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Substance use patterns associated with recent exposure to fentanyl among people who inject drugs in Vancouver, Canada: A cross-sectional urine toxicology screening study

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Abstract

Introduction—Vancouver, Canada is experiencing an opioid overdose crisis where fentanyl, a potent, synthetic opioid contaminating the illicit drug supply, has been detected in the majority of fatal overdose cases. Despite its growing presence throughout North America, few studies have characterized exposure to fentanyl among people who use illicit drugs (PWUD). We sought to identify the prevalence and correlates of fentanyl exposure among PWUD in Vancouver.

Methods—Data were derived from cohort studies of PWUD in Vancouver. In June –October 2016, we administered multi-panel urine drug screens (UDS) to detect recent exposure to fentanyl and eight other substances. Multivariable logistic regression was used to identify substance use patterns associated with recent fentanyl exposure among participants who injected drugs in the past six months (PWID).

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Contributors: TK, EW, MJM, KD and KH designed and managed the cohorts. KH designed the study, drafted the initial manuscript, and incorporated suggestions from the coauthors. EN conducted statistical analyses. All authors made significant contributions to the conception of the analyses, interpretation of the data, and drafting of the manuscript. All authors approved of the final manuscript. KH had full access to all of the data in the study and can take responsibility for the integrity of the data and the accuracy of the data analysis.

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Results—Among 669 PWUD including 250 (37.4%) females and 452 (67.6%) PWID, 97(14.5%) tested positive for fentanyl. All these individuals also tested positive for other substances, most commonly for morphine/heroin (89.9%), amphetamine/methamphetamine(75.3%) and cocaine (74.2%). A fentanyl detection rate was significantly higher among PWID (19.7%) compared to non-injection drug users (3.9%) ($p<0.001$). In multivariable analyses, younger age (adjusted odds ratio [AOR]: 0.96) and testing positive for morphine/heroin (AOR: 6.73), buprenorphine (AOR: 4.25), amphetamine/methamphetamine (AOR: 3.26), cocaine (AOR: 2.92) and cannabis (AOR: 0.52) remained independently associated with fentanyl exposure (all $p<0.05$).

Conclusion—With one in five PWID being exposed to fentanyl, there is an urgent need to design and scale up interventions to reduce overdose risk, including a range of opioid agonist therapies.

Keywords

fentanyl; injection drug use; opioids; opioid agonist therapy; cross-sectional study

1. Introduction

In recent years, many locations in North America have been contending with escalating opioid overdose epidemics (Alberta Health 2017; Gomes et al., 2017; Rudd et al., 2016); British Columbia (BC), Canada is among the hardest hit. Between 2012 and 2016, illicit drug overdose death rates increased more than three-fold, and the rates have continued to rise in 2017 (British Columbia Coroners Service, 2017b). The unprecedented magnitude of the epidemic prompted the local Provincial Health Officer to declare a public health emergency in April 2016 (BC Gov News, 2016). An increasing number of jurisdictions have followed suit, including New Haven, Connecticut (The New York Times, 2016), and the state of Virginia (Virginia Department of Health, 2016).

Available data suggest that illicitly-manufactured fentanyl, a synthetic opioid that is much more potent than heroin, has been involved in a substantial number of overdose deaths in many locations (Canadian Centre on Substance Abuse, 2015; Rudd et al., 2016). In BC, illicit fentanyl was detected in 62% of illicit drug overdose deaths in 2016 (British Columbia Coroners Service, 2017a). In 2016, Health Canada's Drug Analysis Service laboratories analyzed illicit drug samples seized by law enforcement agencies and found that fentanyl was combined with many street drugs: particularly heroin (21.6%) but also other drugs such as cocaine (4.8%) and methamphetamine (1.7%) (Miller and Russell, 2016). Therefore, people who regularly use street drugs are at a particularly high risk of overdose, as they may unknowingly ingest fentanyl.

There is an urgent need to characterize exposure to illicit fentanyl among people who use drugs in order to guide public policy and clinical practice and refine targeted overdose prevention interventions. However, to date, only a very small number of studies have examined patterns of exposure to fentanyl among this population. In Rhode Island, U.S., fentanyl-involved overdose deaths have significantly increased from 35% in 2014 to 55.6% during the first nine months of 2016 (Marshall et al., 2017). In this setting, 11% of 199

young adults who misused prescription opioids reported having used known or suspected fentanyl-contaminated heroin in 2015-16, and the use of fentanyl-contaminated heroin was associated with markers of more intense drug use (e.g., injection drug use) (Macmadu et al., 2017). In a slightly more updated, mixed-methods study, 50% of 149 individuals using illicit opioids or misusing prescription opioids self-reported suspected exposure to illicit fentanyl and the suspected exposure to fentanyl was independently associated with heroin use (Carroll et al., 2017). While self-reported strategies to avoid fentanyl exposure included seeking opioid agonist therapy, study participants reported challenges with accessing structured addiction treatment programs (Carroll et al., 2017). A 2015 study administered urine drug screens (UDS) for fentanyl to 242 clients of harm reduction services across BC and found a fentanyl detection rate of 29% (Amlani et al., 2015). However, they did not examine associations between fentanyl exposure and opioid agonist therapy use or test the urine samples for other substances in addition to fentanyl. Building on these previous studies, our study sought to identify the prevalence of exposure to fentanyl and other substances by means of UDS and examine substance use and opioid agonist therapy utilization patterns that may be associated with fentanyl exposure among people who use illicit drugs in Vancouver, BC.

2. Materials and methods

2.1. Study setting, design and participants

Data were derived from three ongoing prospective cohort studies of people who use drugs in Vancouver: the Vancouver Injection Drug Users Study (VIDUS), the AIDS Care Cohort to evaluate Exposure to Survival Services (ACCESS), and the At-Risk Youth Study (ARYS). VIDUS started in 1996, while ACCESS and ARYS started in 2005. Detailed descriptions of these cohorts have been previously published elsewhere (Strathdee et al., 1998; Wood et al., 2009; Wood et al., 2006). In brief, VIDUS enrolls HIV-seronegative adults (18 years of age) who injected illicit drugs in the month prior to enrollment. ACCESS enrolls HIV-seropositive adults who used an illicit drug other than or in addition to cannabis in the month prior to enrolment. ARYS enrolls street-involved youth aged 14 to 26 who used an illicit drug other than or in addition to cannabis in the month prior to enrollment. The studies use harmonized data collection and follow-up procedures to allow for combined analyses of the different cohorts. Specifically, the cohorts were administered the identical questionnaires with equal follow-up frequency (i.e., every 6 months).

At baseline and semi-annually thereafter, participants complete an interviewer-administered questionnaire, which elicits a range of information, including demographic data, substance use, and healthcare access. On June 16, 2016, a multi-panel qualitative UDS using BTNX Rapid Response™ Multi-Drug Test Panel (Markham, ON, Canada) was added to the data collection procedures. This rapid, chromatographic immunoassay qualitatively and simultaneously detected nine substances in urine within five minutes. The screened substances (calibrator, cut-off value in ng/mL) included: fentanyl (fentanyl, 100, and norfentanyl, 20); morphine/heroin (morphine, 100); methadone (2-Ethylidine-1, 5-dimethyl-3, 3-diphenylpyrrolidine, 100); buprenorphine (BUP-3-D-Glucuronide, 10); oxycodone (oxycodone, 100); cocaine (benzoylecgonine, 150); amphetamine/

methamphetamine (d-amphetamine, 1000); benzodiazepine (oxazepam, 300); and tetrahydrocannabinol, the main psychoactive component of cannabis (11-nor-9-THC-9 COOH, 50) (BTNX, Inc.). According to the product insert, the accuracy of test results was established by testing the same urine samples with gas chromatograph-mass spectrometry specifications and exceeded 95% for all substances listed above (BTNX, Inc.). While detection times for the substances vary depending on many factors, including routes of administration, frequencies of use, and individual metabolism rates, the BTNX fentanyl test panel with the aforementioned cut-off values is commonly believed to detect exposure to fentanyl within a maximum of past three days (Silverstein et al., 1993). All three cohorts have received approvals from the University of British Columbia/Providence Health Care Research Ethics Board.

Eligibility criteria for the present study included: completing both the interviewer-administered follow-up questionnaire and UDS between June 16 and October 26, 2016, and reporting having used any illicit drugs (including non-medical use of prescription drugs) in the past six months. Some participants in the cohorts, particularly those who were enrolled in the cohorts a long time ago, had stopped using illicit drugs altogether during follow-up. Since including such participants in the sample would lead to the underestimation of fentanyl detection rates among the drug-using population, we restricted the sample to those who used illicit drugs at least once in the past six months.

2.2. Measures

The primary outcome was recent exposure to fentanyl, defined as a positive UDS result for fentanyl. In order to describe the sample characteristics, the following variables were considered. Demographic variables included: age (continuous); sex (female vs. male); ethnicity/ancestry (White vs. non-White); and residence in the Downtown Eastside neighborhood in Vancouver, an area with a large open drug market. Self-reported drug use-related variables included: injection drug use; using stimulants (e.g., powder or crack cocaine, crystal methamphetamine), but not any opioids; and non-fatal overdose. UDS results for the remaining nine substances were also included. Since the descriptive statistics of the sample showed that 91.8% of those testing positive for fentanyl reported injection drug use in the past six months (Table 1), bivariable and multivariable logistic regression analyses were restricted to PWID participants (i.e., those who reported having injected drugs in the past six months), and drug use-related variables were revised for the regression analyses. These variables included self-reported use of each of the following eleven drugs: heroin; fentanyl pills or patches (non-medical use); street methadone (i.e., diverted or illicitly manufactured methadone); street buprenorphine-naloxone (i.e., diverted or illicitly manufactured buprenorphine-naloxone); other prescription opioids (non-medical use); powder cocaine; crack cocaine; crystal methamphetamine; benzodiazepine; and cannabis (both medical and non-medical). The use of opioid agonist therapy (OAT) using either methadone or buprenorphine-naloxone was also included. All variables except for age, sex, ethnicity/ancestry and UDS results referred to the past six months. Unless otherwise stated, all variables were dichotomized as yes vs. no.

2.3. Statistical analyses

First, we examined the sample characteristics stratified by UDS results for fentanyl, using the Pearson's Chi-squared test (for binary variables) and Wilcoxon Rank Sum test (for continuous variables). Next, in order to identify a set of substance use patterns associated with a higher odds of recent exposure to fentanyl, we built two multivariable logistic regression models: Model 1 included demographic and UDS results variables, and Model 2 included demographic and self-reported use of drugs and OAT variables. In addition to the UDS results, which only ascertained a very recent exposure to the substances, we wanted to consider longer-term substance use patterns. Therefore, we separately fit the models for UDS results and self-reported substance use patterns. For both models, we used an *a priori*-defined backward model selection procedure based on examination of Akaike Information Criterion (AIC) to fit a multivariable model (Burnham and Anderson, 2002). In brief, we constructed a full model including all variables that were associated with the outcome at $p < 0.10$ in bivariable analyses. After examining the AIC of the model, we removed the variable with the largest p -value and built a reduced model. We continued this iterative process until we reached the lowest AIC score. All p -values were two-sided. All statistical analyses were performed using RStudio, version 0.99.892 (R Foundation for Statistical Computing, Vienna, Austria).

3. Results

In total, 669 participants were eligible for the present study. As shown in Table 1, 250 (37.4%) were female, 367 (54.9%) were white, and the median age was 47 (quartile [Q] 1–3: 35–54) years. Among them, 97 (14.5%) had positive UDS results for fentanyl. The fentanyl detection rate was 19.7% among active PWID (452, 67.6%) whereas it was 3.9% among non-injection drug users (217, 32.4%). Those who tested positive for fentanyl were younger and more likely to be female, more likely to have injected drugs in the past six months, and more likely to have experienced overdose in the past six months (all $p < 0.05$). While those who self-reported having used stimulants but not opioids in the past six months were less likely to test positive for fentanyl ($p < 0.001$), five (5.2%) of those with recent exposure to fentanyl did report having used stimulants but not opioids. All individuals testing positive for fentanyl also tested positive for other substances, most commonly for morphine/heroin (88.7%) followed by amphetamine/methamphetamine (75.3%) and cocaine (72.2%).

As shown in Table 2, when restricting the sample to PWID, demographic characteristics largely remained the same as those in the sample of people who use drugs; 39.6% were female, 56.9% were white, and the median age was 47 (Q1–3: 36–54) years. More than half ($n = 252$; 55.8%) reported having accessed methadone-based OAT in the past six months, while only 21 (4.6%) reported having accessed buprenorphine+naloxone-based OAT. There was no significant difference in methadone-based or buprenorphine+naloxone-based OAT access between those who did and did not test positive for fentanyl (both $p > 0.05$). A small number of participants reported using street methadone ($n = 7$; 1.5%) or street buprenorphine +naloxone ($n = 3$; 0.7%) in the past six months. Again, there was no significant difference in illicit use of these OAT medications between those who did and did not test positive for fentanyl (both $p > 0.05$). As well, those PWID who tested positive for fentanyl also tested

positive for other substances, including morphine/heroin (89.9%), amphetamine/methamphetamine (75.3%) and cocaine (74.2%). Among those individuals (n=89), the most common combination of positive UDS results consisted of morphine/heroin, cocaine and amphetamine/methamphetamine (n=13; 14.6%), followed by a combination of morphine/heroin, methadone and amphetamine/methamphetamine (n=10; 11.2%); morphine/heroin, methadone and cocaine (n=6; 6.7%); and morphine/heroin, methadone, cocaine, amphetamine/methamphetamine and cannabis (n=6; 6.7%).

The results of multivariable analyses are presented in Table 3. As shown, in Model 1 including all UDS results, positive UDS results for morphine/heroin (adjusted odds ratio [AOR]: 6.73; 95% CI: 3.64 – 13.53), buprenorphine (AOR: 4.25; 95% CI: 1.77 – 10.13), cocaine (AOR: 2.92; 95% CI: 1.81 – 4.83) and amphetamine/methamphetamine (AOR: 3.26; 95% CI: 2.01 – 5.42) remained independently and positively associated with positive UDS results for fentanyl. Age (AOR: 0.96; 95% CI: 0.94 – 0.99) and positive UDS results for cannabis (AOR: 0.52; 95% CI: 0.31 – 0.83) were independently and negatively associated with recent exposure to fentanyl. In Model 2, which included self-reported drug use variables, heroin use (AOR: 9.19; 95% CI: 4.19 – 24.71) remained independently and positively associated with testing positive for fentanyl, while age (AOR: 0.97; 95% CI: 0.95 – 0.98) and cannabis use (AOR: 0.46; 95% CI: 0.30 – 0.70) retained independent and negative associations with testing positive for fentanyl.

4. Discussion

In our sample of people who use drugs in Vancouver, we found that the majority of those testing positive for fentanyl were PWID. Among PWID, one-fifth tested positive for fentanyl. Those PWID with recent exposure to fentanyl also tested positive for other substances, most commonly for combinations of opioids and stimulants (i.e., cocaine and amphetamine/methamphetamine). In the multivariable analysis, younger PWID and those who tested positive for morphine/heroin, buprenorphine, amphetamine/methamphetamine or cocaine were more likely to test positive for fentanyl, while those who tested positive for cannabis were less likely to test positive for fentanyl. Examination of self-reported past-six-month substance use patterns showed that the results were largely unchanged, except that stimulant and buprenorphine+naloxone use were not significantly associated with fentanyl exposure.

Our study confirmed that exposure to fentanyl was higher among PWID compared to those using non-injection drugs only, a finding that is consistent with a previous study (Macmadu et al., 2017). The observed fentanyl detection rate (20%) among our sample of PWID may be similar to that (29%) in Amlani et al. (2015) because their rate was likely overestimated due to their specific study design characteristics, which they reported to be a study limitation (Amlani et al., 2015). The fairly high rate of fentanyl exposure among PWID is concerning, and targeted overdose prevention efforts are needed for this population. In particular, our results suggest that younger PWID (among our sample of relatively older PWID) are at an elevated risk of fentanyl exposure. This is congruent with the BC Coroners Service report documenting that those aged 30-39 years had the highest illicit drug overdose death rates (British Columbia Coroners Service, 2017b).

Our findings also suggest that PWID who used both opioids and stimulants were among the most vulnerable to fentanyl exposure. We cannot make a causal inference from our findings about whether opioids or stimulants led to fentanyl exposure. However, the findings that self-reported heroin use, but not illicit fentanyl use, was independently associated with fentanyl exposure, indicate that exposure to fentanyl was largely attributable to fentanyl-adulterated heroin. This is also consistent with previous Health Canada data (Miller and Russell, 2016). However, we also found that 5% of those testing positive for fentanyl reported having used stimulants but not opioids. This indicates that stimulant drugs that are combined with fentanyl may be less prevalent than heroin adulterated with fentanyl, but nonetheless may exist in the local drug market (Amlani et al., 2015; Klar et al., 2016; Miller and Russell, 2016). A recent BC Coroners Service has also reported that cocaine was the most frequently detected substance in fentanyl-involved overdose deaths (British Columbia Coroners Service, 2017a). Therefore, some polysubstance users (i.e., those using both opioids and stimulants), if not many, may have been exposed to fentanyl through stimulants. Individuals consuming stimulants combined with fentanyl may be at an elevated risk for overdose, as they may be less likely to expect being exposed to fentanyl (Klar et al., 2016). Future research should investigate the possibility of stimulants-fentanyl mixture being sold as stimulants on the market.

In contrast, PWID who used cannabis were less likely to test positive for fentanyl. While some local political leaders and law enforcement officials warned that fentanyl is being added to illicit cannabis (CFNR: First Nations Radio, 2016; CTV Vancouver News, 2016), the federal Minister of Health has recently confirmed with chiefs of law enforcement officials that there is zero evidence supporting such claim and clearly stated that the concerns are unfounded (Lift News, 2017). Our findings are consistent with this conclusion. Further, our findings may also indicate that PWID using cannabis are less likely to use some fentanyl-contaminated drugs through substitution of psychoactive substances with cannabis (Sociás et al., 2017). Future research should investigate how cannabis use might mitigate the risk of fentanyl exposure among PWID.

Those who tested positive for buprenorphine were also more likely to be exposed to fentanyl. In BC, the most common buprenorphine formulation related to PWID is buprenorphine+naloxone (College of Physicians and Surgeons of British Columbia, 2017). Unfortunately, the small number of participants who tested positive for buprenorphine or who used buprenorphine+naloxone in our study makes it premature to discuss how buprenorphine+naloxone may shape the risk of fentanyl exposure. However, in BC, buprenorphine+naloxone treatment has been expanded rapidly since 2015, when new clinical guidelines began recommending buprenorphine+naloxone, instead of methadone, as the first-line opioid agonist therapy (British Columbia Centre on Substance Use, 2017; Office of the Provincial Health Officer, 2017). Given the ongoing rapid scale-up of buprenorphine+naloxone treatment in this setting, future research should examine clinical and behavioral characteristics of patients receiving buprenorphine+naloxone treatment and their associations with fentanyl exposure. A recent study in Rhode Island also suggested that opioid users considered seeking buprenorphine+naloxone treatment out of fear of unintended exposure to fentanyl. Such treatment-seeking behavior associated with emergence of illicit fentanyl should be further examined and addressed as well (Carroll et

al., 2017). The rate of fentanyl exposure in this study is concerning and points to the need for the urgent implementation of a range of treatment and harm reduction strategies, including a range of opioid-agonist approaches involving oral and injectable treatments.

This study has some limitations. First, the cross-reactivity of the UDS may have over-estimated the recent exposure to some substances (Saitman et al., 2014). However, we note that this is the first study that ascertained the exposure to fentanyl and a variety of other substances by means of UDS among a large community-recruited sample of people who use illicit drugs. Amlani et al. (2015) also used UDS for fentanyl detection; however, they did not use UDS for other substances, and our sample size was more than twice as large as theirs. Further, our ability to examine self-reported behavioral patterns served to enhance the methodological rigor of the study. Second, self-reported data may be influenced by some reporting bias, although such data have been shown to be mostly valid in studies involving PWID (Darke, 1998). Third, a non-random sample used in the present study limits the generalizability of our findings.

In sum, we found that one in five PWID tested positive for fentanyl. PWID who were younger and who used both heroin and stimulants were among the most vulnerable to fentanyl exposure, whereas PWID who used cannabis were less likely to test positive for fentanyl. Our findings indicate an urgent need to ensure that overdose prevention education reaches the most vulnerable to fentanyl exposure, and to implement a range of opioid agonist approaches, including oral and injectable treatments.

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Highlights

- 1 in 5 people who inject drugs in Vancouver tested positive for fentanyl in 2016.
- Fentanyl exposure appears to be largely attributable to fentanyl-adulterated heroin.
- However, fentanyl-adulterated stimulant drugs also exist in the local drug market.
- Cannabis users were less likely to test positive for fentanyl.
- Future research should examine how cannabis use may mitigate fentanyl exposure.

Table 1
Sample characteristics of people who use drugs in Vancouver, Canada, June – October 2016 (*n* = 669)

Characteristic	Total <i>n</i> (%)	UDS result for fentanyl		<i>p</i> -value
		Positive 97 (14.5%)	Negative 572 (85.5%)	
Age (median, IQR)	47 (35–54)	41 (33–48)	48 (35–55)	<0.001
Female	250 (37.4%)	48 (49.5%)	202 (35.3%)	0.008
White ethnicity/ancestry	367 (54.9%)	55 (56.7%)	312 (54.6%)	0.693
DTES residence *	354 (52.9%)	59 (60.8%)	295 (51.6%)	0.091
Injection drug use *	452 (67.6%)	89 (91.8%)	363 (63.5%)	<0.001
Using stimulants but not opioids *†	222 (33.2%)	5 (5.2%)	217 (37.9%)	<0.001
Non-fatal overdose *	85 (12.7%)	19 (19.6%)	66 (11.5%)	0.029
UDS positive for:				
Morphine/heroin	346 (51.7%)	86 (88.7%)	260 (45.5%)	<0.001
Methadone	316 (47.2%)	50 (51.6%)	266 (46.5%)	0.358
Buprenorphine	34 (5.1%)	10 (10.3%)	24 (4.2%)	0.011
Oxycodone	17 (2.5%)	4 (4.1%)	13 (2.3%)	0.291
Cocaine	359 (53.7%)	70 (72.2%)	289 (50.5%)	<0.001
Amphetamine/methamphetamine	278 (41.6%)	73 (75.3%)	205 (35.8%)	<0.001
Benzodiazepine	122 (18.2%)	23 (23.7%)	99 (17.3%)	0.131
Cannabis	287 (42.9%)	29 (29.9%)	258 (45.1%)	0.005

DTES: Downtown Eastside. IQR: interquartile range. UDS: urine drug screen.

* Denotes behaviours and events in the previous six months.

† Stimulants include power and crack cocaine, crystal methamphetamine and MDMA, while opioids include heroin and any prescription opioids that were used non-medically.

Table 2
Bivariable logistic regression analyses of factors associated with recent exposure to fentanyl among people who inject drugs in Vancouver, Canada, June – October 2016 (*n* = 452)

Characteristic	UDS result for fentanyl		Odds Ratio (95% CI)	<i>p</i> -value
	Positive 89 (19.7%)	Negative 363 (80.3%)		
Age				
Median (IQR)	41 (33–48)	48 (39–54)		
Per year older			0.96 (0.94 – 0.97)	<0.001
Female	44 (49.4%)	135 (37.2%)	1.65 (1.12 – 2.45)	0.035
White ethnicity/ancestry	52 (58.4%)	205 (56.5%)	1.08 (0.73–1.61)	0.739
DTES residence *	57 (64.0%)	217 (59.8%)	1.20 (0.80–1.80)	0.461
UDS positive for:				
Morphine/heroin	80 (89.9%)	199 (54.8%)	7.33 (4.15 – 14.03)	<0.001
Methadone	45 (50.6%)	199 (54.8%)	0.84 (0.57 – 1.25)	0.470
Buprenorphine	10 (11.2%)	18 (5.0%)	2.43 (1.20 – 4.73)	0.032
Oxycodone	4 (4.5%)	7 (1.9%)	2.39 (0.78 – 6.67)	0.172
Cocaine	66 (74.2%)	203 (55.9%)	2.26 (1.48 – 3.53)	0.002
Amphetamine/methamphetamine	67 (75.3%)	169 (46.6%)	3.50 (2.28 – 5.50)	<0.001
Benzodiazepine	21 (23.6%)	70 (19.3%)	1.29 (0.80 – 2.04)	0.364
Cannabis	25 (28.1%)	136 (37.5%)	0.65 (0.42 – 0.99)	0.099
Self-reported drug use *				
Heroin	85 (95.5%)	234 (64.5%)	11.71 (5.41 – 31.25)	<0.001
Fentanyl pills or patches †	13 (14.6%)	22 (6.1%)	2.65 (1.42 – 4.85)	0.009
Methadone †	1 (1.1%)	6 (1.7%)	0.68 (0.07 – 3.11)	0.719
Buprenorphine-naloxone †	2 (2.3%)	1 (0.3%)	8.32 (1.17 – 96.23)	0.085
Other prescriptions opioids †	22 (24.7%)	63 (17.4%)	1.56 (0.97 – 2.47)	0.113
Powder cocaine	25 (28.1%)	154 (42.4%)	0.53 (0.34 – 0.80)	0.014
Crack cocaine	25 (28.1%)	132 (36.4%)	0.68 (0.44 – 1.04)	0.143
Crystal methamphetamine	58 (65.2%)	196 (54.0%)	1.59 (1.07 – 2.40)	0.058
Benzodiazepine	12 (13.5%)	42 (11.6%)	1.19 (0.65 – 2.08)	0.618
Cannabis	38 (42.7%)	215 (59.2%)	0.51 (0.34 – 0.76)	0.005
OAT (methadone) *	48 (53.9%)	204 (56.2%)	0.91 (0.62 – 1.35)	0.700
OAT (buprenorphine-naloxone) *	5 (5.6%)	16 (4.4%)	1.29 (0.50 – 2.93)	0.628

DTES: Downtown Eastside. IQR: interquartile range. OAT: opioid agonist therapy. UDS: urine drug screen.

* Denotes behaviours and events in the previous six months.

† Non-medical use.

Table 3
Multivariable logistic regression analyses of factors associated with recent exposure to fentanyl among people who inject drugs in Vancouver, Canada, June – October 2016 (*n* = 452)

Variable	Adjusted Odds Ratio	95% Confidence Interval	<i>p</i> -value
Model 1 (UDS results)			
Age			
(per year older)	0.96	(0.94 – 0.99)	0.006
UDS positive for:			
Morphine/heroin			
(yes vs. no)	6.73	(3.64 – 13.53)	<0.001
Buprenorphine			
(yes vs. no)	4.25	(1.77 – 10.13)	0.006
Cocaine			
(yes vs. no)	2.92	(1.81 – 4.83)	<0.001
Amphetamine/methamphetamine			
(yes vs. no)	3.26	(2.01 – 5.42)	<0.001
Cannabis			
(yes vs. no)	0.52	(0.31 – 0.83)	0.026
Model 2 (self-reported drug use in the past 6 months)			
Age			
(per year older)	0.97	(0.95 – 0.98)	0.002
Heroin use[*]			
(yes vs. no)	9.19	(4.19 – 24.71)	<0.001
Fentanyl pills or patches use^{*†}			
(yes vs. no)	1.83	(0.94 – 3.49)	0.126
Cannabis use[*]			
(yes vs. no)	0.46	(0.30 – 0.70)	0.002

UDS: urine drug screen.

^{*} Denotes behaviours and events in the previous six months.

[†] Non-medical use.