in the *No Recent Fentanyl Use Group* had overdosed at least once in the last six months. As the quote from Cole describes, the unpredictability of the drug supply is increasing the likelihood of overdose even for people who use drugs regularly. However, like PWID in the *Recent Intentional Fentanyl Use Group* and the *Recent Unintentional Fentanyl Use Group*, most people regardless of whether they are intentionally using fentanyl are concerned about overdosing and are using multiple methods to try to prevent or respond to an overdose.

## Discussion

The findings of this study suggest widespread use of fentanyl among PWID in NYC. The proportion of PWID in our study who were positive for fentanyl was substantially higher than previous studies in NYC, but not as high as previous studies in OH (Daniulaityte et al., 2019) and MA (Kenney et al., 2018). A study of persons who use opioids in NYC between 2016–2019 detected 35% positive for fentanyl, though the proportion testing positive increased by over 300% between 2016 and 2019 (Martinez et al., 2021). A 2017 study examining drug residue in syringes from PWID recruited at NYC syringe services programs found 17% contained fentanyl (Blachman-Forshay et al., 2018). The larger proportion of PWUD testing positive for fentanyl in this study, compared to other studies in the region, may reflect an increasing prevalence of fentanyl in the drug supply, as NYC drug overdose mortality data indicate (Askari MS et al., 2023). It is also plausible that because this study only included PWID, many of whom may use drugs more frequently than individuals who do not inject drugs, our participants may have had an increased likelihood of exposure to fentanyl. Additionally, the difference in the window of exposure for fentanyl from urinalysis (up to 2 weeks) compared to syringe residue testing (a single injection) may also explain the larger proportion of fentanyl positive results in this study.

The overwhelming majority of PWID in this study – regardless of intentionality of recent fentanyl use group – reported heroin as their main drug, indicating a strong preference for heroin over fentanyl. Yet, as our urine toxicology data indicate, PWID seem to have little agency in avoiding fentanyl. Assuming that the prevalence of fentanyl in the drug supply has increased, as data from this study and drug overdose mortality data in NYC suggest (Askari MS et al., 2023), more PWID are likely using fentanyl, including fentanyl that may not be mixed with heroin. Urine toxicology testing in this study found over half of those who tested positive for fentanyl, tested negative for heroin, suggesting that some PWID may be using fentanyl without heroin. These data align with some qualitative accounts of PWID in the *Recent Intentional Fentanyl Use* group who reported using “straight fentanyl”. Additionally, several PWID reported that the potency of heroin has declined, which may indicate a developing, but potentially unknown tolerance to fentanyl that heroin, or heroin containing fentanyl, can no longer satisfy, as Doug and Alicia described. The result could be a shift in preference for fentanyl determined by increased tolerance and dependence, as Alicia experienced. Such a shift could lead to more frequent drug use, as noted in our *Recent Intentional Fentanyl Use Group*, which could result in a further increased risk of drug overdose due to a greater probability of exposure to a particularly potent dose of fentanyl.



There was widespread awareness among our study participants of the ubiquity of fentanyl in the drug supply in NYC. This was the primary reason most participants were concerned about overdose. Given this, we were surprised to discover that some PWID did not suspect they were using fentanyl. As our qualitative findings demonstrate, having a set of trusted dealers provided some individuals with a false assurance that the drugs they were using did not contain fentanyl. Prior research examining overdose prevention strategies among PWUD has found use of a trusted dealer to be a commonly utilized method (Bardwell et al., 2019; Carroll et al., 2017; Ciccarone et al., 2017; Mars et al., 2017; McKnight & des Jarlais, 2018; Rhodes et al., 2019). In a study of PWUD in Vancouver, Canada using a trusted dealer was found to reduce the use of other strategies, such as drug checking (Bardwell et al., 2019), which was also noted in the quote by Alex and reported by others in this study. A study by Carroll et al that examined the potential protective effect of trusted dealers found that some dealers employed a variety of methods to protect their customers from overdose, including warning customers about the potency of a particular batch of heroin, refusing to sell drugs containing fentanyl, and providing naloxone to PWUD, among others (Carroll et al., 2020). We found support for similar behaviors in our study, including by Alicia who reported that her dealer did not want to sell her fentanyl. Prior research indicates that street-level dealers often have a low level of knowledge about the contents of their supply (Ciccarone et al., 2017; Mars et al., 2017). Considering this, the lack of warning provided to PWID with unsuspected fentanyl use should not necessarily be interpreted as purposefully deceptive. Nevertheless, as Carroll et al (Carroll et al., 2020) and others (Goldman et al., 2019; Weicker et al., 2020) have concluded, providing drug checking tools and naloxone to dealers for their own use as well as to provide to PWUD may help to increase transparency about the contents of their supply and mitigate overdose risk.

Less than one-fifth of PWID in this study reported using fentanyl intentionally, yet the sociodemographic characteristics, patterns of drug use, drug treatment, overdose, and psychological conditions of these individuals were distinctly different from PWID who had recent unintentional fentanyl use or had not used fentanyl recently. Our findings are consistent with those of prior research which found that people who intentionally used fentanyl were more likely to be young, white, and polysubstance users (Foglia et al., 2021). While we believe that intention and preference are mutually exclusive concepts as they relate to fentanyl, the terms are frequently used interchangeably. In previous research investigating preference for fentanyl among PWUD, those who preferred fentanyl were younger (Buresh et al., 2019; Hochstatter et al., 2022; Ickowicz et al., 2021; Mazhnaya et al., 2020; Morales et al., 2019), more likely to be white (Morales et al., 2019), homeless (Buresh et al., 2019), inject (Buresh et al., 2019) or use drugs daily (Morales et al., 2019), inject methamphetamine daily (Ickowicz et al., 2021), have overdosed within the last year (Morales et al., 2019), and have severe mental illness (Hochstatter et al., 2022). In our study we also found an increased likelihood of stimulant use, more frequent overdose, more frequent drug use and a prior psychiatric diagnosis among those in the *Recent Intentional Fentanyl Use Group* compared to each of the other two groups. These findings suggest that people using fentanyl intentionally may be in greater need of integrated mental health and harm reduction and/or substance use treatment services.

Concern about overdose was common among PWID, regardless of intentionality of fentanyl use group. Nearly all participants reported using at least one strategy to prevent or respond to an overdose in the last month. Despite this, several PWID reported experiencing and witnessing an increasing number of overdoses in recent years. PWID in the *Recent Intentional Fentanyl Use* group were significantly more likely to have experienced at least one overdose within the previous six months. Previous research examining risk factors for fatal overdose found that a non-fatal overdose within the past six months was independently associated with an elevated risk of a subsequent fatal overdose, with an increasing number of recent overdoses associated with a greater risk of death due to drug overdose (Caudarella et al., 2016). Taken together, these findings suggest that providing targeted overdose prevention and drug treatment services to PWUD who are intentionally using fentanyl is warranted.

The results of this study should be considered in light of some limitations. First, COVID-related disruptions led to recruitment challenges. Our use of additional recruitment strategies may have made our sample less representative, and more akin to snowball sampling. Second, the short exposure window of urine toxicology testing limited our ability to capture fentanyl use over a longer period of time. Given the ubiquity of fentanyl in NYC and that 99% of our sample reported using heroin in the last month, it is certainly possible that many PWID who were UT negative for fentanyl had unintentionally used fentanyl at some point in the previous 30 days. This may partially explain the relative similarities between the *No Recent Fentanyl Use* and *Recent Unintentional Fentanyl Use participants* compared to individuals in the *Recent Intentional Fentanyl Use Group*. Despite these limitations, we believe our use of quantitative and qualitative data, and urine toxicology screening, helped triangulate, contextualize and bolster our findings, leading to a deeper understanding of the complexities of fentanyl use and drug overdose risk.

## Conclusion

The findings from this study demonstrate a high prevalence of fentanyl use among PWID in New York City, despite an expressed preference for heroin. Our results suggest that the pervasiveness of fentanyl may be increasing fentanyl use and tolerance, which may contribute to an increased risk for drug overdose. Expanding access to existing, evidence-based interventions such as naloxone and MOUD is necessary to reduce overdose mortality. Further, exploring the implementation of novel strategies to reduce risk of drug overdose should be considered, including other forms of opioid maintenance treatment and expansion and government support for OPCs.

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### Highlights

- Fentanyl use was widespread though most use was not intentional
- Pervasiveness of fentanyl was likely increasing tolerance and driving preference
- Concern about overdose was high and nearly everyone was taking steps to avoid it
- Non-fatal overdoses were more common among people using fentanyl intentionally

**Table 1.**

Baseline characteristics of PWID, New York City, October 2021 to December 2022

Variable	Complete sample N = 313	Qualitative sample N = 162	p-value
<b>Fentanyl use – urine toxicology</b>			
Positive	260 (83%)	141 (87%)	0.26
Negative	53 (17%)	21 (13%)	
<b>Fentanyl use – self-reported</b>	56 (18%)	24 (15%)	0.40
Yes	257 (82%)	138 (85%)	
No			
<b>Heroin use – urine toxicology</b>			
Positive	126 (40%)	67 (41%)	0.82
Negative	187 (60%)	95 (59%)	
<b>Heroin use – self-reported</b>			
Yes	309 (99%)	159 (98%)	0.69
No	4 (1%)	3 (2%)	
<b>Positive for fentanyl, negative for heroin – urine toxicology</b>	140 (54%)	85 (60%)	0.11
<b>Positive for fentanyl and heroin – urine toxicology</b>	120 (46%)	52 (37%)	0.18
<b>Mean age (SD)</b>	49 (11)	50 (11)	0.18
<b>NYC Borough of Residence</b>			
Brooklyn	108 (35%)	59 (36%)	0.51
Manhattan	82 (26%)	42 (26%)	
Queens	36 (12%)	21 (13%)	
Bronx	32 (10%)	12 (7%)	
Staten Island	15 (4%)	13 (8%)	
Other	40 (13%)	15 (9%)	
<b>Gender identity</b>			
	<b>n (%)</b>	<b>n (%)</b>	0.34
Male	222 (71%)	106 (65%)	
Female	90 (29%)	55 (34%)	
Transgender	1 (<1%)	1 (<1%)	
<b>Race/ethnicity</b>			
Non-Hispanic Black	107 (34%)	55 (34%)	0.88
Non-Hispanic White	96 (31%)	45 (28%)	
Hispanic	84 (27%)	45 (28%)	
Mixed/Other	26 (8%)	16 (10%)	
<b>Housing status – past 6 months</b>			
Unstably housed/houseless	133 (43%)	58 (36%)	0.29
Stably housed	114 (36%)	70 (43%)	
Housed with friends/relatives	66 (21%)	34 (21%)	
<b>Source of income – past 6 months (categorical)</b>			
Government benefits	220 (70%)	120 (74%)	0.79
Irregular employment or friend/relative's income	37 (12%)	17 (10%)	
Possible illegal income	30 (10%)	15 (9%)	

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Variable	Complete sample N = 313	Qualitative sample N = 162	p-value
Regular employment	26 (8%)	10 (6%)	
<b>High school diploma or GED</b>			0.38
Yes	221 (71%)	108 (67%)	
No	92 (29%)	54 (33%)	
<b>Food insecure – last 6 months</b>	200 (64%)	91 (56%)	0.10

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Table 2.

Factors associated with intentionality of fentanyl use among PWID in New York City, 2021–2022

Variable	Group 1 vs 2		p	Group 2 v 3		p	Group 1 v 3		p
	Group 1: Recent Intentional Fentanyl Use N = 56	Group 2: Recent Unintentional Fentanyl Use N = 203		Group 2: Recent Unintentional Fentanyl Use N = 203	Group 3: No Recent Fentanyl Use N = 54		Group 1: Recent Intentional Fentanyl Use N = 56	Group 3: No Recent Fentanyl Use N = 54	
Median age at baseline (IQR)	43(12)	52(16)	<0.001	52(16)	50(17)	0.37	43(12)	50(17)	0.005
Median age of drug injection initiation	24(8)	27(13)	0.04	27(13)	24(12)	0.28	24(8)	24(12)	0.58
Race/Ethnicity			0.003			0.11			0.004
White	28 (50%)	58 (29%)		58 (29%)	10 (19%)		28 (50%)	10 (19%)	
Black	10 (18%)	77 (38%)		77 (38%)	20 (37%)		10 (18%)	20 (37%)	
Hispanic	16 (29%)	47 (23%)		47 (23%)	21 (39%)		16 (29%)	21 (39%)	
Mixed/other	2 (4%)	20 (10%)		20 (10%)	3 (6%)		2 (4%)	3 (6%)	
Food insecurity last 6 months			<0.001			0.10			0.15
No	10 (18%)	85 (42%)		85 (42%)	16 (30%)		10 (18%)	16 (30%)	
Yes	46 (82%)	118 (58%)		118 (58%)	38 (70%)		46 (82%)	38 (70%)	
Kessler psychological distress			0.001			0.03			0.45
Moderate/Minor	25 (45%)	138 (68%)		138 (68%)	28 (52%)		25 (45%)	28 (52%)	
Serious	31 (55%)	65 (32%)		65 (32%)	26 (48%)		31 (55%)	26 (48%)	
Substance use disorder			0.02			0.58			0.11
Mild/Moderate	0 (0%)	19 (9%)		19 (9%)	3 (6%)		0 (0%)	3 (6%)	
Severe	56 (100%)	184 (91%)		184 (91%)	51 (94%)		56 (100%)	51 (94%)	
Psychiatric diagnosis (ever)			0.003			0.85			0.01
No	13 (23%)	91 (45%)		91 (45%)	25 (46%)		13 (23%)	25 (46%)	
Yes	43 (77%)	112 (55%)		112 (55%)	29 (54%)		43 (77%)	29 (54%)	
Receiving methadone treatment			0.25			<0.001			<0.001
Never	3 (8%)	32 (20%)		32 (20%)	28 (57%)		3 (8%)	28 (57%)	
Previous	2 (5%)	10 (6%)		10 (6%)	2 (4%)		2 (5%)	2 (4%)	
Current	32 (86%)	120 (74%)		120 (74%)	19 (39%)		32 (86%)	19 (39%)	
Receiving buprenorphine treatment			0.001			0.40			<0.001
Never	19 (45%)	129 (73%)		129 (73%)	43 (83%)		19 (45%)	43 (83%)	
Previous	21 (50%)	44 (25%)		44 (25%)	9 (17%)		21 (50%)	9 (17%)	
Current	2 (5%)	3 (2%)		3 (2%)	0 (0%)		2 (5%)	0 (0%)	

Variable	Group 1 vs 2		p	Group 2 v 3		p	Group 1 v 3		p
	Group 1: Recent Intentional Fentanyl Use N = 56	Group 2: Recent Unintentional Fentanyl Use N = 203		Group 2: Recent Unintentional Fentanyl Use N = 203	Group 3: No Recent Fentanyl Use N = 54		Group 1: Recent Intentional Fentanyl Use N = 56	Group 3: No Recent Fentanyl Use N = 54	
<b>Stimulant UT result</b>			<b>0.004</b>			0.24			<b>&lt;0.001</b>
Negative	5 (9%)	55 (27%)		55 (27%)	19 (35%)		5 (9%)	19 (35%)	
Positive	51 (91%)	148 (73%)		148 (73%)	35 (65%)		51 (91%)	35 (65%)	
<b># of OD – last 6 months</b>			<b>0.02</b>			0.72			<b>0.04</b>
0	36 (64%)	161 (79%)		161 (79%)	44 (81%)		36 (64%)	44 (81%)	
1	20 (36%)	42 (21%)		42 (21%)	10 (19%)		20 (36%)	10 (19%)	
<b>HCV test result at baseline</b>			<b>0.003</b>			0.11			<b>&lt;0.001</b>
Negative	16 (33%)	109 (57%)		109 (57%)	34 (69%)		16 (33%)	34 (69%)	
Positive	33 (67%)	83 (43%)		83 (43%)	15 (31%)		33 (67%)	15 (31%)	
<b>Main drug</b>			<b>&lt;0.001</b>			<b>&lt;0.001</b>			<b>&lt;0.001</b>
Heroin	35 (62%)	175 (86%)		175 (86%)	35 (65%)		35 (62%)	35 (65%)	
Speedball	0 (0%)	5 (2%)		5 (2%)	2 (4%)		0 (0%)	2 (4%)	
Fentanyl	13 (23%)	3 (1%)		3 (1%)	0 (0%)		13 (23%)	0 (0%)	
Stimulant	7 (12%)	15 (7%)		15 (7%)	16 (30%)		7 (12%)	16 (30%)	
Other	1 (2%)	5 (2%)		5 (2%)	1 (2%)		1 (2%)	1 (2%)	
<b>Median years injecting drugs (IQR)</b>	17 (18)	23 (21)	0.09	23 (21)	23 (20)	0.97	17 (18)	23 (20)	0.21
<b>Median times per day injected (IQR)</b>	3 (2)	2 (1)	<b>0.001</b>	2 (1)	2 (1)	0.70	3 (2)	2 (1)	<b>0.005</b>
<b>Frequency of main drug use</b>			0.56			<b>0.02</b>			<b>0.02</b>
Less Than Daily	17 (30%)	70 (34%)		70 (34%)	28 (52%)		17 (30%)	28 (52%)	
Daily	39 (70%)	133 (66%)		133 (66%)	26 (48%)		39 (70%)	26 (48%)	

Tests of associations: Wilcoxon rank sum test for continuous variables. Pearson's Chi-squared test and Fisher's exact test for categorical variables. Significance level for post-hoc tests set at  $\alpha = 0.05$ .

**Table 3.**

Adoption of overdose preventive behaviors by intentionality of fentanyl use among PWID in New York City, 2021–2022

Variable	Group 1 vs 2		P	Group 2 v 3		p	Group 1 v 3		p
	Group 1: Recent Intentional Fentanyl Use N = 56	Group 2: Recent Unintentional Fentanyl Use N = 203		Group 2: Recent Unintentional Fentanyl Use N = 203	Group 3: No Recent Fentanyl Use N = 54		Group 1: Recent Intentional Fentanyl Use N = 56	Group 3: No Recent Fentanyl Use N = 54	
Using test shots	4 (7%)	28 (14%)	0.18	28 (14%)	11 (20%)	0.23	4 (7%)	11 (20%)	<b>0.04</b>
Tasting drugs before using them (by mouth)	4 (7%)	34 (17%)	0.07	34 (17%)	12 (22%)	0.35	4 (7%)	12 (22%)	<b>0.02</b>
Using trusted dealers	14 (25%)	96 (47%)	<b>0.003</b>	96 (47%)	23 (43%)	0.54	14 (25%)	23 (43%)	0.051
Using drugs with or near others	21 (38%)	69 (34%)	0.63	69 (34%)	22 (41%)	0.36	21 (38%)	22 (41%)	0.73
Using smaller amounts of drugs	29 (52%)	91 (45%)	0.36	91 (45%)	29 (54%)	0.25	29 (52%)	29 (54%)	0.84
When wanting to use, choosing not to	2 (4%)	8 (4%)	>0.99	8 (4%)	2 (4%)	>0.99	2 (4%)	2 (4%)	>0.99
Using prescription opioids instead of heroin	1 (2%)	4 (2%)	>0.99	4 (2%)	1 (2%)	>0.99	1 (2%)	1 (2%)	>0.99
Using drugs other than prescription opioids instead of heroin	0 (0%)	2 (1%)	>0.99	2 (1%)	1 (2%)	0.51	0 (0%)	1 (2%)	0.49
Smoking drugs instead of injecting	6 (11%)	8 (4%)	0.09	8 (4%)	9 (17%)	<b>0.003</b>	6 (11%)	9 (17%)	0.36
Sniffing drugs instead of injecting	10 (18%)	38 (19%)	0.88	38 (19%)	8 (15%)	0.51	10 (18%)	8 (15%)	0.67
Using fentanyl test strips	4 (7%)	37 (18%)	<b>0.044</b>	37 (18%)	5 (9%)	0.11	4 (7%)	5 (9%)	0.74
Keeping naloxone/narcan nearby	32 (57%)	125 (62%)	0.55	125 (62%)	20 (37%)	<b>0.001</b>	32 (57%)	20 (37%)	<b>0.035</b>
Not using multiple drugs at the same time	2 (4%)	2 (1%)	0.21	2 (1%)	2 (4%)	0.20	2 (4%)	2 (4%)	>0.99
Other methods	2 (4%)	9 (4%)	>0.99	9 (4%)	4 (7%)	0.48	2 (4%)	4 (7%)	0.43
Not using overdose	4 (7%)	6 (3%)	0.23	6 (3%)	5 (9%)	0.06	4 (7%)	5 (9%)	0.74



Variable	Group 1 vs 2		P	Group 2 v 3		p	Group 1 v 3		p
	Group 1: Recent Intentional Fentanyl Use N = 56	Group 2: Recent Unintentional Fentanyl Use N = 203		Group 2: Recent Unintentional Fentanyl Use N = 203	Group 3: No Recent Fentanyl Use N = 54		Group 1: Recent Intentional Fentanyl Use N = 56	Group 3: No Recent Fentanyl Use N = 54	
<b>prevention strategies</b>									

Tests of associations: Wilcoxon rank sum test for continuous variables. Pearson's Chi-squared test and Fisher's exact test for categorical variables. Significance level for post-hoc tests set at  $\alpha = 0.05$

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