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The impacts and service responses to Injecting Synthetic Cathinones and Novel Synthetic Opioids amongst marginalised drug using populations – a scoping review

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Words: 2998

Background

A growing body of literature reports on the injection of synthetic cathinones (SC) and novel synthetic opioids (NSO) in marginalised drug using (MDU) populations. This review seeks to establish what is known about the injection of SCs and NSOs impacts on MDUs.

Method

A six-stage iterative scoping literature review was conducted in relation to SCs, NSOs, MDU impacts and service responses. Searches were conducted through Pubmed™ and Google Scholar™.

Results

Two Thousand and Ninety-Nine search items were retrieved. After duplicates were removed (n=880), articles were screened for injecting drug use by MDUs leading to the removal of a further 1102 articles. Three articles were identified through a hand search, yielding a total of 22 articles for appraisal.

Conclusions

SC injection has largely dissipated due to service and policy responses and changes in the drug market. Responses to NSO have been less effective, with extensive use and opioid overdosing due to contamination and adulteration within the illicit drug market. These impacts have stimulated innovative responses such as fentanyl test strips and housing-based consumption sites. The evidence for their effectiveness is not established. In this context, the underlying environmental and structural factors shaping the risk of these populations should be addressed.

Keywords

Synthetic cathinones; Novel synthetic opioids; high risk drug use; marginalised populations

Introduction

Marginalised drug users (MDUs) such as some people who are homeless, have criminal histories and/or mental health issues are known to inject synthetic cathinones and novel synthetic opioids (EMCDDA, 2017a; Giese et al., 2015; Hope et al., 2016; Tarján et al., 2015, 2017). It appears that these populations experience disproportionate injecting-related harms compared to other groups (Van Hout et al., 2018). The injection of synthetic cathinones such as mephedrone, alpha-PVP and pentedrone are linked with HIV outbreaks amongst MDUs in Ireland, Israel and Hungary (Giese et al., 2015; Katchman et al., 2017; Tarján et al., 2017). Northern American MDUs are experiencing overdoses linked to the adulteration of market supplies with novel synthetic opioids such as fentanyl, U-47770 and AH7921 (Wallace et al., 2019). Knowledge deficits exist around the impacts of this injecting in relation to the efficacy of service responses for MDU populations. This paper reviews the current literature on synthetic cathinones and novel synthetic opioids with the aim to scope what is currently known around impacts in order to identify what may be needed in terms of effective policy development and service responses.

Methods

Scoping reviews are a method of exploring an issue broadly (Pham et al., 2014) as they allow for the mapping of all the available extant literature (including grey literature) of previously under-researched topics (Arksey & O'Malley, 2005). This study used an iterative six step process developed by Levac, Colquhoun, & O'Brien, (2010). These steps consist of: (1) identifying the research question; (2) identifying relevant studies; (3) study selection; (4) charting the data, (5) collating, summarizing and reporting the results and (6) an international expert advisory consultation exercise.

The scoping review commenced with posing the research question “What is known about the injecting use of synthetic cathinones (SCs) and novel synthetic opioids (NSOs) by MDUs in relation to impacts (practices, health and social harms) and service responses.” MDUs were defined as a population with a high prevalence of homelessness, criminal histories and/or mental health issues (EMCDDA, 2017).

An exploratory online search was conducted in the National Documentation Centre for Drugs and Library of Ireland (a comprehensive catalogue of international literature of drug pertinent research papers, news and policy documents). This was supplemented by a review of the SCs and NSOs as posted by the European Monitoring Centre on Drugs and Drug Addiction (EMCDDA) website.

This initial search led to the development and refining of search terms (Table 1). Subsequent comprehensive searches of Pubmed™ and Google Scholar™ were performed utilising these search terms. The database searches were restricted to ‘Humans’, publications in the English language and a publication timeframe of between 2009 and 2019 (Table 1-4). Reference lists in articles were also reviewed for undiscovered extant literature, including grey literature.

Eligibility for inclusion criteria centred on whether studies considered injecting SCs or NSOs by MDUs. The title and abstract of each citation were screened for relevance to these parameters where doubt remained team discussions took place (Levac, Colquhoun, & O’Brien, 2010).

Two Thousand and Ninety-Ninety search items were retrieved through the database search. After duplicates were removed (n=880) articles were screened for injecting drug use by MDUs leading to the removal of a further 1102 articles. A further 3 articles were identified through a hand search, yielding a total of 22 articles for critical appraisal (Figure 1).

Included articles were initially recorded in relation to author; year of publication; study location; methodology and key findings broke down relevant information thematically (Richie and Spencer, (1994) (See: Table 5). Articles were thematically organised into ‘Profile as related to use’, ‘Practices and Behaviours associated with injecting’, ‘Social Impacts’, ‘Health Impacts’ and ‘Service Responses’..

As a final stage, the review was forwarded to an Expert International Advisory Group of NPS injecting researchers to identify other pertinent and previously undiscovered papers for inclusion.

Profile as related to use

In Ireland, Van Hout & Bingham (2012) report that poor quality of cocaine and ecstasy; positive peer reports and the ready availability of SCs in ‘head shops’ contributes to the decision of MDUs to initiate SC injection. Research in Hungary (Tarjan et al., 2017) and Israel (Katchnman et al., 2017) found that market shifts preceded a shift towards SC injecting. Csak (2016) reports that the phenomenon of SC injecting is one predominantly associated with poverty and marginalisation in Hungary.

NSO studies report their increased prevalence, specifically fentanyl (NSO) and related analogues, in the context of endemic adulteration of illicit drug market supplies with such substances. Estimated fentanyl exposure ranged from 56% in Baltimore (Park et al., 2019) to 56.3% in Cabell County (Allen et al., 2019) in the United States. Two studies report a link between homelessness and fentanyl exposure (Krieger et al., 2018; Macmadu et al., 2017).

Studies report a high prevalence of homelessness in MDUs reporting SC injecting. Prevalence ranges from 18% in the United Kingdom (Hope et al., 2016) to approximately 63-75% in Ireland (Van Hout and Bingham, 2012, O’Reilly, 2011). Other studies indicate prevalence rates of 57% in

Hungary (Tarjan et al., 2017), 59.5% in Israel (Katchman et al., 2015) and 66.3% in Czechia (Belackova et al., 2017).

High levels of homelessness are also reported in populations exposed to NSOs. Prevalence ranged from 56.9% to 66.1% in Canada (Hyska et al., 2016; Kennedy et al., 2019; Wallace et al., 2018); and 30.4% to 57.1% (Peiper et al., 2018; Latkin et al., 2019; Park et al., 2018; Hunter et al., 2018; Allen et al., 2019) in America.

One Irish study examined SC injecting amongst related prison populations. Drummond et al. (2014) found widespread SC injecting amongst prisoner PWID, particularly incarcerated women. In Hungary, 65% of a population attending a needle and syringe program (NSP) reported a history of imprisonment and most of this population reported injecting SCs (Tarján et al., 2017).

Adulteration of other drugs with fentanyl (NSO) was reported as common place in Canadian prisons and there was a concern that fentanyl was being used to attack and murder people (Bucerus & Haggerty, 2019). Bucerus and Haggerty (2019) reported that the emergence of NSOs led to several changes in Western Canadian prisons. Prisoners reported that there were now more frequent overdoses. However, prisoners also reported that prisons were a relatively safe environment in which to use drugs.

Four out of five prisoners with dual diagnosis in Delaware County, Ohio, USA, tested positive for exposure to acetylfentanyl (Miller et al., 2018). In other NSO studies, populations exposed to fentanyl reported criminal history involving arrest and or imprisonment ranging from 30.6% in Cabell County, West Virginia, USA (Allen et al., 2019) to 58% in Canada (Hunter et al., 2018).

Practices and Behaviours associated with injecting

SCs have been associated with people injecting several times per day (Tarján et al., 2017; Van Hout & Bingham, 2012); sharing needles and equipment with others (ibid.); poor injection practices (Van Hout & Bingham, 2012); street and communal injecting (ibid.); and polydrug use (Belackova et al., 2017; Hope et al., 2016).

SCs can be associated with differing injecting practices. For example, in Hungary people who inject SCs were found to be more likely to share syringes (52.9%:51; 14.6%:41; 29.2%:65) and equipment (64%: 51; 24.4%:41; 38.5%:65) compared to people who injected amphetamines or opioids ($p < 0.05$). People who used SCs were also found, in this study, to inject more frequently on a daily basis and more likely to reuse equipment (Tarján et al., 2017).

In the UK, Hope et al. (2016) reported that people who injected mephedrone (an SC), when compared to groups injecting other substances, were more likely to report sharing (28%; $n=46$ vs. 14%; $n=272$; $p < 0.001$) and receptively sharing equipment (59%; $n =96$ vs 46%; $n = 864$; $p = 0.001$). People who reported injecting mephedrone were also more likely to report injecting other drugs (63% ($n = 102$) vs 15% ($n = 289$); $p < 0.001$). Similarly, Belackova et al., (2017) reports the repeated use of SCs being linked to co-occurring use of stimulants and opioids (AOR=4.3; AOR=2.4) in Czechia.

Studies report the unnecessary use of citric acid as a as a dissolving agent for SC injection, mixing in barrels and groin injecting (Rácz et al., 2016; Van Hout & Bingham, 2012). MDUs are reported frequently to inject at or near the point-of-sale and to engage in communal injecting - often in unsanitary environments such as on the street or in toilets (Rácz et al., 2016; Van Hout & Bingham, 2012).

In the United States, fentanyl may have started emerging in the drug supply as early as 2013 and fentanyl-containing samples were thought to be distinguishable by a sweet taste and white color.(Ciccarone, Ondocsin, & Mars, 2017). Latkin et al., (2019) state that 56% of a population in Baltimore, USA reported exposure to fentanyl contamination in “all” or “almost all” heroin. Seventy-five percent of this sample worried about their friends overdosing and 66% reported receiving naloxone (or a prescription for it). However, only 13% reported having the overdose medication naloxone available “often” or “always” (ibid.).

McKnight & Jarlais (2018) study of a MDUs in New York, USA reported several behaviours in on the part of MDUs who assumed they has used NSOs. These included taking tester shots; finding consistent dealers; carrying naloxone; using with others; reducing use and using fentanyl-test strips (which test for the presence of fentantils). McKnight & Jarlais (2018) note that stigma, poverty and homelessness often prevent the consistent application of these methods and that homelessness is a significant factor in public injecting.

Social Impacts

Fentanyl may be used for facilitating sexual assaults and people may inject in public places to avoid such assaults (Boyd et al., 2018). On the street, people are more likely to be harassed, have their injecting equipment destroyed or confiscated (Boyd et al., 2018; Hunter et al., 2018). Injecting of SCs and NSOs can also lead to homelessness. For example, O’Reilly, McAuliffe, & Long, (2011) report that SC injecting drug contributed to a loss of housing for two interviewees in their study.

Health Impacts

Tarján et al (2017) found the highest hepatitis C (HCV) prevalence among people who inject SCs when compared to those injecting classical drugs like heroin (38.6% versus overall of 23.2%). Within the SCs group, HCV prevalence was highest in those reported to inject pentedrone (52.4%) and methylenedioxypropylvalerone – MDVP (45%), which corresponds to the groups most likely to report sharing of equipment, for both substances. Additionally, those reporting pentedrone injection were more likely to report reusing equipment. HCV prevalence reportedly doubled 42%–71% between 2011-2014 during the time period where SC injection increased dramatically (ibid). HCV prevalence increased 7-fold (12%-76%) in young people who reported injecting SCs (aged <25) and doubled in people who had recently started injecting SCs (<2 years) (op cit). Hope et al (2016) found there was an association between a MDU population reporting injecting mephedrone and HCV prevalence.

Hope et al (2016) found that people who inject mephedrone were three times more likely to have HIV antibodies. Giese et al (2016) found an association with the injection of the SC ‘Snow Blow’ and newly acquired HIV infection. Katchman et al., (2016) found that a rapid increase in the rate of HIV detections in Tel Aviv, Israel was related to a reported rise in the transitioning of MDUs to SC injection.

In a cross-sectional survey of 203 people attending a NSP in Baltimore, USA (Park et al., 2018), independent correlates of nonfatal overdoses included perceiving fentanyl in drugs more than half the time and homelessness. In a questionnaire administered to 199 MDUs, Wallace et al. (2018) reports that almost half of those recently reporting overdosing had overdosed outdoors/on the street; over a quarter had reported overdosing in a shelter or ‘other service’ whilst another quarter reported overdosing in indoor housing.

Services' Responses

The adoption of high risk injecting behaviours and an increase in HCV and HIV infection associated with SC injecting in Hungary (Tarján et al., 2017) occurred during a period of dramatic reductions in funding and distribution of syringes (75% decrease) between 2011-2015. This also included the closure of the Bluepoint service (Hungary's largest NSP). These resource reductions likely exacerbated both these high risk behaviours and consequent health impacts.

SC injecting-related HIV outbreaks in Ireland and Israel were contained through the use of bespoke tailored interventions which addressed the specific needs of these populations (Giese et al., 2015; Katchman et al., 2017). In Ireland, this took the form of engaging with HIV positive people who inject drugs (PWID); offering HIV testing; raising awareness amongst PWID and clinicians of the harms associated with the injection of SCs and the need to engage with methadone and treatment services. There was also enhanced contact tracing and case finding systems accompanied by improved access to NSPs by improving outreach services (Giese et al., 2015). In Israel, a similar multi-faceted approach was utilised with educational activities; increasing syringe exchange supplies; active screening and early initiation into antiretroviral programs; and referrals to drug withdrawal programs (Katchman et al., 2017).

Bucerius and Haggerty (2019) report that prisoner officers in Canada expressed worries about inadvertent exposure to fentanyl and procedures such as wearing protective gear were implemented by some officers despite the evidence of risk being low. This increased response times during overdose crisis management.

The ubiquity of fentanyl-adulteration and contamination has prompted discussion and implementation of several innovative harm reduction services and programs including fentanyl-

testing strips (Krieger et al., 2018); peer witness programs and consumption sites in housing projects (Bardwell et al., 2018). These programs currently lack thorough evaluation.

Fentanyl-test strips are a simple innovation that can test for a variety of fentanyl analogues within a batch of a given sample. Krieger et al (2018) report that 98% of a surveyed MDU population trusted fentanyl test strips and that 95% would use them again. Old age, homelessness and witnessing an overdose were associated with an increased likelihood to report in engaging with drug checking services (Sherman et al., 2019). An American online survey of MDUs intending to use fentanyl test strips suggested that a positive result for fentanyl was associated with a five times higher likelihood of changing their behaviour (Peiper et al., 2018). However, 31% of the sample reported actively seeking out fentanyl (ibid)- some may also prefer fentanyl-heroin combinations(Ciccarone et al., 2017)

A two-tier system of drug consumption sites is operational in Canada whereby supervised consumption sites are federally licensed and overdose prevention sites are given rolling permission to continue their services (Kennedy & Coelho, 2019). In this context, peer workers who have experience of drug use are permitted to work in overdose prevention sites but not in the federally licenced consumption sites and they are not paid for these positions. Kennedy & Coelho (2019) report that MDU populations may be more likely to engage with overdose prevention sites as service users report that they prefer attending services staffed by peer workers. However, a significant issue arises in that the work can be extremely demanding and there is no payment for such workers and/or other benefits associated with normal employment (ibid.)

Homelessness appears to be linked to fentanyl exposure and overdoses (Park et al., 2018) and people who inject fentanyl report experiencing overdoses in homeless services (Wallace, Barber, & Pauly, 2018). Bardwell et al., (2018) suggests that safer consumption sites should be considered

across homeless services; including in the form of peer witness programs where peers may supervise use and prevent overdoses.

Discussion

The injection of SCs and NSOs is associated with significant differences in terms of profile as related to use; injecting practices and behaviours; health impacts; social impacts and service responses. Injection of SCs and NSOs are negatively associated with underlying issues of marginalised drug use such as homelessness, stigma, criminalisation and a lack of effective service responses.

SCs have in some countries largely replaced traditional drugs as a result of a variety of forces including the decreased quality and purity of traditional substances (Tarjan et al., 2017). They appear to be associated with several drug-specific harms (such as the corrosive nature of the substances) and drug-related harms such as increased frequency of injection and sharing needles and equipment. Such harms were exasperated in some jurisdictions due to decreased availability of classical harm reduction services (such as the shutting down of NSPs in Hungary) and the lack of drug-specific interventions. In contrast, Irish and Israeli service and policy responses appear to be largely successful in substantially reducing and/or eliminating these substances and their related harms within their respective jurisdictions (Giese et al., 2015; Katchman et al., 2016).

NSOs have dispersed into traditional drug markets with incredibly high levels of exposure reported (Park et al., 2019; Allen et al., 2019). Unlike SCs, which were largely associated with now largely contained HIV outbreaks, fentanyl and related analogues seem to be associated with a growing opioid overdose epidemic in the USA and Canada. This epidemic is driving a need for

new innovations such as fentanyl-test strips, the expansion of peer-based approaches and consumption sites in housing programs.

Limitations

This review only considered SCs and NSOs injection in MDUs in a ten-year time frame (2009-2019). Our definition of MDU was high threshold and excluded a significant number of studies such as those pertaining to other marginalised populations such as Indigenous people and migrants. Similarly, we included a non-extensive list of novel psychoactive substances which may be injected, namely, a selection of SCs and NSOs.

Conclusion

SC injection is a phenomenon that has largely dissipated in many parts of the world due to service and policy responses and changes in the drug market. However, NSOs continue to remain a substantial and sizeable issue with significant human and social cost. Innovative solutions such as fentanyl test strips, housing-based consumption sites and expanded peer programs programs should be piloted and evaluated. The link between homelessness and the adoption of high risk behaviours such as street injection should prompt policymakers to make greater investment in addressing these specific issues.

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Table 1: Search strategy Google Scholar-Cathinones

1. cathinone* (7360)
2. inject OR injecting OR injection OR PWID (1,380,000)
3. marginalised OR marginalized OR vulnerable OR homeless OR prisoner OR "mental health" (78,100)
4. 1 AND 2 AND 3 (1330*) (*1000 retrieved)

Table 2: Search Strategy PubMed- Cathinones

1. Cathinone (390)
2. methcathinone OR ephedrone (82)
3. N,N-Dimethylcathinone OR metamfepramone (2)
4. Buphedrone (7)
5. 4-Methyl-N-ethylcathinone (9)
6. Mephedrone OR 4-MMC OR M-CAT (326)
7. Amfepramone (39)
8. Bupropion (1735)
9. Methylone OR β k-MDMA (111)
10. Ethylone OR β k-MDEA (22)
11. Butylone OR β k-MBDB (33)
12. Methedrone OR β k-PMMA (25)
13. Flephedrone OR 4-FMC (24)
14. 3-Fluoromethcathinone OR 3-FMC (12)
15. α -Pyrrolidinopropiophenone OR PPP (1288)
16. 4-Methyl- α -pyrrolidinopropiophenone OR MPPP (10)
17. 4-methoxy- α -pyrrolidinopropiophenone OR MOPPP (0)
18. 4-Methyl- α -pyrrolidino-hexanophenon OR MPHP (8)
19. Pyrovalerone (31)
20. 4-Methyl- α -pyrrolidino-butyrophenone OR MPBP (4)
21. 4-Methyl- α -pyrrolidino- α -methylpropiofenone (0)
22. ,4-Methylenedioxy- α -pyrrolidinopropiophenone OR MDPPP (5)
23. 3,4-Methylenedioxy-pyrovalerone OR MDPV (173)
24. N-Ethylcathinone (13)
25. Search 1-25
26. inject OR injecting OR injection OR PWID (102490)
27. marginalised OR marginalized OR vulnerable OR homeless OR prisoner OR "mental health" (148490)
28. Search 26 AND 27 AND 28 (92)

Table 3: Search Strategy Google Scholar- Novel

1. fentanyl OR fentanils (156,000)
2. U-47700 (539)
3. AH-7921 (412)
4. MT-45 (1220)
5. inject OR injecting OR injection OR PWID 1,380,000
6. marginalised OR marginalized OR vulnerable OR homeless OR prisoner OR "mental health" 78,100
7. 1-4 AND 5 AND 6 (8,630*) (*1000 retrieved)

Table 4: Search Strategy PubMed- Cathinones

1. fentanyl OR fentanils OR "illicitly manufactured fentanyl (5271)
2. "2-methoxy-N-phenyl-N-[1-(2-phenylethyl)piperidin-4-yl]acetamide" OR methoxyacetylfentanyl (2)
3. "N-phenyl-N-[1-(2-phenylethyl)piperidin-4-yl]cyclopropanecarboxamide" OR cyclopropylfentanyl (5)
4. "methyl-(2-phenylethyl)-4-[phenyl(propanoyl)amino]piperidine-4-carboxylate" OR carfentanil (113)
5. "3,4-dichloro-N-{[1-(dimethylamino)cyclohexyl]methyl}benzamide" OR AH-7921 (21)
6. "1-cyclohexyl-4-(1, 2-diphenylethyl)piperazine)" OR MT-45 (26)
7. "N-(1-phenethylpiperidin-4-yl)-N-phenylacrylamide" OR acryloylfentanyl (6)
8. "N-phenyl-N-[1-(2-phenylethyl)piperidin-4-yl]furan-2-carboxamide" OR furanylfentanyl (15)
9. U-47700 (43)
10. 1 -9 (5349)
11. inject OR injecting OR injection OR PWID (102490)
12. marginalised OR marginalized OR vulnerable OR homeless OR prisoner OR "mental health" (148490)
13. 1-9 AND 11 and 12 (7)

Figure 1: Search Strategy

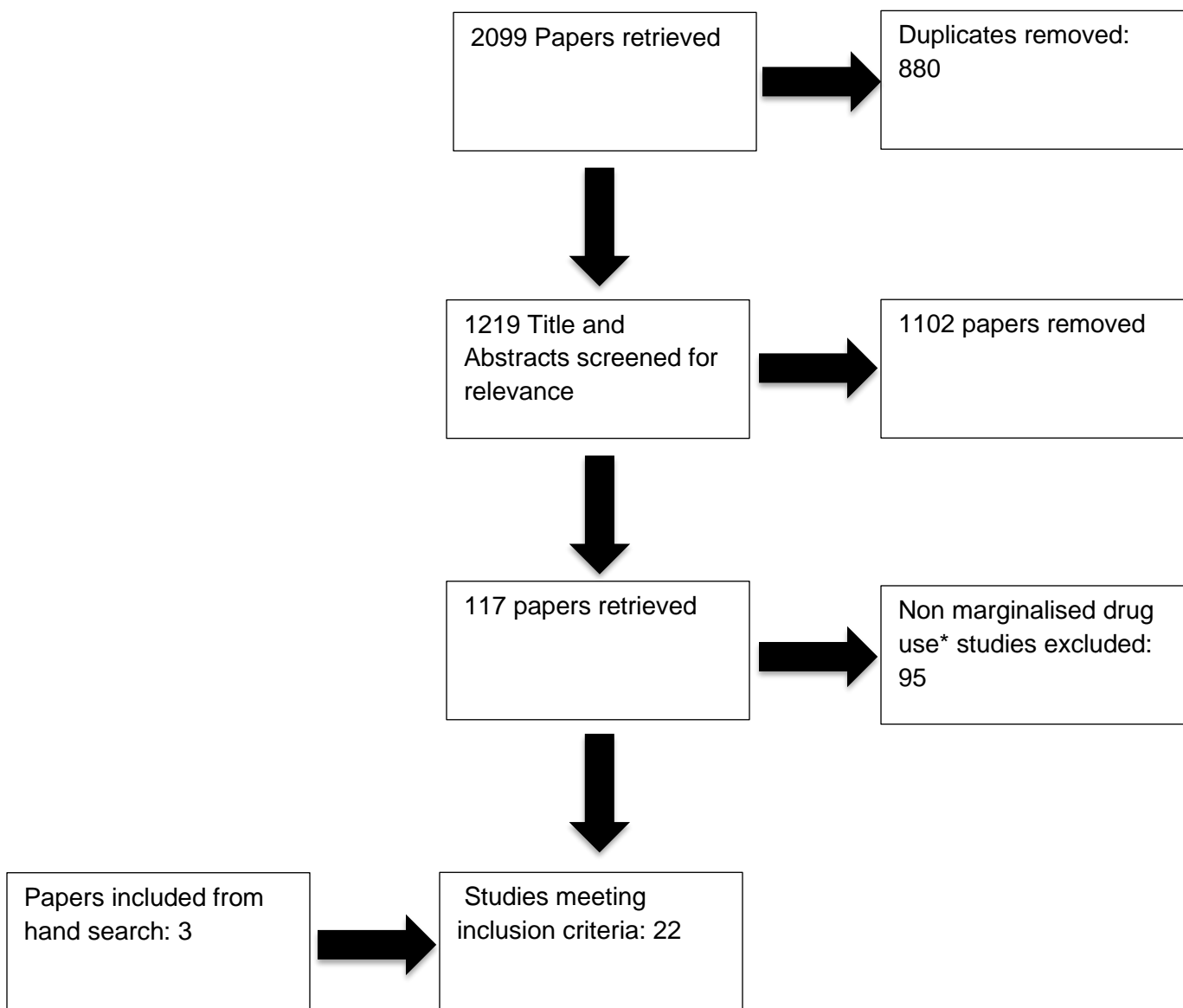


Table 5: Summary of Results

Study (Year)	City, Country	Method	Key findings
(Allen et al., 2019)	Appalachia, United States	Capture and recapture; survey	56.3% reported injecting fentanyl; 57.1% reported being homeless; 30.6% reported being arrested in last 6months;
(Belackova et al., 2017)	Multiple locations, Czechia	Survey, Single-predictor multinomial logit models were	Severity of dependence symptom scores and risky injecting practices associated with repeated synthetic cathinone use in single-predictor models. Repeated use was associated with homelessness (AOR = 3.2), co-occurring use of stimulants and opioids (AOR = 4.3), and use of cannabis (AOR = 2.4) in the past month.
(Bouvier et al., 2017)	Rhode Island, United States	Survey	Participants reporting being homeless in the last six months; having accidentally overdosed; having used heroin; having used fentanyl non-medically; and typically using prescription opioids alone were more likely to report that they would use a supervised injection facility
(Bardwell, Boyd, Kerr, & McNeil, 2018)	Vancouver, Canada	Commentary	Need to consider facilitating drug consumption sites within homeless services
(Boyd et al., 2018)	Vancouver, Canada	In-depth interviews and observation	65% homeless in the last year women in Canada. Use of fentanyl to facilitate sexual assaults.
(Ciccarone et al., 2017)	Northeast Massachusetts and Nashua, New Hampshire	Ethnographic research	Fentanyl started emerging in 2013; distinguish with taste (sweet) and colour (white); admixtures of fentanyl and

			heroin can be considered helpful
(Csak, 2016)	Hungary	Questionnaires, surveys	Marginalised populations are particularly affected by cathinone injecting. Lack of knowledge of available services. Use driven by a desire to escape “reality, problems, pain, poverty and segregation”. Services should include harm reduction, outreach and efforts to enhance employment prospects.
(Giese et al., 2015)	Dublin, Ireland	Case series	HIV outbreak linked to the injection of synthetic cathinone alpha-PVP amongst a population with high levels of homelessness and criminal justice involvement.
(Hope et al., 2016b)	Several sites in the United Kingdom	Serobehaviourial survey	18% homeless. 72% had ever been imprisoned. 8% had injected mephedrone. In multivariate analysis, those injecting mephedrone were found to be younger, less likely to have injected opiates and more likely to have injected cocaine or amphetamines and used a NSP or sexual health service. Those injecting mephedrone more often had hepatitis C antibodies, human immunodeficiency virus and overdosed
(Hunter et al., 2018)	Baltimore, Maryland	Biobehaviourial survey	58% reported injecting fentanyl more than half the time; 33% reported being homeless; 29% had been arrested or incarcerated in last 12 months; 48% reported having their syringes confiscated or discarded by the police; PWID who injected in public places were more likely to be arrested,

			to report overdosing and to share injecting equipment.
(Hyshka et al., 2016)	Alberta, Canada	Survey	12.5% reported injecting fentanyl in last 6 months; 56.9% reported being in unstable accommodation; peer worker involvement may be able to increase engagement at overdose prevention sites
(Katchman et al., 2017)	Tel Aviv, Israel	Case control	59.5% homeless. Injection of cathinone led to HIV outbreak. Interventions helped reduce effect.
(Kennedy et al., 2019)	Vancouver, Canada	Observational field work/in-depth interviews	65% homeless; 86% unstably housed; peer involvement may increase engagement with overdose prevention sites
(Krieger et al., 2018)	Rhode Island, United States	Questionnaire/drug testing/drug checking	98% reported confidence in using fentanyl test strips; 95% said they would use them again; a positive result was associated with homelessness, older age, injecting drug use, ever witnessing an overdose, and concern over overdose and drugs adulteration with fentanyl
(Latkin et al., 2019)	Baltimore, United States	Interviews	52.5% homeless; 66.% injected in last 6 months; majority believed that they were exposed to fentanyl from some to all of the time
(Macmadu et al., 2017)	Rhode Island, New York	Questionnaire	11% reported exposure to fentanyl contaminated heroin; 47.2 ever detained in jail/prison; 54.3% ever homeless. Those in contact with fentanyl-contaminated heroin were more likely to be homeless and have tested positive for HCV (p= <0.05), regular heroin and cocaine use.
(Miller et al., 2018)	Delaware County, United States	Focus groups	4/5 inmates with dual diagnosis accidentally consumed acetyl fentanyl

(McKnight & Des Jarlais, 2018)	New York, United States	In-depth interviews	Study discusses adaptations in response to fentanyl such as taking test doses, using fentanyl test strips, reducing use, using with others and carrying naloxone. Notes stigma, poverty and homelessness as barriers to implementation of such behaviours
(Park et al., 2018)	Cross sectional survey	Baltimore, United States	37% homeless; 53% perceived fentanyl to be present in their drugs half or all the time; non fatal overdoses to perceiving fentanyl in drug more than half the time in last twelve months; homelessness
Peiper et al., (2018)	Online survey	Greensboro, United States	30.4% unstable housing; 56% reported a positive result; those reporting a positive result were five times more likely to change their behaviour; 31% reported wanting fentanyl when they purchased their drugs
Sherman et al., (2019)	Questionnaire	Baltimore, Maryland, Boston, Massachusetts, and Providence, Rhode Island, United States	Factors independently associated with intent to use drug checking included: older age; homelessness; being non-white; witnessing ≥ 1 fatal overdose ; and suspected recent fentanyl exposure.
Wallace et al. (2018)	Cross-sectional survey	Victoria, Canada	66.1% homeless reporting recent non-fatal overdose; 28.6% criminal history; almost half reported their latest overdose occurred in an open or public space; over quarter reported a recent overdose service organization or shelter and another quarter reported having overdosed in indoor housing. Fentanyl injection and public injection were positively associated with recent non-fatal overdose.

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