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Drug checking in the fentanyl era: utilization and interest among people who inject drugs in San Diego, California

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Abstract

Background—In North America, overdose rates have steeply risen over the past five years, largely due to the ubiquity of illicitly manufactured fentanyls in the drug supply. Drug checking services (DCS) represent a promising harm reduction strategy and characterizing access among people who inject drugs (PWID) is a priority.

Methods—Between February-October 2022, PWID participating in a cohort study in San Diego, CA and Tijuana, Mexico completed structured surveys including questions about DCS, socio-demographics and substance use behaviors. We used Poisson regression to assess factors associated with lifetime DCS use and characterized experiences with DCS and interest in free access to DCS.

Results—Of 426 PWID, 72% were male, 59% Latinx, 79% were experiencing homelessness and 56% ever experienced a nonfatal overdose. One third had heard of DCS, of whom 57% had ever used them. Among the latter, most (98%) reported using fentanyl test strips (FTS) the last time they used DCS; 66% did so less than once per month. In the last six months, respondents used FTS to check methamphetamine (48%), heroin (30%) or fentanyl (29%). Relative to White/non-Latinx PWID, those who were non-White/Latinx were significantly less likely to have used DCS [adjusted risk ratio (aRR): 0.22; 95% CI: 0.10, 0.47), as were PWID experiencing homelessness (aRR:0.45; 95% CI: 0.28, 0.72). However, a significant interaction indicated that non-White/Latinx syringe service program (SSP) clients were more likely to have used DCS than non-SSP clients (aRR: 2.79; CI: 1.09, 7.2). Among all PWID, 44% expressed interest in free access to FTS, while 84% (of 196 PWID) expressed interest in advanced spectrometry DCS to identify and quantify multiple substances.

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Conclusions—Our findings highlight low rates of DCS awareness and utilization, inequities by race/ethnicity and housing situation, high interest in advanced spectrometry DCS versus FTS, and the potential role of SSPs in improving access to DCS, especially among racial/ethnic minorities.

Introduction and background

Due to the unregulated nature of the illicit drug supply, people who use drugs (PWUD) cannot be certain that a substance they intend to use is not cut, contaminated, or adulterated with unwanted chemicals or in higher concentrations than they can tolerate. This has led to numerous unintentional poisonings and overdoses, particularly in light of the increasing presence of illicitly manufactured fentanyls ("fentanyl" hereafter), a phenomenon that is well-documented in the United States (US) and Canada.[1–8] Other dangerous adulterants that can increase the risk of overdose or have other unintended side effects, such as novel designer benzodiazepines, sedatives (e.g., xylazine), and synthetic opioids (e.g., nitazenes) have also been detected in the illicit drug supply.[9–11] Drug overdose has claimed the lives of nearly one million people in the US since 1999, with an annual record of over 107,000 in 2021.[12] The present study is situated in San Diego, California, US where fatal overdoses have dramatically increased in recent years: between 2017–2021 there was a 133% increase in drug overdose deaths (534 versus 1,242).[13] In 2017, 15% of drug overdose deaths were fentanyl-related, which rose to 64% by 2021.[14]

Drug checking tools can address the uncertainties of the illicit drug supply and can help PWUD avert poisonings, overdose, or other adverse outcomes by testing their drugs for unexpected substances before consumption. Drug checking services (DCS) have been offered in Europe at festivals and nightlife scenes for decades, most of which have utilized colorimetric spot-test technologies.[15] This involves placing a drop of a chemical reagent on a small drug sample, resulting in a visible color reaction that is compared with color charts to determine the sample contents. Another drug checking technology that has been increasingly utilized following the widespread saturation of fentanyl into illicit drug supplies has been fentanyl test strips (FTS). FTS were developed to detect fentanyl in urine but can also detect fentanyl in drug samples diluted in water.[16] Similar test strips are utilized to detect benzodiazepines, amphetamines and other substances.[17,18] Both colorimetric and immunoassay DCS are valuable confirmatory methods, but are unable to identify and quantify multiple substances with a single test.[19] Advanced technologies involving spectrometry apparatuses, such as handheld high-pressure mass spectrometers (HPMS) and Fourier transform infrared (FTIR) spectrometers can detect multiple chemicals in minute drug samples and provide quantitative information on drug potency and adulterants.[20] Importantly, advanced spectrometry technologies have lower sensitivity relative to FTS and therefore are recommended to be utilized in conjunction with FTS to ensure detection of fentanyl in low concentrations.[21]

Distinct from nightlife- or festival-based DCS, community-based DCS in North America are typically offered in harm reduction settings such as syringe service programs (SSPs), safe consumption sites, or overdose prevention sites – services targeted toward PWUD at increased risk of overdose due to regular illicit drug use and injection drug use.[20,22] Community-based DCS in North America have increasingly provided FTS over the past few

years and, more recently, some have incorporated advanced spectrometry DCS.[22,23] In this context, DCS that allow the identification and quantification of multiple substances may provide particularly useful information to help PWUD adapt drug use behaviors accordingly to prevent harms. In addition to providing drug content information to PWUD, data collected from these community-based DCS can serve to monitor trends in the illicit drug supply and inform public health responses.[24]

Amid growing fatal overdose trends in San Diego, a local SSP planned to implement an FTIR-based DCS, following experiences from other harm reduction services in US and Canadian settings with similarly high fentanyl penetration of the illicit drug supply and polysubstance use.[20,22,25,26] Characterizing target PWUD's access, needs, preferences, and potential barriers when planning for DCS implementation or expansion in local contexts is key to designing tailored programs with potential to reduce overdoses and poisonings.[27] We leveraged a NIDA-funded cohort study of 426 PWID in San Diego to characterize baseline information about awareness, interest, and use of DCS. We also sought to identify potential disparities in lifetime use of DCS. Additionally, we assessed PWIDs' perceived barriers and service preferences to inform further DCS implementation strategies. We discuss the implications of survey results for public health and harm reduction efforts in San Diego and other settings.

Materials and methods

Study design

Data for the present analysis comes from a longitudinal cohort study that aimed to collect information about drug use trends, the drug market, service utilization, overdose, and infectious diseases from PWID along the US-Mexico border, as described elsewhere.[28,29] Two teams of full-time, trained, bilingual interviewers sought participants via mobile and street outreach and screened potential participants for study inclusion criteria which included being at least 18 years old, speaking English or Spanish, past-month injection drug use, and residing in San Diego or Tijuana, Baja California, Mexico. Baseline data collection occurred using computer-assisted, interviewer-administered surveys between October 2020 and October 2021 among 612 study participants (410 San Diego residents and 202 Tijuana residents). Thereafter, interviewers located participants to complete semi-annual follow-up surveys. Participants receive $20 for each survey completed. Per the parent study design, San Diego residents were purposively recruited to ensure inclusion of PWID who engaged in cross-border drug use, meaning they had used drugs in Mexico within the previous two years, which was determined with a preliminary screening question.

An additional 108 PWID were recruited in San Diego by the same method between February – June 2022 to accommodate a new sub-study examining COVID testing and vaccination that required additional participants.[30] We added questions about DCS to all surveys beginning in February 2022 – as such, most participants from the original cohort answered these questions on follow-up surveys, although some were lost to death or had not yet been located for follow up. Participants recruited for the COVID sub-study answered DCS questions on their baseline survey. In May 2022 we added questions about advanced spectrometry DCS to all baseline and follow-up surveys.

Participants

As the focus of this study was DCS in San Diego, we utilized survey data from the 426 San Diego resident participants who had completed DCS survey questions. Recruitment was focused on structurally vulnerable PWID. Study participants were recruited from several central areas across the city of San Diego with a focus on areas in and near the downtown where illicit drug use is known to occur. A variety of locations were covered, including streets, parks, shelters, motels, river canyons, encampments and parking lots, with emphasis on locations not meant for habitation where unsheltered individuals gather and where there is an elevated prevalence of drug use. Some participants were also recruited in Tijuana when engaging in cross border drug use, many of whom were recruited near the downtown red-light district and the Tijuana river canal where drug use and homelessness is common.[31] Those found eligible were invited to participate and provided written informed consent.

Survey measures

Participants reported sociodemographics (e.g., age, sex, race, and ethnicity). Race and ethnicity categories were not mutually exclusive. We created a combined race/ethnicity variable indicating whether participants were non-White race/ethnicity, where anyone who selected non-White or “other” race and/or Hispanic/Latinx ethnicity was classified as non-White. We collected information on structural factors, including whether participants had been stopped or arrested by police, their sleeping arrangements, and whether they were SSP clients. Interviewers asked whether participants had been “stopped, but not arrested, by law enforcement in the last six months,” and “how many times were you arrested in the last six months,” which were combined into a single binary variable indicating interactions with law enforcement. Participants who reported always or mostly sleeping in a shelter/welfare residence, workplace, rented room, vehicle, abandoned building, deportee shelter, on the streets, or in a shooting gallery in the last six months were considered to be experiencing homelessness. Study participants were asked where they acquired syringes in the past six months; those who indicated they had received syringes from a local SSP were considered SSP clients.

Interviewers asked participants about past six-month use of a variety of illicit drugs one-by-one. In this analysis, drug use referred to any method of use reported (e.g., injecting, smoking, inhaling, etc.). Participants were also asked about whether they injected specific combinations of opioids and stimulants, including heroin and cocaine, heroin and crystal meth, china white and crystal meth, and fentanyl and crystal meth. If participants indicated injecting any combination of opioids and stimulants in the prior six months, this was assessed in a binary “polysubstance injection” variable. Study participants were asked about how many times per day on average they injected any drug or drug combination. Additionally, participants were asked how many times in the past they had overdosed, defined as “a situation where you passed out, could not wake up, *or* your lips turned blue” following drug use.

In a series of questions about DCS, participants were first asked, “Have you ever heard of drug checking tools or services, like drug testing strips, that can be used to test the safety of your drug supply?” Respondents who said they had heard of such services were asked

if they had ever used them. Persons who had never heard of DCS were classified as not having used DCS. PWID who reported prior use of any DCS were asked about what kinds of tools or services they had used, what drugs they had checked and the results, how often they used the indicated services, and whether they changed any of their drug use behaviors following drug checking results. Furthermore, all participants were asked if they would be interested in getting free access to FTS and whether they had any concerns about using FTS. Finally, beginning in May 2022, an additional question was added to the survey whereby interviewers were instructed to describe the possibility of a community based DCS using advanced spectrometry in San Diego, through which participants would be able to determine the types and approximate concentrations of substances found in a small sample of a drug. Participants were then asked if they would be interested in this type of service, whether they would be willing to go to a SSP to access the service, whether they would utilize a drop-box to leave drugs to be tested with the service, how they would prefer to receive test results, and whether they would be interested in accessing an online dashboard to view trends in community-wide DCS results. Response options that included an “other” category were assessed and re-assigned when researchers determined responses fell into a pre-determined category. When more than three participants mentioned an “other” response not previously specified, we categorized these in an additional response category.

Statistical analysis

Participant characteristics

First, we used descriptive statistics such as frequencies and percentages for binary variables and means and standard deviations or medians and interquartile ranges for continuous variables to summarize the sociodemographic, structural, and drug use characteristics of study participants, distinguishing between San Diego residents who were recruited in San Diego versus those who were recruited in Tijuana (to capture cross border drug use).

Drug checking experiences

Next, we provided participants’ aggregate responses regarding DCS awareness and experiences, including whether they had ever heard of or used DCS, the last type of DCS used, frequency of DCS use, drugs checked with DCS and their results, and self-reported changes in drug use behaviors following DCS utilization. Among PWID who had heard of DCS but not utilized them, we provided their indicated reasons for not doing so.

Correlates of lifetime DCS utilization

In a regression analysis, the key outcome of interest was a binary variable reflecting whether participants reported having used DCS before. We performed robust Poisson regression analysis to assess univariate and multivariable associations with lifetime DCS use. Variables that were significantly associated with the outcome at a 10% alpha level in univariate analyses were considered for inclusion in the final multivariable model.

To ensure the structural integrity of the final model, we evaluated all potential two-way interactions between the predictor variables and retained in the final model interactions that were significant at a 10% alpha level. We also estimated and tested the simple main effects

of factors involved in interactions and assessed the final model for multicollinearity using variance inflation factors and condition index diagnostics. Analyses were conducted using R[32] and RStudio.[33]

Drug checking interests

Finally, we presented descriptive statistics of participant responses regarding interest in and preferences for FTS and advanced spectrometry drug checking (Table 4).

Results

Participant characteristics

Of 518 total San Diego resident participants, 92 (18%) were excluded from the present analysis because they did not answer questions about drug checking due to death (N=21) or because they had not yet been relocated for follow-up (N=71) (see appendix A for differences between those included and those excluded from analysis). As displayed in Table 1, most participants were male (72%) with an average age of 44 years (standard deviation (SD): 11). Race categories were not mutually exclusive; 56% of participants identified as White, followed by half (50%) who identified as “other”. Over half of participants were Hispanic/Latinx (59%). Most participants with Hispanic/Latinx ethnicity (n=252) indicated “other” race (81%), followed by 39% that reported White race, 8% that reported mixed race, 6% that reported Native American race, 4% that reported Black race, and 1% that reported Hawaiian or Pacific Islander race. About 70% of the sample indicated non-White race and/or ethnicity.

A quarter of participants had been stopped or arrested by police in the past six months, most were experiencing homelessness (79%), and less than half were SSP clients (42%). Forty-five percent of participants engaged in cross-border drug use within the two years prior to enrolment.

Methamphetamine was the drug most commonly used in the past six months (74%), followed by fentanyl (53%), and heroin (52%). A third of the sample indicated past six-month polysubstance injection and the median number of average daily injections reported was 1 (inter-quartile range (IQR): 0.0–2.4). Over half of participants had ever overdosed (56%), with a median of 1 lifetime overdose (IQR=0.0–3.0).

Prior DCS utilization

Among the analytic sample (N=426), 34% of participants had ever heard of DCS and 19% had ever utilized them (Table 2). Among participants who knew about DCS but had not used them (n=61), the most common reasons for not doing so were disinterest (33%), feeling there was “no point” in checking drugs due to lack of alternatives (18%), or that such services were not easily accessible to them (18%).

Among the 82 participants who had ever utilized DCS, the majority reported last using FTS (98%), but most did so less than once per month in the prior six months. Among participants who had used FTS in the prior six months (n=63), 48% reported using them to check methamphetamine followed by 30.2% who checked heroin. Some participants indicated they

used FTS as a confirmatory method to identify fentanyl (29%). Other than one person who reported testing cocaine, participants did not report testing any other type of drug with FTS. Among participants who used FTS in the prior six months to check drugs other than fentanyl (n=50), most reported they had at least one positive result (86%). Those who had a positive fentanyl result upon testing their drugs with FTS (n=43), about a third indicated doing something differently, such as choosing not to use that drug (n=7), returning the drug or giving it to someone else (n=2), using less of the drug (n=1), smoking instead of injecting (n=1), injecting more slowly (n=1), doing a tester shot (n=1), using drugs in the presence of other people (n=1), or finding a new supplier (n=1).

Correlates of DCS utilization: Univariate analysis

As shown in Table 3, non-White race/ethnicity was negatively associated with DCS utilization (Risk Ratio (RR): 0.31; 95% CI: 0.20–0.49). In terms of structural factors, people who were stopped or arrested by police in the prior six months were more likely to have used DCS (RR: 1.79; 95% CI: 1.12–2.78), as were SSP clients (RR: 3.0; 95% CI: 1.91–4.85). Past six-month homelessness was negatively associated with the likelihood of using DCS (RR: 0.51; 95% CI: 0.33–0.81). Past six-month use of methamphetamine (RR: 1.75; 95% CI: 1.02–3.25) and cocaine (RR: 2.34; 95% CI: 1.31–3.93) was positively associated with drug checking, whereas tranquilizer use was negatively associated (RR: 0.41; 95% CI: 0.13–0.99).

Independent Correlates of DCS Use: Multivariable analysis

The results from the multivariable regression model are shown in Table 3. Relative to White, non-Latinx participants, those with non-White race/ethnicity were significantly less likely to have ever utilized DCS (Adjusted Risk Ratio (aRR): 0.22; 95% CI: 0.10–0.47). Homelessness was also independently associated with lower rates of lifetime DCS utilization (aRR: 0.45; 95% CI: 0.28–0.72). We discovered a significant interaction between being an SSP client and non-White race/ethnicity (p=0.032), indicating that being an SSP client moderated the relationship between non-White race/ethnicity and DCS utilization. Specifically, for non-White participants, being an SSP client was associated with increased likelihood of DCS utilization (aRR: 3.92; 95% CI: 1.97–8.18), whereas for White participants, being an SSP client did not significantly affect their likelihood of DCS utilization.

DCS interests and preferences

All participants (N=426) were asked if they would be interested in getting free access to FTS to test their drugs for fentanyl, to which less than half (44%) said yes (Table 4). When asked about any concerns with using FTS (n=426), most respondents had none. However, 94 participants (22%) reported distrust in FTS results, some indicated they would not want to go to an SSP to get FTS (8%), and some were disinterested in knowing if their drugs contain fentanyl (4%). Several FTS related concerns were documented in an “other” category (n=33). Of these, 15 participants said they do not use fentanyl; we assume these participants did not understand that FTS can be utilized to avoid unknowingly using fentanyl. A few others (n=6) indicated the desire to know more detail about the contents of their drugs, such as purity or what other substances may be present.

Of the sub-sample of 196 participants who were asked if they would be interested in a community based DCS involving advanced spectrometry DCS, most (84%) indicated interest (Table 4) and willingness to go to an SSP to use this service (87%). In a follow-up question, participants were asked if they would utilize a community drop box where they could anonymously leave drug samples or paraphernalia to be tested and later access results confidentially. Most (83%) indicated willingness to utilize such a service. When asked how they would prefer to receive FTIR results, most said in-person (73%), followed by 33% who would prefer logging into an online dashboard. Finally, participants were asked if they would use an online dashboard that reported community-level DCS results and trends over time, with 83% indicating they would.

Discussion

In this study of PWID in San Diego, California, over half had experienced an overdose, yet only one third had ever heard of DCS and only one fifth had ever used DCS, with most having used FTS the last time they did so. Although there had been efforts to expand FTS access in San Diego before our study took place, our findings indicate that many vulnerable PWUD had not yet been reached. Furthermore, most participants who indicated they had used FTS before reported doing so infrequently. Local SSPs have not had a regular, steady supply of FTS and services were interrupted during the COVID-19 pandemic. To make harm reduction tools more accessible, efforts are underway to strategically place vending machines in San Diego that provide FTS and naloxone, a strategy that has been successfully implemented in other communities.[34] Studies of FTS across a variety of settings show PWUD often report intentions to engage in protective behaviors following fentanyl-positive test results, including discarding the drug altogether, doing a tester shot, using less of the drug, using more slowly, or using in the presence of others.[8,35–41] In this study, one third of those who found fentanyl in their drug after using FTS reported modifying their behavior as a result. However, research is needed to determine whether DCS utilization translates into significant reductions in overdose incidence and mortality.

We found significant disparities in DCS utilization among this sample of San Diego PWID. PWID experiencing homelessness were much less likely to have used DCS compared to sheltered PWID, despite their higher engagement with SSPs (results not shown). A study of DCS in three U.S. cities also found that people experiencing homelessness had reduced odds of drug checking.[25] However, in Vancouver, Canada, homelessness was associated with greater odds of DCS utilization, perhaps due to differences in the reach and type of organization where services were provided, as DCS in this context were offered at a supervised injection facility, which are not available in San Diego.[22] Unhoused populations often experience police harassment, including displacement,[23,31,42] and are disproportionately victims of crimes such as robbery,[43] which may make it difficult to consistently possess drug checking tools, such as FTS. People who are unsheltered have been consistently shown to be at increased risk of overdose[29,44] and should be prioritized for harm reduction services using mobile outreach. Discrepancies in DCS utilization among PWUD experiencing homelessness in San Diego warrants further quantitative and qualitative investigation.

Latinx PWID have historically had less access to harm reduction services, likely as a result of more acute stigma against drug use, language barriers and, for those who are undocumented, fear of deportation.[45–48] This is particularly poignant in California, the state with the highest annual number of opioid overdose deaths among Latinx persons between 2018–2020.[49] Importantly, we found that non-White PWID who were SSP clients were much more likely to have used DCS relative to those who were not SSP clients, indicating its role as an important point-of-service for engaging PWID of color. It is important for harm reduction services to have representation of racial minority practitioners who are bilingual and have lived substance use experience to promote culturally responsive services and foster engagement among uniquely marginalized PWUD populations.[50]

This study highlights a major need for increased access to and education about harm reduction tools for PWUD at risk of overdose, including how to use FTS such that the results can be trusted and acted upon. Less than half of participants indicated interest in free FTS, while the majority of respondents who were asked indicated interest in advanced spectrometry DCS offered through SSPs. Over one fifth reported mistrust in FTS, which might suggest the need for improved training to use them. The low interest in FTS may also speak to the limited utility of FTS alone in a fentanyl-saturated illicit drug market.[51] Important to note, this sample varies compared to samples in other DCS studies regarding the types of drugs used. For example, in our sample there were much higher rates of methamphetamine use and lower rates of opioid use relative to PWUD samples in studies conducted in the US east coast.[25] This reflects previously noted geographic variations in illicit drug markets and use trends.[26,52–54] Participants in three east coast cities reported interest in take-home and on-site FTS (89% and 78%), much higher than the interest in FTS reported among participants in our study. Among participants in these east coast cities, there was variation regarding interest in FTIR, with 75% indicating interest overall, which was slightly lower than the interest expressed by those asked in the present study.[25] Variations with regard to substances used and rates of DCS utilization and interest have been found among PWUD in other cities as well.[22,55] Such differences highlight the importance of assessing target population needs and preferences before implementing or expanding community-based DCS or other innovative harm reduction services. Given some PWUD use fentanyl intentionally, FTS alone may be insufficient in meeting overdose prevention needs.[29] Advanced spectrometry DCS allow PWUD to identify and quantify a variety of substances, including fentanyl, in a single drug sample and make decisions accordingly to prevent overdose. However, even with increased DCS availability, PWUD are still bound to the limitations of the local drug supply, and may feel they have no alternatives to using the drugs they already have.[56] In light of this reality, safe supply programs have formed in Canada to provide PWUD with safer, pharmaceutical grade options.[57]

An additional consideration for community DCS is how participants may prefer to access DCS or submit drug samples for testing. Given the criminalized nature of drug use, it is foreseeable that some PWUD may be hesitant to travel to an SSP with a drug sample to be tested. Furthermore, some may have difficulty doing so during regular operating hours. For more advanced drug checking, community DCS in other areas have implemented anonymous mail-in or drop-off options to accommodate PWUD who are unwilling or unable to access DCS in person.[58] Our preliminary results indicate PWID willingness to both

attend in-person and to use an anonymous drop box for advanced spectrometry testing. Most respondents indicated a preference to receive DCS results in-person, although some had other preferences, such as accessing results through an online portal (although some older PWID and PWID experiencing homelessness have less access to mobile technology).[59,60] Among participants of a study in US East Coast cities, over half identified SSPs as a place they would like to access DCS, but also indicated other healthcare and social services locations that could be appropriate providers.[25]

Policy and practice implications

In many US states DCS equipment has historically been considered drug paraphernalia and, as such, provision of DCS has existed in a legal grey area.[61,62] In recent years several US states have explicitly allowed SSPs to distribute DCS to target PWUD with increased overdose risk,[61] making SSPs common providers of DCS. Some states, including California in 2022,[63] have declassified some DCS as drug paraphernalia, allowing for the expansion of DCS beyond SSPs. In order to enhance access to DCS, states should adopt these policies and expand harm reduction education efforts. While the expansion of DCS provision beyond SSPs is important, SSPs are well-positioned to provide harm reduction services to marginalized PWUD at increased risk of overdose given their commitment to non-judgmental service provision.[23] However, SSPs are typically grass roots organizations that may have difficulty acquiring the necessary resources to purchase, administer, and maintain DCS, particularly advanced spectrometry technologies.[23] Decriminalizing all DCS could facilitate broader adoption and avert the burden of service provision from falling mainly on SSPs.[61] Adoption of other harm reduction services in the US, such as supervised injection facilities, may also increase the utilization of DCS in addition to providing other services to prevent overdose. Communities should also consider the unique needs and preferences for DCS in distinct PWUD populations, including those who use drugs recreationally or in nightlife settings and who may not typically engage in SSP services.[27,64] Importantly, effectiveness of DCS in reducing overdose rates has not yet been determined, and DCS implementation and expansion should be accompanied by rigorous evaluations and cost assessments to inform the development of future overdose prevention efforts.

Beyond providing immediate information about an individual's drug contents, DCS can inform community drug monitoring systems. Collaboration with local organizations, such as public health departments or universities could facilitate the development of such a resource, as is the case in the Vancouver Island Drug Checking Project, through which the University of Victoria manages monthly online reports of aggregate DCS results.[65] Additionally, such data aggregation could help with prediction efforts to better anticipate overdose outbreaks and plan public health responses accordingly, similar to routine surveillance efforts in the infectious disease field.[66,67] People with lived experience should be involved in the development of services, data collection, research questions, interpretation, dissemination, and any planned public health response efforts.[68]

Limitations

The findings of our study are limited to a convenience sample of PWID in San Diego. Additionally, participants were recruited in a purposive manner to ensure inclusion of key

populations, namely people recently engaged in cross-border drug use and people who had not been vaccinated or tested for COVID-19, which may have over-sampled especially marginalized PWID. All measures in the present study were self-report and may have been subject to social desirability or recall bias. Additionally, the cross-sectional nature of this analysis precludes drawing inferences about temporality or causality between DCS utilization and associated variables.

Our measure of being an SSP client was based on whether participants acquired syringes at an SSP in the prior six months which may have underestimated SSP utilization. Our measure of DCS utilization referred to lifetime use, which may not reflect recent DCS utilization, although DCS have only become available in San Diego in the past few years. Finally, questions about advanced spectrometry DCS were added to the survey later so that only a subset of study participants had the opportunity to answer these questions.

Since drug markets and harm reduction resources and laws vary geographically, our findings may not be generalized to other cities. However, participants of the present study represent a key PWUD demographic at high-risk of overdose and, as such, in high need of harm reduction resources.

Conclusions

Our findings indicate a need to expand DCS awareness and utilization to prevent overdose among PWUD in San Diego County, especially in the context of growing fentanyl penetration and introduction of other contaminants into the drug supply.[69] This includes removing legal barriers and supporting DCS distribution. It will be important to assess participant utilization frequency and satisfaction, DCS results, participant behavior change, and the impacts of advanced spectrometry DCS on a variety of outcomes, including overdose. Ongoing studies of DCS utilization are warranted to assess barriers to use, including racial/ethnic disparities, which can be used to optimize services. Furthermore, some DCS interventions have integrated additional training, counseling, coaching, or specific messaging to accompany DCS provision,[40,70] and it will be important to determine whether these models result in better participant satisfaction and reductions in overdose rates.

Supplementary Material

Refer to Web version on PubMed Central for supplementary material.

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Table 1.

Participant characteristics stratified by city of recruitment in a cohort of people who inject drugs who reside in San Diego, California, February - October 2022

	Overall	Recruited in Tijuana	Recruited in San Diego
n	426	158	268
Demographics			
Sex (Male) (n(%))	308 (72)	120 (76)	188 (70)
Age (mean (SD))	44 (11)	44 (9)	44 (12)
Race			
White (n(%))	237 (56)	56 (35)	181 (68)
Native American (n(%))	23 (5)	3 (2)	20 (8)
Asian (n(%))	7 (2)	1 (1)	6 (2)
Black (n(%))	38 (9)	8 (5)	30 (11)
Hawaiian or Pacific Islander (n(%))	6 (1)	0 (0)	6 (2)
Mixed Race (n(%))	23 (5)	13 (8)	10 (4)
Other (n(%))	211 (50)	125 (80)	86 (32)
Ethnicity			
Hispanic/Latinx (n(%))	252 (60)	140 (89)	112 (42)
Race/Ethnicity combination			
Non-White Race/Ethnicity (n(%))	295 (70)	145 (92)	150 (56)
Structural Factors			
Stopped/Arrested by police * (n(%))	108 (25)	8 (5)	100 (37)
Homelessness * (n(%))	337 (80)	128 (81)	209 (78)
SSP Client * (n(%))	178 (42)	9 (6)	169 (63)
Cross-border drug use (n(%))	196 (46)	158 (100)	38 (14)
Drug Use			
Fentanyl * (n(%))	226 (53)	70 (44)	156 (58)
China White * (n(%))	36 (9)	21 (13)	15 (6)
Heroin * (n(%))	220 (52)	99 (63)	58 (23)
Prescription Opioids * (n(%))	17 (4)	1 (1)	16 (6)
Methamphetamine * (n(%))	313 (74)	94 (60)	219 (82)
Cocaine * (n(%))	40 (9)	4 (3)	40 (15)
Ecstasy * (n(%))	11 (3)	7 (2.0)	4 (4.9)
Tranquilizers * (n(%))	47 (11)	28 (18)	19 (7)
Polysubstance injection * (n(%))	138 (32)	80 (51)	58 (22)
Average daily injections * (median (IQR))	1.0 (2.4)	2.5 (3.0)	0.3 (3.0)
Ever overdosed before (n(%))	239 (56)	72 (46)	167 (62)

	Overall	Recruited in Tijuana	Recruited in San Diego
Count of past overdoses (median (IQR))	1.0 (3.0)	0.0 (2.0)	1.0 (4.0)

* all indicated variables refer to the 6 months prior to survey date

SSP = syringe services program

Table 2.

Lifetime drug checking services experiences among a cohort of people who inject drugs in San Diego, California, February-October 2022, N=426 *

	Response (n(%))
Have you ever heard of drug checking tools or services? (N=426)	
Yes	143 (34)
Have you ever used drug checking tools or services? (n=426)	
Yes	82 (19)
What drug checking service did you use last? (n=82) **	
FTS	80 (98)
Other drug testing strip	2 (2)
Tests that show presence of drug in colors	2 (2)
A machine that tests your drugs' contents	0 (0)
How often did you use drug checking services in the last 6 months? (n=82)	
Never	16 (20)
Less than once per month	38 (46)
1–3 times per month	16 (20)
Once per week	1 (1)
More than once per week	11 (13)
In the last 6 months, what drugs did you test with FTS? (n=63) **	
Illicitly manufactured fentanyl	18 (29)
Heroin	19 (30)
Crystal/Methamphetamine	30 (48)
Cocaine	1 (2)
Other drug	0 (0)
In the last 6 months, did you find any samples contained fentanyl? (n=50)	
Yes	43 (86)
Did you do anything different as a result of finding fentanyl in your drugs? (n=43)	
Yes	15 (35)

* Questions responses have different sample sizes due to survey skip logic, which eliminates certain questions for participants based on prior responses, or because participants preferred not to answer.

** Items indicated are not mutually exclusive.

FTS = fentanyl test strips

Table 3.

Poisson regression univariate and multivariable associations with lifetime drug checking services utilization among a cohort of people who inject drugs in San Diego, California, February - October 2022

	RR	95% CI	p-value	aRR	95% CI	p-value
Demographics						
Sex (Male)	0.70	0.45, 1.11	0.120			
Age	0.99	0.97, 1.01	0.500			
Hispanic Ethnicity	0.30	0.19, 0.48	<0.001			
Non-White Race/Ethnicity	0.31	0.20, 0.49	<0.001	0.22	0.10, 0.47	<0.001
Structural Factors						
Stopped/Arrested by police *	1.79	1.13, 2.78	0.011			
Homelessness *	0.51	0.33, 0.81	0.004	0.45	0.28, 0.72	<0.001
SSP Client *	3.00	1.91, 4.85	<0.001	1.57	0.85, 3.04	0.200
Drug Use						
Fentanyl *	1.38	0.89, 2.17	0.200			
China White *	1.17	0.52, 2.28	0.700			
Heroin *	0.81	0.52, 1.25	0.300			
Prescription Opioids *	1.90	0.74, 4.01	0.130			
Methamphetamine *	1.75	1.02, 3.25	0.056			
Cocaine *	2.34	1.31, 3.93	0.002			
Ecstasy *	1.93	0.59, 4.65	0.200			
Tranquilizers *	0.41	0.13, 0.99	0.085			
Polysubstance injection *	0.81	0.49, 1.30	0.400			
Average daily injections *	0.94	0.81, 1.10	0.500			
Count of past overdoses	1.00	0.97, 1.02	0.700			
Ever overdosed before	1.36	0.87, 2.15	0.200			
Interaction						

Int J Drug Policy. Author manuscript; available in PMC 2023 September 27.

	RR	95% CI	p-value	aRR	95% CI	p-value
SSP Client * Non-White Race/Ethnicity				2.79	1.09, 7.2	0.032
Simple Main Effects						
Effect of being an SSP client on non-White participants:				3.92	1.97, 8.18	<0.001
Effect of being an SSP client on White participants:				1.36	0.75, 2.62	0.300

[*] All indicated variables refer to the 6 months prior to survey date.

SSP = syringe services program

Table 4.

Interest in and preferences for drug checking services among a cohort of people who inject drugs in San Diego, California, February-October 2022, N=426 *

	Response (n(%))
Would you be interested in getting free access to FTS (n=426)	
Yes	186 (44)
Do you have any concerns about using FTS? (n=426) **	
Don't trust the results / unreliable	94 (22)
Don't want to go to the syringe services program to get them	33 (8)
Don't want to know if my drugs contain fentanyl	18 (4)
Getting stopped or arrested by police	5 (1)
Worried about people finding out I use drugs	3 (1)
Other: I don't use fentanyl	15 (4)
Other: FTS don't tell me amount of fentanyl (purity) / what else is in the drug sample	6 (1)
Other: Uncategorized	12 (3)
Would you be interested in an advanced spectrometry drug checking service? (n=196)	
Yes	165 (84)
Not sure	9 (5)
Would you be willing to go to a syringe services program to use this service? (n=195)	
Yes	170 (87)
Not sure	5 (3)
Would you use a drop box to leave your drug samples for advanced spectrometry testing? (n=194)	
Yes	161 (83)
Not sure	11 (6)
How would you prefer to get the test results? (n=189) **	
In person	137 (73)
Logging onto an online portal	63 (33)
By anonymous phone call	32 (17)
Other: Email	6 (3)
Other: Uncategorized	12 (6)
Would you be interested in using an online dashboard to see community-wide drug checking results? (n=195)	
Yes	162 (83)
Not sure	13 (7)

* Question responses have different sample sizes due to survey skip logic, which eliminates certain questions for participants based on prior responses.

** Items indicated are not mutually exclusive.

FTS = fentanyl test strips