

Harm reduction utilization in an opioid crisis epicentre during the era of fentanyl inhalation: A cross-sectional study

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Abstract

Background

Inhalation ('smoking') has become the predominant route of fentanyl use in British Columbia, Canada, where it is among the highest opioid mortality rates found in North America. Adapting harm reduction services to the high prevalence of smoking fentanyl is critical for preventing overdose and saving lives. This study aimed to explore utilization and access patterns of harm reduction among those who exclusively smoked fentanyl.

Methods

A cross-sectional survey was conducted in an urban centre hospital in Vancouver, BC among individuals reporting fentanyl as their primary substance of use (N = 256). Structured interviews explored demographics, health, and patterns of use, with smoking defined as synonymous to inhalation of fentanyl. Thematic analysis of qualitative data explored subjective effects of fentanyl. Bivariate logistic regressions evaluated factors associated with exclusive smoking, including dosing, stimulant co-use, and perceived overdose risk. Bivariate and multivariate regressions examined relationships between exclusive smoking and overdose history (lifetime and past 6 months). Utilization of harm reduction services was examined in relation to exclusive smoking, including carrying naloxone, safe administration supplies (e.g. syringes, stericups/cookers), drug testing tools, supervised consumption sites, and overdose prevention sites.

Results

Smoking was the most common route of fentanyl use in the past six months (73.2%), followed by injection (13.0%). Exclusive smoking was associated with lower odds of overdose in the past six months compared to non-exclusive smoking (aOR: 0.328 [0.145–0.710]). Exclusive smoking was significantly associated with reduced odds of using harm reduction supplies specifically for opioid administration (e.g. syringes, stericups/cookers) (OR: 0.40 [0.20–0.77]). Use of overdose prevention sites (OPS) also yielded significantly lower odds of exclusive smoking (OR: 0.51 [0.27–0.96]). Exclusively smoking was significantly associated with reporting lower odds of using overall number of harm reduction practices. Specifically, each additional tool used was associated with about a 22% reduction in the odds of exclusive smoking (OR = 0.78, [0.62–0.97]).

Conclusions

Although smoking fentanyl is associated with lower overdose risk than other routes, overdose rates remains high. While being the dominant route of use, individuals who smoke fentanyl report reduced use

of harm reduction services, underscoring the need for targeted public health tailoring.

1.0 Introduction

Fentanyl can be administered through numerous routes, including transdermal, oral, smoked (inhaled), intranasal (insufflated), rectal, intrathecal, intramuscular, and intravenous. For consistency and clarity, the term, *smoking* will encompass any administration method involving inhalation of vaporized fentanyl through the respiratory system. This includes, but is not limited to, “Chasing the Dragon” (CTD), which involves inhaling the vapor of heated fentanyl on foil using a straw-like device - bongs, pyrolysis of fentanyl-laced cigarette, and dabbing.

A recent rapid ethnography conducted in San Francisco by Ciccarone and colleagues identified CTD as the most common smoking method (1). Other observed approaches included dabbing, which involves heating the tip of a ceramic, glass, or metal tube and inhaling through the cool end, and smoking with bongs, which vary widely in designs (1). Snorting, while popular during the 1980s, now appears to serve primarily as a way to test potency—known locally as “tooting”—and provides reduced drug effect due to substantial loss to the oropharynx and limited absorption across the nasal mucosa (2, 3). Smoking heroin or fentanyl-containing cigarettes (pyrolysis) is also practiced, though heroin degradation is greater with this method due to the higher temperatures required (4).

Across North America, smoking has become the dominant route of fentanyl administration. Multiple west coast studies report a widespread shift from injection to smoking (5–7). In San Francisco, Kral et al. documented a significant increase in daily fentanyl smoking and a decline in injection between 2018 and 2020 (6). In British Columbia (BC), Canada, provincial coroner data from April 2024 indicate that smoking was the most common route among people who died from substance use (72%), followed by nasal insufflation (20%), injection (12%), and oral use (3%) (8).

The public-wide perception that smoking fentanyl is safer than injection may partially explain the dominance of smoking. According to the BC Harm Reduction Client Survey, participants smoking opioids listed safety reasons, such as a lower likelihood of overdosing, as their biggest reason for smoking (9). Intravenous administration of fentanyl indeed confers significant risks. Intravenous administration has been known to result in the highest drug concentration in the blood due to being 100% bioavailable (10). Increased bioavailability and high lipophilicity with injection would also result in the substance crossing the blood-brain barrier, causing respiratory depression (10). Furthermore, it has been significantly associated with soft-tissue infections such as cellulitis and blood-borne infections such as hepatitis and HIV/AIDS. In contrast, drugs administered orally will undergo some first-pass metabolism and will demonstrate less than 100% bioavailability, resulting in lower blood concentrations (11). Due to high risks associated with intravenous use of fentanyl, many countries like the United States, Spain, Australia and Scotland to recommend users to switch from injection to other modes of administration for their safety (7, 12, 13).

While injecting fentanyl has been perceived as the most dangerous route of administration in terms of overdose, smoking fentanyl also confers concerning risks. Smoking fentanyl has pharmacological properties like intravenous administration. For instance, smoking heroin can reach its peak subjective and objective effects within 2–5 minutes, with rapid appearance of heroin, 6-acetylmorphine, and morphine in the blood, and elimination from the body occurring at a rate comparable to the intravenous route (4). It bypasses the first stage metabolism through alveolar and nasal mucosa absorption directly to cerebral arterial blood, resulting in toxicity of the brain (2). CTD has been shown to increase the risk of aggressive toxic leukoencephalopathy, movement disorders, and hydrocephalus where if severe, can result in permanent brain damage and death (2). Given that fentanyl smoking is known to be very social, sharing smoking equipment with fentanyl residue is also a concerning risk for overdose (1).

Despite established evidence supporting harm reduction approaches for people who use drugs, the design of many services has historically centered on risks associated with injection, leaving gaps in engagement with individuals who smoke substances (14). A recent narrative synthesis found that distribution of safer smoking materials (e.g., glass pipes, mouthpieces, foils) within harm reduction programs increases safer use behaviors and can reduce risky practices like sharing, yet these services remain underutilized and inconsistently implemented (15). Moreover, supervised inhalation or smoking facilities, which allow people to use drugs under observation and with immediate overdose response are a critical yet underdeveloped component of harm reduction infrastructure (16). Since many individuals who smoke drugs may not seek out injection-oriented services, adapting harm reduction frameworks to include safer smoking supplies, education, and supervised inhalation spaces is essential to adapt to the dominance of smoking as the major route of administration for fentanyl.

To guide this service adaptation, specific harm reduction services that are underutilized among those who exclusively smoke fentanyl during the fentanyl crisis remain understudied. This study aims to characterize patterns of fentanyl administration routes and assess utilization and access of various harm reduction services.

2.0 Methodology

Study Design

The Fentanyl Cohort study (FCS) is a cross-sectional survey of people who used fentanyl as their primary substance of use in the previous 6 months (N = 256). It was conducted in the biggest acute care hospital in Vancouver, British Columbia (BC). The participants were admitted for conditions non-specific to addiction in the emergency department and all hospital units, and once identified for opioid use, they were initially screened by a specialized addiction consultation service, called the Complex Pain and Addiction Service (CPAS).

Participants

The inclusion criteria were adult patients aged ≥ 18 years, with opioid use disorder (OUD) and active opioid use in the previous 6 months, as identified by the treating physician. Patients must have given informed consent to the survey. The exclusion criteria included patients who do not have OUD identified by the treating physician, did not want to consent, are unable to communicate in English, or are impaired by medical or psychiatric conditions preventing informed consent for recruitment and participation.

Measurements

A structured interview was used to assess participants' demographics, drug use characteristics, treatment history, and harm reduction service utilization. Participants were asked how they usually used their street opioids in the past 6 months, provided with examples of injection, snorting, or smoking (Appendix A). Considering that fentanyl inhalation is also commonly referred to as 'smoking', inhalation and smoking were mentioned interchangeably. Other routes of administration could be specified verbally. A binary variable was defined by exclusively smoking their street opioids in the past 6 months ("Exclusively smoking") versus not using smoking or combined with other forms of route of administration ("Not exclusively smoking").

Questions related to harm reduction either asked about recent habitual use (e.g. "Over the past 6 months, have you been getting your drugs checked with test strips?") or general regular use (e.g. "When you use, do you usually use an overdose prevention site?"). The use of harm reduction tools or practices in the last 6 months included carrying naloxone, safe administration supplies (e.g. syringes, stericups/cookers), drug testing strips and spectrometers, supervised consumption sites (SCS), overdose prevention sites (OPS), no use at all, and any other unlisted methods to further understand possible risk perception profiles among those who smoke and access to services (17–19). Generalized 'regular' use was also assessed for overdose phone applications, testing drugs, and testing doses (e.g. "When you use, do you usually use an overdose prevention application on the phone").

Non-fatal overdose occurrences were assessed with the following survey question: "How many times have you experienced an opioid overdose in your life?". Answers were dichotomized into "yes" (having experienced at least one overdose) or "no" (zero overdoses) to reflect prior history of overdose. Overdose in the prior 6 months was determined based on whether their last self-reported overdose was within the last 6 months when asked "When was your last overdose?".

There is limited documentation and standardization of street-sourced fentanyl dosing. To determine mean reported doses of fentanyl, self-reported terminology (e.g. "\$100 worth", "half ball", "1 zip", etc.) were converted by consulting with a person with lived experience and active volunteer contributions with Vancouver's Downtown Eastside (Appendix B; Acknowledgements), and cross-verified with another research group (20).

Statistical Analysis

Statistical analyses were performed with R Studio software version 2024.12.0 + 467. For preliminary exploratory analyses, a Shapiro-Wilk normality test was used to determine distribution of the smoking variable to guide further statistical tests. Statistical significance for all analyses was defined as $p < 0.05$. Complete-case analysis was conducted for all questions, removing missing values for individual variables and reporting total counts.

As part of understanding reasons for smoking fentanyl, which can guide harm reduction services, bivariate logistic regressions were conducted between exclusive smoking in the past 6 months and sociodemographic (e.g. age, gender, ethnicity), self-perceived risk of overdose, tolerance or potential adulteration through average daily total fentanyl dose (21), and co-use of stimulants for a possible use purpose of 'speedballing' in the last 6 months (22).

To further explore experiences and reasons for fentanyl use, participants were asked to describe their experience or effects of their "high" with fentanyl compared to heroin. Thematic analysis was also conducted to summarize the subjective effects of acute consumption of fentanyl for exclusive and non-exclusive smoking.

Along with the subjective data, we also quantified the risk of overdose using bivariate logistic regression between exclusive smoking and self-reported 6-month history of overdose. A subsequent multivariate logistic regression model adjusted for gender, age, ethnicity, 6-month harm reduction variables as listed previously, regular use of overdose phone applications, and harm reduction counts. Bidirectional stepwise regression was used to statistically balance multi-dimensionality and to reduce any prediction error. An equivalent approach was conducted using with bivariate logistic regressions for binary lifetime history of overdose and exclusive smoking, followed by multivariate and step-wise models with the same covariates.

An aggregate count of harm reduction strategies or tools was generated to reflect the extent of using harm reduction tools or strategies from the listed practices: SCS, OPS, administration supplies, overdose app, testing doses, test strips, spectrometers, carrying naloxone, and reporting 'other'. The harm reduction use counts per individual were summarized through a mean and analyzed through bivariate linear regression with exclusive smoking as an outcome. Bivariate logistic regressions were also conducted for various harm reduction services against the exclusive smoking outcome.

3.0 Results

3.1 Sociodemographics and Rationale for Smoking

Participants were mostly male (65.1%) and of European descent (58.7%), with a mean age of 44.4 years (SD, 11.5; range, 24–78). Among the total of 219 subjects who provided their primary route(s) of opioid administration in the past 6 months, 185 reported smoking, and 51 injecting, 8 snorting, and 5 oral/pills non-mutually exclusively. Among these counts, 73.2% were exclusively smoking, 13.0% exclusively injecting, 9.3% both smoking and injecting, and 4.6% reported multiple routes of administration including

snorting and oral routes, depicted in Fig. 1 similar to prior publications (23). In other words, 158 were categorized as exclusively smoking (75.6%), and 61 were not exclusively smoking (29.2%). The remaining participants who reported more than one primary route of administration were included in “not exclusively smoking”, due to a small number of observations, and to focus on the effects of smoking fentanyl specifically.

Participants who exclusively smoked were on average marginally younger than those who did not exclusively smoke (43.0 ± 10.4 vs. 46.2 ± 10.8 years; unadjusted OR: 0.97 [0.95–1.00]) (Table 1). A higher proportion of exclusively smoking participants identified as male (65%) and of Caucasian descent (59.6%). However, there were no significant associations between exclusively smoking and other sociodemographic including gender and ethnicity ($p > 0.05$). Co-use of stimulants specifically with fentanyl was not significantly associated with exclusively smoking ($p > 0.05$). The average dose of fentanyl used was also not significantly associated with exclusive smoking among the subset of individuals who were asked their average total fentanyl dose on a using day ($n = 118$) (Table 1).

Table 1

Demographics and routes of administration variables and for each subgroup, with analytic sample size N = 219. Proportions are calculated based on observations per subgroup after removing missing values separately for each variable. Proportions for 'other' were not included were relevant. * indicates $p < 0.05$.

Characteristic	Total (n = 256)	Not exclusively smoking, n (%) (n = 61)	Exclusively smoking, n (%) (n = 158)	Unadjusted OR (95% CI)	p
Age (n = 218)	44.4 (11.5)	46.2 ± 10.8	43 ± 10.4	0.97 (0.95–1.00)	0.038*
Gender (n = 218)					
Man	164 (65.1%)	41 (67.2%)	102 (65%)	1.00	
Woman	84 (33.3%)	18 (29.5%)	53 (33.8%)	1.18 (0.63–2.29)	0.609
Non-Binary	4 (1.6%)	2 (3.3%)	2 (1.3%)	0.40 (0.05–3.44)	0.370
Ethnicity (n = 217)					
Caucasian	148 (58.7%)	37 (60.7%)	93 (59.6%)	1.00	
Indigenous	62 (24.6%)	13 (21.3%)	43 (27.6%)	1.32 (0.65–2.80)	0.460
Other	42 (16.7%)				
Average fentanyl dose on using day (n = 118)	1.98 ± 5.14	1.19 ± 1.45	1.71 ± 2.77	1.11 (0.92–1.48)	0.364
Co-use of stimulants with fentanyl (last 6 mo) (n = 212)					
Yes	149 (70.3%)	42 (71.2%)	107 (69.9%)	0.94 (0.48–1.80)	
No	63 (30.0%)	17 (28.8%)	46 (30.1%)		

Characterizing self-perceived risk of overdose over the past 6 months, 52.8% (n = 133) of all participants reported low risk, 19.8% (n = 50) reported medium risk, and 17.9% (n = 45) high risk. The majority of participants overall reported low overdose risk, including 58.3% out of those exclusively smoking and 47.4% of those not exclusively smoking. While both administration route groups were comparable in medium self-perceived overdose risk, 28.1% of those exclusively smoking and 17.9% of those not

exclusively smoking reported high overdose risk (Fig. 2). From bivariate regressions, self-perceived overdose risk was not significantly associated with exclusive smoking.

Thematic analysis of perceived effects of fentanyl “high” compared to heroin identified 11 main themes based on higher proportions: (1) blacking out or unconsciousness; (2) aversive effects (e.g., agitation, negative affect, withdrawal symptoms, general dislike); (3) euphoria (e.g., “happy,” relaxed); (4) pain reduction; (5) sedation (e.g., sleepy, drowsy); (6) anxiolytic effects (e.g., calming, mood stabilization); (7) increased focus or alertness; (8) variable or hard to identify due to contamination; (9) absence of a high or sense of routine/normalcy; (10) greater potency, addictiveness, or intensity compared to heroin; and (11) no difference from heroin.

Individuals who did not exclusively smoke more often proportionately described blacking out, reporting fentanyl as similar to heroin, and experiencing pain reduction than those who exclusively smoked. In contrast, individuals who exclusively smoked more frequently reported sedative effects, variability due to contamination, and greater potency. These proportional differences were small, ranging from ± 3.8% to 7.5%, and should be interpreted with caution, with no significant associations distinguished between exclusive from non-exclusive smoking. Among those who answered perceived effects of fentanyl “high”, three participants directly mentioned route of administration, namely smoking (Table 2), reflecting notions of unpredictability, pain reduction, euphoria, and invasiveness of injection.

Table 2

Examples of narratives provided that were related to routes of administration when asked to describe the effects of fentanyl relative to heroin.

Quote
“It's totally different. With heroin, it's like you do it and then you get this warm rush go through you, and it's like a big bear hug by a big grizzly bear that's really friendly. With fentanyl, you do it, if it's got benzos or tranqs in it, you nod off. What's the fun in that? It's way better to just do the dragon, you can control yourself because you don't know how strong it is. I go into the shallow end and try it to see what it's like, I don't go in the deep end and go drowning. I guess you could say it's a cure for depression, now I just feel normal. After 35 years, you get used to it. I wish you could just quit in 4 days. When you're fixing, you're usually getting more addicted to the ritual than the dope. I don't know what it is.”
“Smoking gives pain relief and euphoric rush , more effective and better pain relief than other opioids”
“I injected 3 times and that totally felt different than smoking it. I didn't want the feeling of injecting it, and made me feel uneasy - it felt more dangerous and uncertain. ”

Overall, 83.5% (n = 177) of participants had a history of any overdose over their lifetime. Among those with overdose history, 72.9% reported exclusively smoking the last 6 months. In evaluating overdose risk, exclusive smoking in the last 6 months was significantly associated with lower odds of overdose in the last six months, both in the unadjusted model (OR = 0.43, 95% CI: 0.21–0.85, p = 0.016), and after adjusting for covariates (i.e. age, gender, harm reduction variables) in multivariate regression (aOR 0.329, [95% CI: 0.145–0.710, p = 0.006) and step-wise regression (aOR 0.323, [95% CI: 0.143–0.698], p = 0.005)

(Table 3). In the stepwise regression model, age, gender, and ethnicity were forced into inclusion, while the final model additionally retained test strips and SCS.

No significant association was observed between exclusive smoking and lifetime overdose history ($p > 0.05$) in unadjusted bivariate, multi-variate, and stepwise models (Table 2). For these regression models, there were $n = 160$ and $n = 92$ observations available after preprocessing and removing missing values across variables for 6-month and lifetime overdose, respectively.

Table 3
6-month and lifetime overdose history results for exclusive and non-exclusive smoking. Unadjusted bivariate regression and adjusted multivariate, stepwise regression model results were reported. * indicates $p < 0.05$.

	Total (N = 256)	Not exclusively smoking, n (%) (n = 61)	Exclusively smoking, n (%) (n = 158)	Unadjusted OR (95% CI)	<i>p</i>	Adjusted OR (95% CI)	<i>p</i>
6-month history of overdose (n = 160)	95 (37.4%)	33 (66%)	57 (45.6%)	0.43 (0.21– 0.85)	0.016*	0.329 (0.145– 0.710)	0.006*
Lifetime history of overdose (n = 192)	193 (76.0%)	48 (84.2%)	129 (83.2%)	0.93 (0.39– 2.06)	0.864	1.03 (0.357– 2.730)	0.950

3.2. Harm reduction utilization among those who exclusively smoke

Bivariate regressions characterized service utilization trends for those who exclusively smoke. Among other services listed (Table 3), exclusive smoking was significantly associated with reduced odds of using harm reduction supplies specifically for opioid administration (e.g. syringes, stericups/cookers) (unadjusted OR: 0.40 [0.20–0.77], $p = 0.006$). Use of overdose prevention sites (OPS) also yielded significantly lower odds of exclusive smoking (unadjusted OR: 0.51 [0.27–0.96], $p = 0.038$). No significant associated with odds for exclusive smoking were found for no use of harm reduction supplies at all, and use of other harm reduction and healthcare services including: supervised consumption sites (SCS), drug testing (e.g. test strips, spectrometers), testing dose, overdose apps, participation in withdrawal management (or “detox”), safer supply drug prescriptions in the last 6 months (i.e. Dilaudid Hydromorphone, fentanyl patch, MEslon, etc.), carrying naloxone in the last 6 months, cognitive behavioural therapy (CBT), Narcotics Anonymous, and oral naltrexone. Exclusively smoking was significantly associated with reporting lower odds of using harm reduction practices (Table 3).

Specifically, each additional tool used was associated with about a 22% reduction in the odds of exclusive smoking (unadjusted OR = 0.78, [95% CI: 0.62–0.97]).

Table 4

Harm reduction utilization in individuals exclusively smoking vs. not exclusively smoking. Questions that ask about use for the last 6 months are indicated as '(6 mo)', and questions that ask about habitual or "usual" use are indicated as "regular". Total observations after removing missing values were reported. * indicates $p < 0.05$.

Harm reduction tools or services	Value	Not exclusively smoking, n (%) (n = 61)	Exclusively smoking, n (%) (n = 158)	Unadjusted OR (95% CI)	p
Mean count of harm reduction strategies/tools accessed (n = 193)		2.96 ± 1.43	2.42 ± 1.48	0.78 (0.62–0.97)	0.0279*
Carried naloxone (6 mo) (n = 205)	No	15 (26.3%)	38 (25.7%)	-	0.925
	Yes	42 (73.7%)	110 (74.3%)	1.03 (0.51–2.05)	
Safe administration supply use (e.g. syringes, stericups/cookers) (6 mo) (n = 195)	No	19 (37.3%)	86 (59.7%)	-	0.006*
	Yes	32 (62.7%)	58 (40.3%)	0.40 (0.2–0.77)	
Use of drug test strips (6 mo) (n = 195)	No	46 (90.2%)	125 (86.8%)	-	0.528
	Yes	5 (9.8%)	19 (13.2%)	1.40 (0.53–4.41)	
Use of drug spectrometers (6 mo) (n = 195)	No	47 (92.2%)	131 (91%)	-	0.797
	Yes	4 (7.8%)	13 (9%)	1.17 (0.39–4.3)	
Use of supervised consumption sites (6 mo) (n = 195)	No	44 (86.3%)	112 (77.8%)	-	0.197
	Yes	7 (13.7%)	32 (22.2%)	1.8 (0.77–4.7)	
Use of overdose prevention sites (OPS) (6 mo) (n = 205)	No	21 (38.2%)	82 (54.7%)	-	0.038*
	Yes	34 (61.8%)	68 (45.3%)	0.51 (0.27–0.96)	
Use of other unlisted harm reduction methods (6 mo) (n = 195)	No	50 (98%)	143 (99.3%)	-	0.460
	Yes	1 (2%)	1 (0.7%)	0.35 (0.01–8.95)	
Regular use of overdose phone applications (n = 205)	No	47 (85.5%)	141 (94%)	-	0.056
	Yes	8 (14.5%)	9 (6%)	0.38 (0.14–1.05)	

Harm reduction tools or services	Value	Not exclusively smoking, n (%) (n = 61)	Exclusively smoking, n (%) (n = 158)	Unadjusted OR (95% CI)	p
Regularly test drugs (n = 205)	No	36 (65.5%)	98 (65.3%)	-	0.987
	Yes	19 (34.5%)	52 (34.7%)	1.01 (0.53–1.95)	
Regularly test doses (n = 205)	No	33 (60%)	99 (66%)	-	0.427
	Yes	22 (40%)	51 (34%)	0.77 (0.41–1.47)	
No use of harm reduction methods (6 mo) (n = 195)	No	43 (84.3%)	101 (70.1%)	-	0.052
	Yes	8 (15.7%)	43 (29.9%)	2.29 (1.04–5.61)	

4.0 Discussion

Our study reinforces the dominant shift towards smoking where the majority of the participants exclusively smoked fentanyl (73.2%) rather than resorting to other routes of administration. Exclusively injecting (13%) was the next most common form of route of administration followed by another mix of various routes of administration. This result is very similar to the British Columbia's Coroner's data where 73% reported smoking (8). Smoking prevalence in our study was higher than the previous 2019 survey of harm reduction clients in BC, which showed that 40% exclusively smoked opioids, 19% injected, and 28% did both, which suggests smoking being an already dominant form of route of administration back in 2019 but also its rate continuing to increase (23).

Those who exclusively smoked fentanyl were younger and had a lower proportion of perceived risk of overdose. Although not statistically significant, higher proportion of those exclusively smoking reported low self-perceived overdose risk (58.3% smoking vs. 47.4% not smoking) while those who were not exclusively smoking reported higher proportion of high perceived risk (28.1% smoking vs. 17.9% not smoking). This lower perceived risk translated statistically where a 6-month history of exclusively smoking was significantly less associated with self-reported recent history of overdose. This result is consistent with some of the existing literature reporting increased risk of overdose associated with injection practices. From a study of 563 participants who used fentanyl in California, non-fatal overdose in the past 3 months was more frequent in those who injected fentanyl than smoked (7). Similarly, in Victoria, British Columbia, Canada, those who injected fentanyl were positively associated with non-fatal overdose (24). Furthermore, a systematic review of case reports on fentanyl analogue related fatalities showed the intravenous route of administration as the most common route reported for causes of overdose death (10).

While our results show a combination of subjective and objective measures that suggest smoking as a safer mode of use, use of highly potent fentanyl continues to pose substantial overdose risk. Although individuals who primarily smoked fentanyl reported fewer overdoses relative to those who injected, 72.9% of participants with a history of overdose exclusively smoked, reflecting the overall dominance of smoking among those who have overdosed. Furthermore, there were no statistically significant differences in lifetime history of nonfatal overdose between smoking and not smoking fentanyl.

Despite the dominance of smoking among those who overdose, there was a clear gap in engagement with harm-reduction services by route of administration. Those who exclusively smoked used significantly fewer harm reduction strategies/tools (2.96 vs. 2.42), safe drug paraphernalia such as syringes and cookers (62.7% vs. 40.3%), and overdose prevention sites (61.8% vs. 45.3%). These findings highlight a mismatch between smoking as the dominant route of fentanyl use and the access to harm-reduction services.

Our results align with the temporal lag of harm reduction services which were historically designed to reduce the harms associated with injecting illicit substances (25). Early harm reduction initiatives, including needle exchange programs and supervised injection facilities, emerged in response to the public health crises of the 1980s and 1990s, when injection was the predominant route of opioid use and evidence of infectious disease outbreaks among people who inject drugs was mounting. Many of the harm reduction services were designed to reduce risks of blood-borne infections such as HIV and hepatitis C transmission, and abscesses (14, 26, 27). As a result, the design, funding, and policies governing harm reduction programs have largely centered on injection-related risks, leaving gaps for individuals who use alternative routes, such as smoking. More specifically, harm reduction services that may benefit from adaptation to smoking include the distribution of safe drug paraphernalia, such as glass pipes and foils, and the expansion of overdose prevention sites to accommodate inhalation.

Overdose prevention sites are one of the pillars of harm reduction services where a safe place is provided for people who use drugs. It provides the opportunity for early intervention in the event of an overdose, reducing trauma for staff and service users, and connecting with treatment if users want (28). There may be significant opportunities for these sites to specifically adapt to those who exclusively smoke. The high prevalence of smoking warrants providing specific services including safe inhalation sites, burn prevention including inhalation injury, as well as expanding overdose prevention interventions such as BeSafe (9, 23) and Risk Assessment and Management Platform (RAMP) (29). While inhalation rooms exist across Europe with appropriate ventilation and cooling systems, there is still ongoing effort to expand them further in North America (30, 31).

Local distributions of sterile smoking supplies, such as glass pipes and aluminum foil, are important to improve both health outcomes and awareness associated with drug use in participants (32–34). Access to these supplies reduces high-risk behaviors like sharing and improvising equipment, while also providing opportunities for education and engagement with broader health services (32–34). Interestingly in our study, those who smoked primarily were statistically significantly younger than those

who primarily injected, a possible indication of preference in route of administration being fueled by shifting market and culture. As smoking fentanyl is very social, sharing equipment and information, more people, especially younger generations entering the drug use communities, may be smoking more (1). To adapt to this social nature of smoking, safe drug paraphernalia becomes even more critical to prevent sharing, which can increase risk of overdose and infections.

Beyond harm reduction services, further research on treatment should also be explored in the form of opioid agonist treatment. Internationally, the Netherlands provides a clear example of adapting treatment to inhalation as a dominant route of administration of heroin. Since the 1990s, inhalation has long been the preferred route of heroin use, with the majority of users choosing to smoke rather than inject (35, 36). This established preference directly informed the development of the Dutch heroin-assisted treatment program, which incorporated supervised inhalation as a therapeutic mode of administration. A randomized controlled trial in the Netherlands demonstrated that inhaled heroin combined with methadone treatment significantly reduced illicit heroin use and was more cost-effective than methadone alone (36, 37). Furthermore, four-year follow-up data demonstrated sustained improvements in their mental health, physical health, social functioning, and reductions in illicit heroin use among participants in either inhaled or injectable HAT programs (38). Future research should explore differences in access and retention to opioid agonist treatment between those who smoke and do not smoke fentanyl.

This study has several limitations. First, the survey was based on self-report without any collateral information or biological correlates. However, studies of similar drug using populations have confirmed the validity of self-report as a reliable method of eliciting information from participants (39, 40). Second, the survey did not discern the different ways the opioid could be smoked. Opioids can be administered through smoking via a bong, dabbing, or 'chasing the dragon', each known to confer varying degrees of harm (2). Future studies could explore the prevalence of the varying forms of smoking and their associated risks. Third, this study may be less generalizable as participants were recruited from a hospital setting that were admitted for non-addiction specific reasons. Although they may have more severe forms of substance use and medical comorbidities that provide a unique representation of concurrent disorders that may not be captured in addiction-specific patient cases, it is also possible that we are missing information from those who are not help-seeking. Finally, the cross-sectional design of this study was deemed more feasible than a longitudinal approach due to inherent barriers in treatment retention among people using drugs, especially in the resource-limited healthcare system of this region. As such, future studies could involve longitudinal methods to better draw causality regarding risks associated with routes of administration. Therefore, the lack of significant difference between smoking and intravenous administration on self-reported history of overdose should be interpreted in the context of the acute care setting, sample size, regional pattern in Vancouver, and possible emerging trends.

5.0 Conclusions

Given that exclusive smoking of fentanyl has become the dominant route of administration, it is critical to adapt and fill in the gaps in current harm-reduction and clinical services, which were largely developed in an era when injection was the primary mode of consumption. Service models must evolve to ensure that people who smoke fentanyl, despite reporting fewer overdoses in the recent past, are not overlooked in overdose-prevention planning. This includes expanding access to safer-smoking supplies, integrating inhalation spaces within overdose-prevention sites, and providing risk-communication strategies that address the misconception that smoking prevents overdose potential. Further studies are required to evaluate the effectiveness of various interventions tailored to those who smoke fentanyl during the ongoing overdose crisis.

Glossary

Chasing the Dragon (CTD): Smoking opioids, like fentanyl, by heating on foil and inhaling the vapor. Often considered less dangerous than injecting but still carries health risks.

Opioid Agonist Treatment (OAT): Use of drugs such as methadone or buprenorphine to treat opioid dependence and withdrawal, often part of harm reduction.

Dabbing: Vaporizing opioids on a heated surface and inhaling. This method is increasingly used for fentanyl.

Pyrolysis: Decomposition of substances through heat. For opioids, this refers to burning fentanyl in cigarettes.

Soft-Tissue Infections: Infections like abscesses or cellulitis linked to injection drug use and poor hygiene.

Overdose Prevention Sites (OPS): Facilities where drugs can be consumed under medical supervision to reduce overdose risks and provide harm reduction services.

Inhalation Rooms: Supervised spaces for inhaling drugs, used in European harm reduction with proper ventilation and medical support.

Insufflation: Inhaling powdered drugs (snorting). Less common for fentanyl, but used historically for heroin.

Stericups/Cookers: Small containers used to mix and heat substances for injection, distributed at harm reduction sites to reduce infection.

Supervised Consumption Sites (SCS): Facilities where drugs are used under medical supervision, providing access to clean supplies and healthcare.

PWOUD (People Who Use Opioids): Refers to individuals who use opioids, either legally or illicitly.

Declarations

Ethics approval

This study was conducted in accordance with the ethical standards set by the World Medical Association Declaration of Helsinki and followed the International Committee of Medical Journal Editors (ICMJE) recommendations. The study protocol was reviewed and approved by the University of British Columbia's Clinical Research Ethics Board (CREB), with approval granted on January 16 2023 under reference number H22-00879. All participants were fully informed of the study's purpose and procedures, and written informed consent was obtained from each participant prior to their involvement. The privacy rights of the participants were rigorously protected throughout the study.

Consent for publication

Not applicable.

Availability of data and materials

The datasets used and/or analysed during the current study are available from the corresponding author on reasonable request.

Competing interests

The authors declare that they have no competing interests.

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Author's contributions

MS and RMK conceptualized the study. MS, AWK FC, MI, and RMK developed the study design and analysis methodology. AWK, RM, and MI conducted the investigation and data collection. MI and RMK provided resources, acquired funding, and supervised the project, with additional project administration by RM. AWK and JK performed the formal analysis, and AWK curated the data and created the visualizations. MS, AWK, JK, GK, and RMK drafted the original manuscript. FC, CS, RM, PA, and MI provided critical revisions and edited the manuscript.

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Figures



Figure 1

Routes of opioid administration (N = 219). 73.2% of participants exclusively smoke opioids, 13.0% exclusively inject, 9.3% both smoke and inject, and 4.6% smoke and/or inject combined with snorting and/or oral methods.

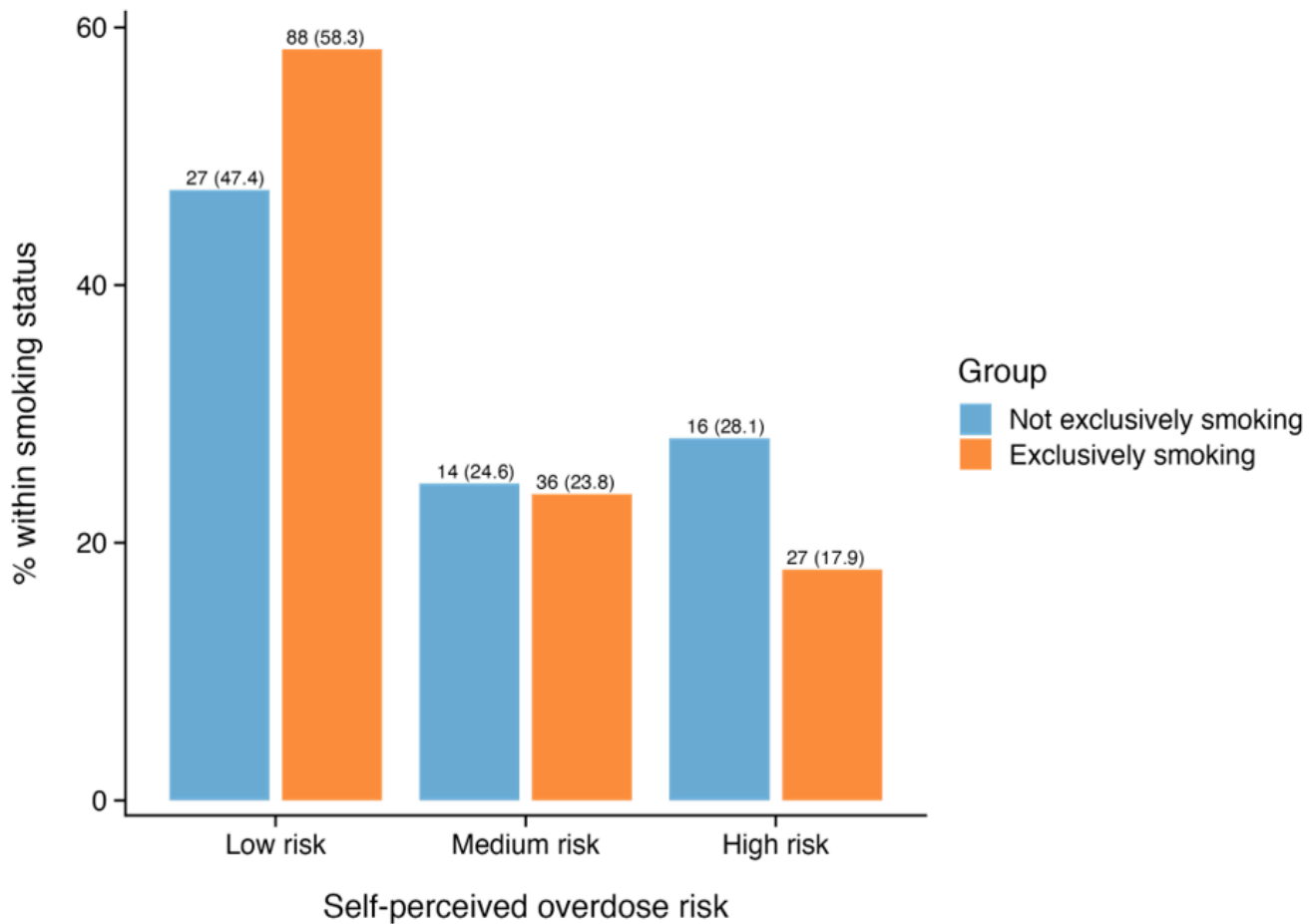


Figure 2

Self-perceived overdose risk by exclusive smoking vs. non-exclusive smoking by risk perception group. Counts and proportions (%) were found out of each smoking group, paired within each low-risk, medium-risk, and high-risk categories.

Supplementary Files

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