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Substance residue analysis as an alternative to drug checking? - Traces from drug paraphernalia as a source for laboratory analysis

ABSTRACT

Purpose: Drug checking is a popular method to reduce risks of drug use. In many countries, including Finland, legislation restricts implementing drug checking. The aim of this study was to explore whether some benefits of drug checking could be achieved by substance residue analysis.

Design: Drug paraphernalia (mostly empty plastic bags) were used in the study. Participants left a sample and information about the former content to a local needle exchange point. After laboratory analysis, participants could return for the results and a short consultation on the substance(s) found. Afterwards, participants were asked whether they would still use the batch.

Findings: Ninety-eight samples were received. In most cases, the samples had originally been sold as amphetamine (n = 39). Overall, laboratory results matched with supposed content in 52 cases, but in 21 cases, the sold content had been altered, in 17 cases, only other psychoactive substances were found, and in 8 cases, no traces of psychoactive substances were found. Participants returned for results in two-thirds of the cases. When the laboratory result did not match participants' expectations, the majority of participants estimated they would not use the same batch (17/25) or would use it in a different way (2/25).

Originality: While reports on drug checking are numerous, studies exploring possibilities to achieve harm-reducing benefits of drug checking by analyzing drug residues are scarce. The results of this pilot study suggest some benefits of drug checking can be achieved by substance residue analysis.

Keywords

Harm Reduction, Drug Checking, Illicit Drugs, Drug Residue Analysis, Drug Monitoring

Article classification: Research Paper

Introduction

Numerous health risks are related to drug use. Different drugs pose different kinds of health risks, and the routes of use, as well as doses and frequency of use, are factors related to the risks (e.g., van Amsterdam *et al.*, 2015). Risks and harms of drug use can be reduced by educating people who use drugs (PWUD) on the risks (Ritter, 2006). Besides knowing the risks of the substances bought, another aspect related to risks is that drugs can be sold as something that they are not; for example, according to a study in the UK, one out of five samples tested in a festival setting were not what they were supposed to be (Measham, 2019).

Increasingly, the drug market situation is being monitored (Brunt, 2017), and the related harms and risks have been reduced (Measham and Turnbull, 2021) by drug checking services. Drug checking refers to a wide range of services that enable PWUD "to chemically analyze their street-acquired drugs and receive individualized and fact-based consultation regarding the contents, and the associated risks, of compounds detected in their samples" (Kerr and Tupper, 2017).

The opportunity to get to know the actual content and to engage in a short counselling session has been shown to reduce the risk of overdosing or accidentally taking unknown and potentially harmful substances (Saleemi *et al.*, 2017; Mema *et al.*, 2018; Measham, 2019; Measham and Turnbull, 2021). Typically, drug checking is targeted to specific groups, most commonly festival- or nightclubs-goers (Brunt, 2017; Saleemi *et al.*, 2017; Mema *et al.*, 2018), and more rarely for people who have problems with drugs or intravenous use of drugs (Karamouzian *et al.*, 2018; Sande and Šabić, 2018). Currently, no studies have compared samples brought by these two groups as clients of drug checking.

At least 20 countries have implemented drug checking (Barratt *et al.*, 2018). Because handling and possessing drugs are strictly regulated and drug legislation differs considerably between countries (The European Monitoring Centre for Drugs and Drug Addiction [EMCDDA], 2019), and because legal systems vary from common law to civil law traditions (e.g., Pejovic, 2001), the practical implementation of drug checking has to be fitted to the national juridical environment. No systematic review of the legal basis of drug checking services in different countries exists. However, ways to solve legal obstacles include handling of drugs without "final intention to consumption" in Denmark (Helsefonden and Oak Foundation, 2018), checking as a form of "anonymous confiscation" in Slovenia (Sande and Sabic, 2018), separate legislation for drug checking in New Zealand (Misuse of Drugs Act, 1975), official agreements not to prosecute in Netherlands (Claudine Lyons Consulting, 2019), local "exceptions to legal restrictions" in the United Kingdom (Guirguis *et al.*, 2020), and volunteer-based unofficial settings in the United States (Dancesafe, 2022).

The legal environment in Finland does not allow workers and researchers of non-governmental organizations to receive or handle drugs originated from illegal sources. Therefore, we wanted to explore whether some of the main risk-reducing benefits of drug checking could be achieved by other means. A pilot study called Kadulta Labraan (in English: From the Street into the Lab) in co-operation with A-Clinic Foundation, the Finnish Institute for Health and Welfare (THL), and the Deaconess Foundation was conducted between November 2018 and March 2019. The study was based on substance residue analysis: Empty plastic bags and other paraphernalia with traces of drugs were collected and analyzed instead of actual drugs. A similar kind of substance residue approach had already been used in Finland for injected substances in used syringes in the European Syringe Collection and Analysis Enterprise (ESCAPE) project. After a laboratory analysis, the participants had the possibility to hear what kinds of traces were found from their sample.

The first aim of the study was to see what kind of persons would bring samples to substance residue analysis: Could such a study reach PWUD who do not have earlier contact to drug services? The second aim was to find out whether the traces found in the residues matched with the information the drug had been sold with as well as what the participants expected to be found in the sample. The third aim was to find out whether information about the actual content and risks related to it would potentially affect participants' intent to take the drug. In addition, valuable information on the composition of substances sold as drugs in the local clandestine market was obtained.

Research methodology

Setting and sample collection procedure

The study setting originates from the project Muunto (in English, Transform*)*, which explored the possibilities and benefits of introducing drug checking in Finland. Project workers negotiated with various officials to map out the de facto legal framework for drug checking. The main problems for practical implementation were related to obtaining a permit for nongovernmental actors to handle and receive drugs acquired from the illegal market.

The Narcotics Act (373/2008) states that the handling and possession of controlled narcotics is prohibited. Certain exceptions can be made for research purposes, but these are not applicable for controlled narcotics of illegal origin. Only governmental security officials, such as police and Customs officials, can handle drugs of illegal origin when performing confiscation and disposing of confiscated narcotics, as well as for the purpose of preventing, exposing, and investigating crimes.

Needle exchange services were adopted in Finland in 1997. In these services, people who inject drugs (PWID) return used needles and syringes to acquire new ones. Although the used syringes include small residual amounts of the injected narcotic solution, this was never considered a problem or a reason to require permission to handle narcotics because the amount of residue in a syringe is only a small fraction of the amount needed for one narcotic dose, and therefore it is not considered suitable for a narcotic purpose. In 2017 the THL began to study the residue in syringes as part of EMCDDA-promoted ESCAPE project (see Brunt *et al.*, 2021). This study demonstrated that the used narcotics could be unambiguously identified from the drug residues in syringes.

As it became evident that narcotics of illegal origin could not be acquired for our study, we adopted this new approach of analyzing drug residues in drug paraphernalia to imitate drug checking.

The study was advertised by word-of-mouth and via leaflets in needle exchange programs and other service points directed to persons with a contact to drug services, in closed or anonymous web forums, and in unofficial discussion clubs to inform people who use drugs recreationally. Advertising was not directed to the public because the number of samples included in the study had to be limited beforehand due to laboratory costs.

Samples were collected at a needle exchange program service point in Helsinki one to two times per week. Clean, empty plastic bags were also available in the premises for people who participated in the study without consuming the sample. The samples were analyzed in the Forensic Toxicology laboratory of the THL once in a month.

Ninety-eight samples of used drug paraphernalia were collected between November 2018 and March 2019. These samples PWUD brought for analysis included mostly empty plastic bags, but also a straw as well as two filter-and-cup combinations used for preparation or use of drugs.

Each participant (i.e., person who brought a sample) was asked what they were sold or given and what they expected the laboratory to find. Participants were also asked whether the paraphernalia had been in contact with other substances to clarify that the sample had not been contaminated. If a participant had used the substance, he or she was asked questions about the route of administration, effects of use, and possible side-effects. If a participant wanted, he or she could answer to few categorized background questions concerning gender, age, education, work status, intravenous drug use, and use of drug services. If a participant wanted to leave a self-chosen nickname, they were given a date when the laboratory result would be available under that nickname and a possibility to hear the result of their sample.

If the participant came back for the results, a brief intervention (see Henry-Edwards *et al.*, 2003) directed to the use of the substance(s) found in the laboratory was given. The participant was then asked whether they would now – knowing the actual content and risks related to it – (a) use the substance from the same batch, (b) not use the substance from the same batch, or (c) use it differently (e.g., change the route of use or the amount of the substance used).

Because the sample collection was anonymous and it was possible for a single person to bring multiple samples during the collection period, the number of people who participated in the project is unknown. Therefore, the results related to background information are presented as per sample, not as per participant.

Laboratory testing and data analysis

Samples were analyzed qualitatively with both ultra-high-performance liquid chromatography-tandem mass spectrometry (UHPLC-MS/MS) and high-resolution time-of-flight mass spectrometry (UHPLC-HR-TOF-MS) in the Forensic Toxicology laboratory of the THL. Analytical methods used in this study have been described in detail elsewhere (EMCDDA, 2021; Sundström *et al.*, 2013). The cut-off levels of both methods are in low ng/mL range, and therefore more than sufficient for drug residue analysis. Samples that contained more than one substance were analyzed semi-quantitatively to identify which substance was the main component.

The results of the laboratory analysis were transferred via encrypted connection between the laboratory and other researchers. The database including laboratory results and anonymous interview data was merged by a researcher of the A-Clinic Foundation. IBM SPSS Statistics for Windows, version 25 (IBM Corp, 2017) was used for statistical analyses.

This approach is likely to emphasize samples about which participants were suspicious, therefore the results cannot be generalized to the surrounding drug market, and they only represent the samples of this pilot study. Frequency distributions and cross tabulations are presented, but no statistical comparisons are performed. The results for all samples (N = 98) and for the samples brought by a person with (n = 56) and without (n = 31) an earlier contact with substance use treatment services are reported.

Ethics

Participation in the research project was voluntary and anonymous. Participants were informed of the study protocol verbally, and written material ranging from leaflets to the research plan was offered and was available.

No written consent was collected from the participants because it would have risked their anonymity. The participants used self-chosen pseudonyms for receiving the results. To protect the privacy of the participants, the equivalency between pseudonyms and the sample-codes used for communication between the laboratory and sample collectors was only known by sample collectors.

All participants were informed on characteristics of the testing of drug paraphernalia samples, including possibility for only qualitative analysis of the residues and a minimal yet existing risk of a false result. To reduce the possibility of using the result to benefit illegal drug trade (Brunt, 2017), the results were only given to participants verbally, a protocol aimed to reduce that risk.

The study protocol was approved by the Ethical Committee of the A-Clinic Foundation and the Deaconess Foundation. The research permit was obtained from the City of Helsinki.

Findings

Background information

Table I presents the data regarding background information of the participants who had brought samples. Male participants brought in 64 samples, and female participants brought in 18 (information is missing from 16 samples). Most commonly, a sample was brought by an under 30 years (n=40) old participant or a participant aged 30 to 45 years (n=37). Only 8 samples were brought by a participant over 45 years (information is missing from 13 samples). Out of 77 samples with information on socioeconomic status, 31 were brought by persons who were unemployed, 26 by persons who were employed, and 19 samples by students (one sample was given "other" status). Out of 68 samples with information on educational degree, 17 samples were brought by participants with a higher educational degree, 33 by participants with a secondary educational degree, and 18 by participants with primary education or less.

The participation attracted both PWUD with a history of substance use services (SUSs, 56 samples out of 87 with this information) and PWUD without prior use of SUSs. The most common SUSs mentioned were needle exchange, institutional drug rehabilitation, and opioid substitution treatment. Out of 86 samples with information about participants' intravenous drug use, 52 samples were brought by persons who had used drugs intravenously, of which 33 had used drugs during the prior month. Most samples brought by participants with prior use of SUS were from persons who had used drugs intravenously (50/54). Only two (out of 31) samples brought by persons without a history of SUS use were from persons who had used drugs intravenously. Samples from persons with a history of SUS use were most commonly (31/56) from persons aged 30 to 45 years, whereas samples from people without a history of SUS use were usually (22/30) from persons who were younger than 30.

Samples that came from people with no history of SUS use were more often from young (22/30, 30 years old or younger), working (15/29), or student (11/29) participants. All these samples were from people with a secondary education degree (9/24) or higher (15/24) education.

Samples from persons with a history of SUS use were typically (31/55) from participants aged 31 to 45. Of these samples, many were from participants with only primary education or less (18/44). Only four (out of 54) of the samples brought by participants with service use history were also from people who had never used drugs intravenously.

Table I. Background information on the participants who had brought samples (per sample).

	All (N=98)	Had used substance use services (n=56)	Had not used substance use services (n=31)
Gender			
Men	78.0	71.2	90.0
Women	22.0	28.8	10.0
n	82	52	30
Age			
30 years or younger	47.1	32.7	73.3
31-45 years	43.5	56.4	20.0
46 years or older	9.4	10.9	6.7
n	85	55	30
Working status			
Student	24.7	16.7	37.9
Unemployed	40.3	58.3	10.3
Employed	33.8	22.9	51.7
Other	1.3	2.1	0.0
n	77	48	29
Education			
Bachelor or higher	25.0	4.5	62.5
Secondary school	48.5	54.5	37.5
Primary school	25.0	38.6	0.0
Unfinished primary school	1.5	2.3	0.0
n	68	44	24
Intravenous drug use			
Never	39.5	7.4	93.5
Yes. but not in past year	7.0	11.1	0.0
Yes. but not in past month	15.1	20.4	6.5
Yes. in past month	38.4	61.1	0.0
n	86	54	31

The content of the samples

Out of 98 samples, 39 had been originally bought as amphetamine (Table II). Twenty had been acquired as different benzodiazepines (alprazolam, clonazepam, and diazepam). Multiple samples had also been sold as MDMA (n = 13), ketamine or s-ketamine (10), 2C-B (n = 2), heroin (n = 2), LSD (n = 2), MDPV (n = 2), and methamphetamine (n = 2). Individual samples were sold or given to participants as 2-FMA, 3-MeO-PCP, 4-HO-MET, crack, MDA, and PCP.

Table II shows the laboratory results that matched the description a participant gave when leaving the sample. Only 52 samples were revealed as the same substance the user thought it was. In 21 samples, traces of the substance matching the sold substance were found, but also traces of other psychoactive substances. Most common combination found was amphetamine that had been adulterated with caffeine. Other combinations found more than once were amphetamine adulterated with methamphetamine, and MDMA adulterated with caffeine and cocaine.

Seventeen samples had no trace of the supposed substance, but contained traces of other psychoactive substances. Two samples had been sold as amphetamine but contained cocaine. Two samples sold as alprazolam (described as Xanax tablets) contained a mixture of amantadine, cyproheptadine, and promethazine. Traces of amphetamine were found in two samples sold as methamphetamine. In eight samples, no psychoactive substance was found.

Explanation for a few inexplicable results, such as a mixture zolpidem, MDMA, and pregabalin sold as crack-cocaine and finding THC in a samples sold as clonazepam and heroin, could relate to problems caused by the study protocol: A participant might have mixed two empty plastic bags or have handled the bags with fingers with traces of substances.

Table II. Equivalency between information on how drug residue in the sample was originally sold as and the re-sult of the laboratory analysis

Sold as	n	Yes	Partly	No	Not-hing*	
Amphetamine	39	16	16	5	2	amphetamine+caffeine (10), ampheta-mine+methamphetamine (3), ampheta-mine+methamphetamine+caffeine+phenacetin (1), amphetamine+cocaine (1), cocaine (1), cocaine+ phenacetin (1), MDMA (1), amphetamine+methamphe-tamine+phenacetin (1), methamphetamine (1), midazo-lam+buprenorphine+tizanidine (1)
Alprazolam	13	10	0	2	1	amantadine+cyproheptadine+promethazine (2)
MDMA	13	9	3	0	1	MDMA+caffeine+cocaine (2), MDMA+procaine (1)
Ketamine	10	6	0	2	2	methoxetamine (1), propranolol (1)
Clonazepam	5	4	1	0	0	clonazepam+THC (1)
2C-B	2	1	0	1	0	amphetamine (1)
Diazepam	2	2	0	0	0	-
Heroin	2	0	0	1	1	THC (1)
LSD	2	1	0	0	1	
Methamphetamine	2	0	0	2	0	amphetamine (1), caffeine+amphetamine (1)
MDPV	2	0	0	2	0	amphetamine (1), MDPHP (1)
2-FMA	1	1	0	0	0	-
3-MeO-PCP	1	1	0	0	0	-
4-HO-MET	1	1	0	0	0	-
Crack-cocaine	1	0	0	1	0	zolpidem+MDMA+pregabalin (1)
MDA	1	0	1	0	0	MDA+MDMA (1)
PCP	1	0	0	1	0	tizanidine (1)
Total	98	52	21	17	8	

*No psychoactive components were found in the analysis.

The samples brought by persons who had used SUSs during their lifetime had mainly been sold or given out as stimulants (30/56) or benzodiazepines (18/56). In contrast, the samples brought by persons with no history of drug services had been sold as stimulants (9/31), MDMA/MDA (9/31), dissociatives (9/31), or psychedelics (4/31), but not as benzodiazepines.

Mostly, the participants had used the substance before bringing the sample to the study (68/98). However, in 23 cases, the participants had not used the substance that had been kept in the paraphernalia sample. The information about prior use was missing from seven samples. Both persons who had used SUSs (9/55) and those had not used SUSs (12/31) had not used the drug in the sample brought to the study. The main routes of administration were intravenous (24/46) and oral (18/46) for people who had used SUSs, whereas the main routes were oral (11/19) and nasal (8/19) for people who had not used SUSs. Unexpected side-effects were reported in relation to 15

samples: The most common side-effects reported were tiredness (5/15), problems with sleep (3/15), balance disturbance (2/15), and unexpectedly long duration of the effects (2/15).

When bringing a sample, participants were also asked if they expected a laboratory result to match the information they had received from the seller. Of the 73 answers, 43 expected results to match the information from the seller, 15 expected the laboratory to find traces of the sold substance as well as some other substance, and 15 expected that only traces of some other substance would be found. In three-fourths (31/43) of the samples, the laboratory results matched with the sold content if the participant had expected the result to match. In half of the samples (8/15), the result did not match the sold content if the participant had expected them not to match.

Impact of drug information on the intent to use the batch

Of the 98 samples, the participants came back to hear the results of 61 samples (62 %). Participants were asked if the results were what they expected (a different question compared to what the substance was sold as). In 33 (out of 60) of these samples, the laboratory result matched the expectations of the participant. However, in 27 (n = 60) cases it did not. One participant did not answer if the sample matched the expectations. The result might not have been what the participant had expected even though the sample contained the same substance that had been indicated when originally acquiring it, as well as in those cases when the sample did not contain the drug it was supposed to contain.

In around half of the cases (24/51), a participant estimated that after hearing the result and information about the found substances, they would not use the substance in a same way as before the information. In five cases, the participant estimated they would change the pattern of use (dosage or route of consumption), and in 19 cases, the participant said they would not use the drug at all in the light of the laboratory results and the information given. Participants answered that they would not use the batch after having a discussion based on the laboratory results in more than one-third (6/16) of the samples, which had not been used. Almost all of the participants who returned to hear the result and had a discussion based on it found the discussion useful (40/41), and the majority (26/42) evaluated that the discussion had offered them new information.

When samples did not match expectations, the majority (17/25) estimated they would not use the same batch anymore, and in two cases, the participant would change the pattern of use. When the results were what a participant had expected, the majority (20/26) estimated they would use the substance in the same way as earlier.

The participants who had no history of SUS use were more likely to appear to hear the results compared to those with a history of SUS use: From the samples brought by individuals with no history of SUS use, all but one result were successfully passed to a participant. Less than half of participants (27/56) with a history of using SUSs came to hear the results.

Discussion

The study used a method of substance residue analysis to imitate some aspects of drug checking by analyzing traces of drugs from used drug paraphernalia (i.e., trash used to store or to use drugs) instead of actual drugs. The setting was a compromise with limitations that related to the national de facto legal framework. Even though the paraphernalia was collected, one-fourth of the samples had not been used by participants before they were brought to the study.

The samples were collected at a local needle exchange point, but around one-third of the samples were brought by participants who had no prior experience with SUSs. All but one of the participants without an SUS background, who were usually young and educated, returned to hear the results of their sample. This suggests the chosen method – similar to drug checking services (Hungerbuehler *et al.*, 2011) – could also attract recreational users who have not been reached by classical drug education or SUSs.

The research data consisted of only 98 samples collected in a short time at only one collecting point, within a limited number of days and hours of operation. The samples are likely biased because the participants most likely brought samples that were suspicious in one way or another. Therefore, the results regarding the samples, and how the laboratory results match information about what participants had acquired, should not be generalized.

About half of the samples matched the supposed content. The remaining samples were mainly adulterated with very similar substances; for example, amphetamines contained mainly other stimulants such as caffeine and methamphetamine. However, during the study, the findings related to two samples containing a mixture of amantadine, cyproheptadine, and promethazine but sold as Xanax tablets were reported to the EMCDDA Early Warning System by the National Focal Point.

Participants were also asked whether they expected laboratory findings to match the claims of the seller. There was symmetry between participants' expectations, but samples that participants believed to contain what was stated by a seller did not always match the laboratory results and vice versa.

Is substance residue analysis an alternative to drug checking?

In most cases, the method of using used drug paraphernalia, such as empty plastic bags, was found a valid method to identify psychoactive components. However, quantitative information, such as concentrations of various substances, could not be obtained.

Using highly sensitive laboratory equipment to analyze very small residues was time-consuming compared to usual onsite drug checking methods, and – as pointed out before – the method lacked a quantitative analysis. Furthermore, non-psychoactive substances used as adulterants were not systematically analyzed and the lacking legal framework excluded substances in liquid form or blotters as those were more difficult to interpret as trash.

One weakness compared to drug checking methods was a higher probability for a participant to contaminate the sample, to bring paraphernalia that had been used multiple times, or to substitute the sample accidentally before giving it off for the study. In a few samples, the discrepancy between the laboratory results and the information received from the participants might be explained by such errors. For example, THC might have been exposed to the drug paraphernalia sample via the participant's hands. Although these shortcomings cannot be removed, the occurrence and harms related to such errors can be minimized by verifying that the paraphernalia has only been in touch with a single batch and by informing participants about these possible explanations.

Although used plastic bags and other paraphernalia related to drug use were collected, in around one-fourth of study cases, the contents of the sample paraphernalia were not used by participants before they brought the sample to the study. In a long-term collection of substance residues, the proportion of samples that have not been used would likely be higher because PWUD would get used to it as a form of drug checking, thus bringing samples to be tested before consumption.

The individual feedback on the content and related risks is not the only potential benefit of substance residue analysis. Indeed, it can also be used – just like drug checking (e.g., Martins *et al*., 2017) – for general alerts and monitoring of atypical batches in the drug markets as long as the participants are asked to describe the former content.

Contrary to trace residue analysis of discarded drug packaging (West *et al.*, 2021), the setting used in this study could combine laboratory data on contents of paraphernalia with the description from a PWUD on which the drug was sold and how it looks. The setting also makes it possible contact the PWUD and to give them feedback on the risks related to the finding. Compared to other study methods, such as studies based on the analysis of contents of used syringes (Brunt *et al.*, 2021) or wastewater-based epidemiology (Kankaanpää *et al.*, 2016), substance residue analysis is not based on randomized sampling or extensive population coverage, and therefore it does not produce information that could be generalized to the overall drug market. However, it might detect atypical batches from the market faster and give detailed information on such batches (drug's effects and the way the drug is described when sold).

The current study supports the argument that unorthodox methods utilizing some aspects of drug checking have the potential to reduce the use of potentially dangerous substances in the same way as drug checking (i.e., Mema *et al.*, 2018; Saleemi *et al.*, 2017; Measham, 2019). From those participants whose samples did not contain the substance they had expected, two-thirds evaluated that they would not have used the drug if they had known the result of the laboratory test and information about the risks related to the findings.

As in Slovenia (Sande and Sabic, 2018), the United States (Sherman *et al.*, 2019), and Denmark (Helsefonden and Oak Foundation 2018), our study reached a high-risk group of PWID. It is worth noticing that the regular clients of the collecting point, PWID, came remarkably rarely to hear the results. One reason for this might be the limited opening hours and the long waiting time. To prevent harm among PWID, reasons behind these problems should be studied and the protocol reconsidered to overcome them.

Further research and practical implementation

This study presented a unique way not only to monitor a local drug market but also to explore potential benefits of drug-checking services in countries where drug checking confronts legal challenges. Compromises to meet the restrictive legal framework came at the price of accuracy (e.g., lack of drug concentrations and possibility of contamination or substitution of the samples) and time. Altogether, the study suggests that many benefits of drug checking could be gained using very small residues found from the items used to store or use drugs instead of actual substances.

This study was a short-term pilot, and more information is needed on the potential benefits of the current approach. At the time of writing, a new project implementing substance residue analysis is being launched in Finland. Over the course of the new project, samples will be collected over 2 years at five collection sites that offer different types of services to find out whether sites with different customer profiles and geographical locations attract people with different drug use profiles. In the new project, the results will also be compared to other information sources (e.g., confiscated drugs and overdose deaths).

The challenges related to the de facto legal framework are very country-specific, and constraints particularly related to time in our study could be significantly reduced even if minimal residues are used instead of actual drugs. Although the legal framework is a very important aspect when setting up a drug-checking service, no systematic studies address the ways legal obstacles have been overcome in various countries. This question should be studied in the future to gain a broad view of

the different legal solutions so the most suitable alternatives could be considered in countries still struggling with legal restrictions to drug checking.

Substance residue analysis could be a way to obtain experience and present potential benefits of drug checking for policymakers in the future. In this way, substance residue analysis could also act as a stepping stone towards reforms in the legal environment where implementation of drug checking is not possible.

Conclusion

Although this study was a short-term pilot, and more information is needed to be able to evaluate the true potential of this method, it can be concluded that many beneficial outcomes of drug-checking services can be achieved by substance residue analysis.

First, although samples were collected at a needle exchange point, PWUD who did not have earlier contact to drug services brought samples for substance residue analysis, which indicates this method – similar to a drug-checking service – could attract recreational and other PWUD to classical drug education or SUSs.

The traces found in the residues did not match the information the drug had been sold with nor what the participants expected to be found in the sample in all cases. Even if in many cases participants had used a sample, some had not. In these cases, information on the actual content and risks related to it indeed affected participants' intent to take the drug. The participants who had already consumed the substance in the residue found the discussion related to the laboratory results useful and most discussions benefited participants indirectly by offering new information.

In addition, valuable information on the composition of substances sold in the local clandestine market as drugs was obtained. This adds another piece of information to the general comprehension of the drug market and could have an effect on behavior of PWUD by means of increased awareness of risks associated with mislabeled drugs in the clandestine market.

In addition, substance residue analysis could be a way for policymakers to obtain experience and present potential benefits of drug checking, which may have far-reaching consequences for national drug policies.

Conflict of interest

Authors have no conflict of interest to declare.

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