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Public Health and Public Order Outcomes Associated with Supervised Drug Consumption Facilities: a Systematic Review

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Abstract

Purpose of Review Supervised drug consumption facilities (SCFs) have increasingly been implemented in response to public health and public order concerns associated with illicit drug use. We systematically reviewed the literature investigating the health and community impacts of SCFs.

Recent Findings Consistent evidence demonstrates that SCFs mitigate overdose-related harms and unsafe drug use behaviours, as well as facilitate uptake of addiction treatment and other health services among people who use drugs (PWUD). Further, SCFs have been associated with improvements in public order without increasing drug-related crime. SCFs have also been shown to be cost-effective.

Summary This systematic review suggests that SCFs are effectively meeting their primary public health and order objectives and therefore supports their role within a continuum of services for PWUD. Additional studies are needed to better understand the potential long-term health impacts of SCFs and how innovations in SCF programming may help to optimize the effectiveness of this intervention.

Introduction

Illicit drug use remains a major global public health concern and, in particular, is a key driver of HIV/AIDS and overdose epidemics [1–4]. Public drug use and public disposal of syringes are also community concerns in various settings, particularly in inner-city neighbourhoods [5]. In an effort to mitigate these challenges, supervised drug consumption facilities (SCFs) have been established in a number of cities worldwide [6•, 7•]. SCFs are healthcare facilities that provide sterile equipment and a safe and hygienic space for people who use drugs (PWUD) to consume pre-obtained illicit drugs under the supervision of nurses or other trained staff [7•]. SCFs are also referred to as drug consumption rooms and include supervised injection facilities (SIFs), which accommodate people who inject drugs (PWID), and supervised inhalation rooms (SIRs), which accommodate people who inhale drugs.

Although SCFs vary in design and operational procedures, the aims of SCFs are similar across sites [8, 9]. Specifically, the primary objectives of SCFs are to attract higher-risk PWUD and to offer the following public health and public order benefits: (1) reduce the harms associated with illicit drug use, including fatal overdose

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and infectious disease transmission; (2) connect PWUD with addiction treatment and other health and social services; and (3) reduce public order and safety problems associated with illicit drug use (e.g. public drug use, publicly-discarded syringes) [8, 9]. Since the first legally-sanctioned SCF opened in Berne, Switzerland in 1986 [7•], these facilities have increasingly been implemented and there are now more than 90 SCFs operating internationally [7•]. Nonetheless, concerns regarding the potential negative consequences of SCFs, including that these may promote drug use and crime, have made these facilities difficult to implement [8, 10, 11].

In recent years, the evidence specific to SCFs has grown considerably. However, previous reviews of this evidence have suffered from some notable methodological shortcomings, including employment of search strategies that were narrow in scope, application of broad study eligibility criteria that resulted in the inclusion of low-quality evidence, and/or lack of assessment of the quality of included evidence [6•, 8, 12]. Guided by the primary health and public order objectives of SCFs noted above, the purpose of the present study was to systematically review existing quantitative research on the health and community outcomes associated with SCFs. In addition, we sought to identify underexplored opportunities to inform future research specific to SCFs.

Methods

Search Strategy

Following the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) guidelines for systematic reviews (see Supplement 1) [13], we searched for SCF studies published in the following databases from inception to May 01, 2017: *MEDLINE*, *EMBASE*, *Web of Science*, *PsychINFO*, *Google Scholar* and *CINAHL*. Search terms were combined using appropriate Boolean operators and included the subject heading terms or key words related to SCFs (see Supplement 2 for a detailed search strategy). In addition to electronic databases, we searched the reference lists of retrieved studies, relevant conference proceedings and key journals in the area of addiction. We also conducted a comprehensive grey literature search (i.e. dissertations, reports). We did not restrict our search to a specific language.

Inclusion and Exclusion Criteria

The population, interventions, comparisons, outcomes and study designs considered in the review are listed in Table 1.

Study Screening, Data Extraction and Analysis

Title and abstract screening were conducted to identify studies that potentially met our inclusion criteria. Full texts of all potentially eligible studies were retrieved (MCK) and independently assessed for eligibility by two authors (MCK and MK). Disagreements between the authors were resolved through discussion. Extracted data on study-specific information were summarized narratively and in a structured table.

Quality Assessment

Quality assessment of cohort, cross-sectional and pre-post studies was conducted using the 14-item National Heart, Blood and Lung Institute (NHBLI) Quality Assessment Tool for Observational Cohort and Cross-Sectional Studies [14] or the 12-item NHBLI Quality Assessment Tool for Before-After (Pre-Post) Studies [15], as appropriate. Quality assessment for cost-effectiveness studies was completed using the Joanna Briggs Institute's Critical Appraisal Checklist for Economic Evaluations [16].

Results

As shown in Fig. 1, database searching yielded 1476 records, and hand searching yielded an additional 85 records to account for a total of 1469 potentially eligible studies after duplicate removal. Of these, 1128 records were excluded through title and abstract screenings. Assessment of the full text of the remaining 341 records resulted in the exclusion of an additional 294 studies. In total, 47 studies published between 2003 and 2017 met the eligibility criteria and were included in the review.

Summary of Included Studies

Of the 47 included studies, the majority ($n = 28$) were conducted in Vancouver, Canada; ten were conducted in Sydney, Australia; and the remaining studies were conducted in the following European countries: Germany ($n = 4$), Denmark ($n = 2$), Spain ($n = 2$) and the Netherlands ($n = 1$). Seventeen studies employed prospective cohort designs, while the remaining studies employed times series or pre-post ecological ($n = 10$), cross-sectional ($n = 9$), mathematical simulation ($n = 8$) or series cross-sectional ($n = 3$) designs. Study quality scores are presented in Table S1–3. Overall, most studies had good methodological quality. Additional study-specific information (including study location, design, participant characteristics, exposure(s), outcome(s), and main findings) is presented in Table 2.

Table 1 Population, interventions, comparisons, outcomes and study design (PICOS) criteria for study inclusion

Criteria	Definition
Population	People who use or inject drugs and the broader communities in which supervised drug consumption facilities (SCFs) are located
Interventions[a]	Use, establishment or operation of SCFs
Comparisons	No exposure to SCFs
Outcomes[a]	All individual- or population-level health or social outcomes
Study design[b]	Original quantitative studies that assessed associations between SCFs and outcome(s) of interest for statistical and/or *a priori*-defined clinical significance

[a] Original quantitative research studies were included if they examined the relationship between any aspect of use, establishment or operation of SCFs (including any service provided within SCFs) and any individual- or population-level health or social outcome (with significance assessed through an appropriate statistical test; the estimation of a measure of association (such as an odds ratio or rate ratio) and 95% confidence intervals; or an *a priori*-defined effect size considered to be of clinical significance). Feasibility studies that considered potential outcomes associated with the hypothetical establishment of SCFs were excluded. Studies that examined SCF use as an outcome were excluded, as examining characteristics of SCF users was beyond the scope of the present study. We also excluded studies that examined outcomes associated with exposure to larger facilities with integrated SCFs (unless use or operation of the SCF specifically was examined)

[b] Review articles, case reports, case series, commentaries, editorials, qualitative studies and descriptive studies (that did not assess statistical or *a priori*-defined clinical significance) were excluded. If separate records presented overlapping results, the publication with the most complete information was included

Objective 1: to Reduce the Harms Associated with Illicit Drug Use

1a. Overdose-Related Morbidity and Mortality

Of eight studies examining overdose-related outcomes [18, 20, 21, 29, 36, 37, 49, 52], six suggested a protective effect of SCFs [18, 20, 29, 37, 49, 52]. For example, the establishment of Insite, Vancouver's largest SIF, was associated with a 35% reduction in overdose deaths in the immediate vicinity of the SIF after the facility opened, compared to a 9% reduction in the rest of the city [52]. An earlier simulation study found that Insite averts an estimated 1.9 to 11.7 overdose deaths per year [37]. Similar findings have been observed in ecological and simulation studies conducted in Germany [18, 20]. Likewise, the establishment of the SIF in Sydney, Australia, was associated with declines in opioid poisoning emergency department presentations [29] and ambulance attendances at opioid-related overdoses near the SIF [49]. However, there were no statistically significant changes in the number of opioid-related deaths in the neighbourhood of the SIF compared to the rest of the state after the SIF opened [29]. Another Sydney

Fig. 1 Flowchart of record screening and selection process. *From* [17]
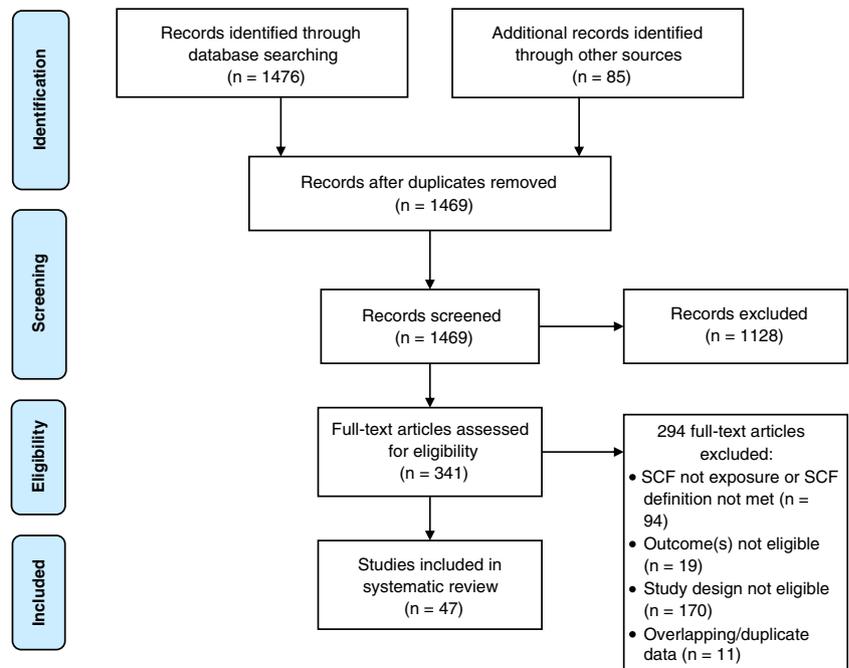
Table 2 Summary of included studies examining health and community outcomes associated with supervised drug consumption facilities (SCFs), arranged chronologically ($n = 47$)

Authors	Location	Study design	Participants	Exposure(s)	Outcome(s)	Main findings
Poschadel et al. 2003 [18]	Saarbrücken, Hannover, Hamburg and Frankfurt, Germany	Time series	N/A	Establishment of SCFs	Monthly police records of drug-related deaths	After the establishment of SCFs, there were significant reductions in drug-related deaths in the four respective cities (all $p < 0.05$].
Zurhold et al. 2003 [19]	Hamburg, Germany	Cross-sectional	616 people who use illicit drugs (PWUD) who used the SCF; mean age 32.6 years; 20% female	Frequent ($\geq$ daily) SCF use; occasional (<daily to $\geq$weekly) SCF use; rare (<weekly) SCF use	Self-reported utilization of other services since began visiting SCFs (yes vs. no)	Frequent SCF users were more likely to use syringe exchange services compared to occasional or rare visitors (59 vs. 54 and 44%, respectively; $p < 0.05$). The same was true of counselling services (corresponding percentages = 46 vs. 35 and 25%; $p < 0.01$), medical services (37 vs. 29 and 17%; $p < 0.01$) and education on safer use (9 vs. 3 and 3%; $p < 0.05$).
Hedrich 2004[b] [20]	Germany	Mathematical simulation	N/A	Operation of SCFs	Estimated annual overdose fatalities prevented	An estimated > 10 deaths are prevented by SCFs in Germany each year.
van Beek et al. 2004 [21]	Sydney, Australia	Cross-sectional (derived from prospective cohort)	3747 people who inject drugs (PWID) and used supervised injection facility (SIF)	Frequent SIF use (top quartile of the visits' frequency distribution during the study period (i.e. 11+ visits during 17-month study period, measured through SIF database))	Non-fatal overdose at SIF during the study period (yes vs. no), measured through SIF database	In multivariable logistic regression analyses, frequent SIF use was positively associated with experiencing a non-fatal overdose within the SIF (AOR = 6.1; 95% CI 4.3–8.6).
Wood et al. 2004 [5]	Vancouver, Canada	Pre-post ecological	N/A	Establishment of SIF (6 weeks before vs. 12 weeks after SIF opened)	Number of people injecting in public, publicly-discarded syringes and injection-related litter in the 10 blocks surrounding the SIF (measured by researcher counts)	The SIF opening was associated with reductions in the number of people injecting in public (mean daily # 2.4 (95% confidence interval [CI] 1.9–3.0) after vs. 4.3 (95% CI 3.5–5.4) before SIF opening), publicly discarded syringes (mean daily # 5.4 (95% CI 4.7–6.3) after vs. 11.5 (95% CI 10.0–13.2) before SIF opening), and injection-related litter (mean daily # 310 (95% CI 305–317) after vs. 601 (95% CI 590–613) before SIF opening) (all $p < 0.05$)
Freeman et al. 2005 [22]	Sydney, Australia	Time series	N/A	Establishment of SIF	Police-recorded trends in theft and robbery incidents; drug use and drug dealing (measured by proxy of drug-related and total loiterers,	The SIF opening did not contribute to significant changes in trends (increases/decreases) in theft incidents, robbery incidents or drug-related loitering at the front of SIF after it opened (all

Table 2 (continued)

Authors	Location	Study design	Participants	Exposure(s)	Outcome(s)	Main findings
					counted by hired personnel)	$p > 0.05$). There were slight increases in drug-related loitering at the back of the SIF and total loitering at both the back and front of the SIF after opening (all $p < 0.05$).
Kerr et al. 2005 [23]	Vancouver, Canada	Cross-sectional and retrospective analyses (derived from prospective cohort)	431 PWID	Self-reported SIF use (all, most or some vs. few or no injections at SIF) in the previous 6 months	Self-reported syringe sharing (borrowing or lending) in the previous 6 months (yes vs. no)	In multivariable logistic regression analyses, SIF use was associated with reduced syringe sharing (AOR = 0.30; 95% CI 0.11–0.82). The odds of syringe sharing between SIF users and non-users were similar prior to the SIF opening ($p = 0.50$), suggesting that the observed reduction in syringe sharing among SIF users was not due to the SIF selecting PWID at inherently lower risk of syringe sharing.
Thein et al. 2005 [24]	Sydney, Australia	Series cross-sectional	515 and 540 residents; 209 and 207 business owners in the 2 respective study years (i.e. 2000 and 2002)	Establishment and operation of SIF (17 months after vs. 7 months before)	Support for SIFs; whether or not SIF reduces risk of HIV/HCV; reduces publicly discarded syringes; show dangers of injecting; reduces public injection; encourages drug injection; attracts PWUD; encourages belief that heroin injection is legal; makes law enforcement difficult (all yes vs. no)	The level of support for the SIF significantly increased in the neighbourhood of established SIF (68 to 78%, $p < 0.001$) among residents. There was no significant change in support for the SIF among business owners ($p > 0.20$). There was an increase in the proportion of residents who agreed that SIFs reduce risk of HIV/ HCV (87 to 92%, $p = 0.0004$) and reduce discarded syringes (80 to 82%, $p = 0.01$). There was an increase in the proportion of residents who disagreed that SIFS encourage illicit drug injection (62 to 73%, $p < 0.001$), or encourage belief that heroin injection is legal (44 to 52%, $p = 0.006$). Among business owners, there was an increase in the proportion who agreed that SIFs reduce public injection (67 to 72%, $p = 0.01$) and show dangers of injecting drug use (47 to 51%, $p < 0.001$), and there was a decrease in the

Table 2 (continued)

Authors	Location	Study design	Participants	Exposure(s)	Outcome(s)	Main findings
						proportion who agreed that SIFs encourage people to think that heroin injection is legal (55 to 43%, $p = 0.001$).
Wood et al. 2005 [25]	Vancouver, Canada	Cross-sectional (derived from prospective cohort)	582 PWID who used SIF (479 HIV-negative and 103 HIV-positive at baseline); 30% female	Self-reported exclusive SIF use for injection drug use in the previous month (yes vs. no)	Self-reported borrowing a used syringe in the previous 6 months among HIV-negative participants; Lending a used syringe in the previous 6 months among HIV-positive participants (both yes vs. no)	In bivariable logistic regression analyses, exclusive SIF use was associated with decreased odds of syringe borrowing among HIV-negative participants (OR = 0.14; 95% CI 0.00–0.78) but was not significantly associated with syringe lending among HIV-positive participants (OR = 0.94; 95% CI 0.00–7.90).
Kerr et al. 2006 [26]	Vancouver, Canada	Prospective cohort	871 PWID; median age (IQR) 35.3 (28.6–41.3) years; 39% female	Establishment of SIF (year after the SIF's opening vs. the year before)	Self-reported relapse into injection among former users; stopping injecting; introduction /discontinuation of methadone	There were no substantial changes in rates of relapse into injection drug use (17 to 20%), stopping injected drug use (17 vs. 15%), starting methadone use (11 vs. 7%), or stopping methadone use (13 vs. 11%).
Wood et al. 2006 [11]	Vancouver, Canada	Pre-post ecological	N/A	Establishment of SIF (year before vs. year after SIF opened)	Police-recorded drug trafficking and drug-related crime in neighbourhood of SIF	There were no increases in the number of drug trafficking offences (124 vs. 116, $p = 0.803$) or assaults/robbery offences (174 vs. 180, $p = 0.565$). A decline was observed in vehicle break-ins/vehicle theft offences (302 vs. 227, $p = 0.001$).
Wood et al. 2006 [27]	Vancouver, Canada	Prospective cohort	1031 PWID who used the SIF[a]	Regular SIF use (≥ weekly vs. < weekly) in the previous 6 months; any contact with an addictions counsellor at the SIF in the previous 6 months (both measured through the SIF database)	Use of detoxification service (measured through database linkage)	In multivariable Cox regression analyses, regular SIF use (AHR = 1.72; 95% CI 1.25–2.38) and contact with the SIF addictions counsellor (AHR = 1.98; 95% CI 1.26–3.10) were associated with more rapid time to entry into a detoxification programme.
Kerr et al. 2007 [28]	Vancouver, Canada	Prospective cohort	1065 PWID who used the SIF[a]	N/A	Rate of initiation into injection drug use at the SIF (measured through self-report and subtracting age at first injection from current age)	Among the entire population of SIF users ($n = {\sim}5000$), the estimated number who may have initiated injection drug use inside the SIF since the SIF opened was 5 (95% CI 2–12), which is comparatively lower than the expected rate of initiation into injection drug use among local street-involved youth

Table 2 (continued)

Authors	Location	Study design	Participants	Exposure(s)	Outcome(s)	Main findings
						during a similar follow-up period (100 initiations; 95% CI 81–122).
NCHECR 2007[b] [29]	Sydney, Australia	Pre-post ecological	1652 opioid-related deaths; 1558 opioid poisoning presentations at emergency departments (EDs)	Establishment of SIF (60 months after vs. 36 prior to opening)	Opioid-related deaths (measured by the state health department); opioid poisoning presentations at two EDs (measured by ED records)	There was a significant decrease from an average of 4 to 1 deaths per month in the immediate vicinity of the SIF after the SIF was established ($p < 0.001$), compared to a decrease from 27 to 8 deaths in the rest of the state ($p < 0.001$). This difference in rate changes was not statistically significant ($p = 0.877$). There was a significant decrease from an average of 11 to 7 opioid poisoning ED presentations (35% reduction) after the SIF establishment ($p < 0.001$).
Salmon et al. 2007 [30]	Sydney, Australia	Series cross-sectional	515, 540 and 316 residents and 269, 207 and 210 business operators in the 3 respective study years (i.e. 2000, 2002 and 2005)	Establishment and operation of SIF	Witnessed public injection in last month; publicly discarded syringes in last month; drugs offered for purchase in the last month (all yes vs. no)	The proportions of residents who had witnessed public injecting in the last month were 33, 28 and 19% in 2000, 2002 and 2005, respectively ($p < 0.001$), while the corresponding proportions for business operators were 38, 32, and 28% ($p = 0.03$). The proportion of residents who had seen publicly discarded syringes in the last month was 67, 58 and 40% in 2000, 2002 and 2005, respectively ($p < 0.001$) while the corresponding proportions for business owners were 72, 64 and 57% ($p = 0.01$). The proportion of residents who had been offered drugs for purchase in the last month was 28, 29 and 26% in 2000, 2002 and 2005 ($p = 0.80$). The corresponding proportions for business owners were 33, 34 and 28% ($p = 0.26$).
Stoltz et al. 2007 [31]	Vancouver, Canada	Cross-sectional (derived from prospective cohort)	760 PWID who used SIF[a]	Consistent SIF use ($\geq 25\%$ of injections vs. $<25\%$) in the previous 6 months	Self-reported changes since SIF opening in: syringe reuse; rushed injecting; injecting outdoors; use of sterile water; cooking or filtering drugs; tying off; safer syringe	In multivariable logistic regression analyses, consistent SIF use was positively associated with a change in each injection behaviour: reuse syringes less often (AOR = 2.04; 95% CI 1.38–3.01), less rushed during

Table 2 (continued)

Authors	Location	Study design	Participants	Exposure(s)	Outcome(s)	Main findings
					disposal; easier finding vein; injecting in clean place (all yes vs. no)	injection (AOR = 2.79; 95% CI 2.03–3.85), less injecting outdoors (AOR = 2.70; 95% CI 1.93–3.87), using clean water for injecting (AOR = 2.99; 95% CI 2.13–4.18), cooking or filtering drugs prior to injecting (AOR = 2.76; 95% CI 1.84–4.15), tying off prior to injection (AOR = 2.63; 95% CI 1.58–4.37), safer disposal of syringes (AOR = 2.13; 95% CI1.47–3.09), easier finding of a vein (AOR = 2.66; 95% CI 1.83–3.86) and injecting in a clean place (AOR = 2.85; 95% CI 2.09–3.87).
Wood et al. 2007 [32]	Vancouver, Canada	Prospective cohort	1031 PWID who used SIF[a]	Establishment of SIF (year before vs. year after SIF opened)	Enrolment in detoxification service; number of visits to the SIF in the month after detoxification enrolment (both measured through database linkage)	In multivariable generalized estimated equations (GEE) with logit link analyses, there was a significant increase in uptake of detoxification services in the year after vs. the year before the SIF opened (AOR = 1.32; 95% CI 1.11–1.58. In multivariable Cox regression analyses, detoxification service use was associated with more rapid entry into MMT (AHR = 1.56; 95% CI 1.04–2.34) and other forms of addiction treatment (AHR = 3.73; 95% CI 2.57–5.39). Among those who enrolled in detoxification, the rate of SIF use declined in the month after enrollment compared to the rate of SIF use in the month prior to enrolment (19 vs. 24 visits, p = 0.002).
Bayoumi and Zaric 2008 [33]	Vancouver, Canada	Mathematical simulation	Estimated 3000 to 20,000 PWID infected with HIV and/or HCV	SIF operation (simulation over 10 years)	Cost-effectiveness of the SIF based on the prevention of incident HIV and HCV infections (with the SIF vs. without the SIF)	An estimated 1191 incident HIV and 54 incident HCV cases were averted over 10 years, resulting in an estimated minimum savings of $CAD 14 million and 920 years of life gained over 10 years.
Kimber et al. 2008 [34]	Sydney, Australia	Prospective cohort	3715 PWID who used SIF; 47% > 30 years; <40% female	Frequent SIF use (top quartile of the visits' frequency distribution	Addiction treatment referral (received at least one written referral during	In multivariable Cox regression analyses, frequent SIF use was positively associated with drug

Table 2 (continued)

Authors	Location	Study design	Participants	Exposure(s)	Outcome(s)	Main findings
				during the 17 month study period (i.e. 12+ visits, measured through SIF database))	the study period); Addiction treatment uptake (use of referral card, yes vs. no).	treatment referral (AHR = 1.6; 95% CI 1.2–2.2) but was not significantly associated with drug treatment referral uptake (AOR = 0.8; 95% CI 0.4–2.0).
Lloyd-Smith et al. 2008 [35]	Vancouver, Canada	Prospective cohort	1065 PWID who used SIF[a]	Self-reported exclusive SIF use for injection drug use in the previous 6 months (yes vs. no)	Current cutaneous injection-related infection (CIRI), measured visually by study nurse (yes vs. no)	In multivariable generalized linear mixed-effects analyses, exclusive SIF use was not significantly associated with development of a CIRI (AOR = 0.58; 95% CI 0.29–1.19).
Milloy et al. 2008 [36]	Vancouver, Canada	Prospective cohort	1090 PWID who used SIF[a]	Self-reported frequent SIF use in the previous 6 months (≥ 75 vs. <75% of injections); self-reporting that SIF use had resulted in a change in injection practices in the previous 6 months (yes vs. no).	Self-reported non-fatal overdose in the previous 6 months (yes vs. no)	In multivariable GEE analyses, frequent SIF use was not associated with recent non-fatal overdose (AOR 1.01; 95% CI 0.77–1.32). In bivariable GEE analyses, reporting that SIF use had changed injection practices was not associated with recent non-fatal overdose (AOR = 0.77; 95% CI 0.53–1.11).
Milloy et al. 2008 [37]	Vancouver, Canada	Mathematical simulation	453 potentially fatal overdose events out of 766,486 injections during the study period	Operation of SIF	Overdose deaths averted	An estimated 1.9 to 11.7 overdose deaths are averted per year.
Richardson et al. 2008 [38]	Vancouver, Canada	Prospective cohort	1090 PWID who use SIF[a]	Self-reported SIF use (≥ 25 vs. <25% of injections) in the previous 6 months	Self-reported employment (job with regular salary or temporary work) in the previous 6 months (yes vs. no)	In multivariable GEE analyses, SIF use was not associated with employment (AOR = 1.05; 95% CI 0.88–1.27).
Wood et al. 2008 [39]	Vancouver, Canada	Prospective cohort	1087 PWID who used SIF[a]	Self-reported frequent SIF use (≥ 75 vs. < 75% of injections) in the previous 6 months	Self-reported receipt of safer injection education at the SIF in the previous 6 months (yes vs. no)	In multivariable GEE with logit link analyses, frequent SIF use was associated with an increased likelihood of receiving safer injection education at the SIF (AOR = 1.47; 95% CI 1.22–1.77).
Bravo et al. 2009 [40]	Barcelona and Madrid, Spain	Cross-sectional (derived from prospective cohort)	249 people who inject heroin aged 30 years or younger (137 in Barcelona; 112 in Madrid); 76% >25 years; 26% female	Any use of at least one of five SIFs since last interview (mean = 17.3 months [SD = 5.7 months])	Self-reporting of not borrowing used syringes; not sharing injection equipment since the last interview (yes vs. no)	In multivariable logistic regression analyses, SIF use was associated with not borrowing used syringes (AOR = 3.3; 95% CI 1.4–7.7). SIF use was not significantly associated with not sharing injection equipment (AOR = 1.1; 95% CI 0.5–2.2).
Marshall et al. 2009 [41]	Vancouver, Canada	Prospective cohort	794 PWID who used the SIF and reported sexual	Time since recruitment from the SIF (measured	Consistent condom use during vaginal and/or	In multivariable GEE with logit link analyses, use of SIF healthcare

Table 2 (continued)

Authors	Location	Study design	Participants	Exposure(s)	Outcome(s)	Main findings
			activity during one or more interviews[a]	in SIF database); self-reported use of medical services at Insite (e.g. nurse consultation, HIV testing, referral to health services) in the previous 6 months (yes vs. no)	anal intercourse in the previous 6 months (always vs. usually, sometimes, occasionally, never)	services was marginally associated with consistent condom use among those with regular partners (AOR = 1.27; 95% CI 0.99–1.64) but not among those with casual partners (OR = 0.94; 95% CI 0.71–1.26). Time since recruitment from the SIF was associated with consistent condom use among those with regular partners (AOR = 1.29; 95% CI 1.06–1.55) but not those with casual partners (AOR = 1.15; 95% CI 0.90–1.47).
Milloy et al. 2009 [42]	Vancouver, Canada	Prospective cohort	902 PWID who used the SIF[a]	Self-reported frequent SIF use (≥ 75 vs. < 75% of injections) in the previous 6 months	Self-reported incarceration in the previous 6 months (yes vs. no)	In multivariable GEE analyses, frequent SIF use was not associated with recent incarceration (AOR 0.99; 95% CI 0.79–1.23).
Andresen and Boyd 2010 [43]	Vancouver, Canada	Mathematical simulation	Estimated 5000 PWID in population	SIF operation	Benefit cost-ratios for the SIF based on prevention of incident HIV infections and overdose deaths	Mathematical modelling estimated that Insite prevents approximately 35 incident cases of HIV infection and 3 overdose deaths per year, providing an annual excess of $6 million with an average cost-benefit ratio of 5.12:1.
Baars et al. 2010 [44]	Rotterdam, Utrecht and South Limburg, Netherlands	Cross-sectional	309 PWUD; mean age (SD) 41.5 (7.4) years; 22% female	Self-reported SCF use at least once in the last 6 months (yes vs. no)	Hepatitis B vaccination programme awareness (yes vs. no) and self-reported uptake (yes vs. no)	In multivariable logistic regression analyses, SCF users were more likely to be aware of Hepatitis B vaccination programme than non-users (AOR = 1.86; 95% CI 1.04–3.33), but SCF use was not associated with Hepatitis B vaccination uptake (p > 0.05; data not shown).
Fitzgerald et al. 2010 [45][b]	Sydney, Australia	Time series	N/A	Establishment and operation of SIF	Police recorded trends of criminal incidents of robbery, property crime and illicit drug offences (use or deal amphetamines narcotics and cocaine)	Incidence of robbery and property offences declined in both the neighbourhood of SIF and the rest of Sydney between 1999 and 2010. Illicit drug offence incidents declined in the neighbourhood of the SIF between 1999 and 2003 and then remained stable until 2009. A similar pattern was observed in the rest of Sydney (drug arrests declined from 1999

Table 2 (continued)

Authors	Location	Study design	Participants	Exposure(s)	Outcome(s)	Main findings
Lloyd-Smith et al. 2010 [46]	Vancouver, Canada	Prospective cohort	1083 PWID who used SIF[a]	Referral to hospital by a SIF nurse (yes vs. no), measured by linkage to SIF database	Hospitalization for CIRI (yes vs. no); duration of hospitalization (in days), both measured by linkages to local hospital inpatient database	to 2003, but with a slight upward trend from 2003 to 2010). In multivariable Cox regression analyses, referral to hospital by SIF nurses was associated with increased likelihood of hospitalization for CIRI (AHR = 5.38; 95% CI 3.39–8.55). Referral to hospital by SIF nurses was significantly and independently associated with shorter duration of stay in hospital (4 days [IQR 2–7] vs. 12 days [IQR 5–33]). Each referral by a SIF nurse would result in an estimated savings of $CAD 5696 [IQR $2136–18,512].
Milloy et al. 2010 [47]	Vancouver, Canada	Prospective cohort	1083 PWID who used SIF[a]	Self-reported frequent SIF use (≥75 vs. <75% of injections) in the previous 6 months	Self-reported inability to access addiction treatment in the previous 6 months (yes vs. no)	In bivariable GEE with logit link analyses, frequent SIF use was not significantly associated with trying but being unable to access addiction treatment (OR = 1.08; 95% CI 0.84–1.40).
Pinkerton et al. 2010 [48]	Vancouver, Canada	Mathematical simulation	Estimated 5000 PWID	Operation of SIF	Annual number of HIV infections and associated costs	If the SIF ceased operating, there would be an estimated increase from 179.3 to 262.8 annual incident HIV infections among local PWID, which would be associated with $CAD 17.6 million in lifetime HIV-related healthcare costs. These savings from future hypothetical healthcare costs exceed the annual operating costs of the SIF (approximately $CAD 3 million).
Salmon et al. 2010 [49]	Sydney, Australia	Pre-post ecological	20,409 ambulance attendees at opioid-related overdoses (1485 in the SIF neighbourhood) before and after the opening of the SIF	Establishment and operation of SIF (36 months before vs. 60 months after the SIF opened)	Average monthly ambulance attendances at suspected opioid-related overdoses in the vicinity of the SIF vs. the rest of the state (measured through ambulance service database)	After the opening of the SIF, the average monthly ambulance attendances at suspected opioid-related overdoses declined significantly in the immediate vicinity of the SIF (by 68%) compared to 61% in the rest of the state during SIF operating hours (p = 0.002). During the SIF operating hours, this difference was more pronounced with an 80% decline in the immediate

Table 2 (continued)

Authors	Location	Study design	Participants	Exposure(s)	Outcome(s)	Main findings
						vicinity of the SIF compared to a 60% decline in the rest of the state ($p < 0.001$).
Scherbaum et al. 2010 [50]	Essen, Germany	Prospective cohort	129 PWID who initiated use of the SIF or began attending the SIF again after 6+ weeks of non-attendance; mean age (SD) 31 (6); 25% female	Changes over time (1, 2, 3 months after first use of SIF vs. first use of SIF)	Outdoor drug use; use of non-sterile equipment; equipment sharing; injection-related abscesses	Compared to baseline, at 1 month follow-up of first use of the SIF, the proportion of 71 participants who reported outdoor drug use, use of non-sterile equipment and equipment sharing remained relatively stable at approximately 50, 50 and 20%, respectively (all $p > 0.30$). At 1 month follow-up compared to baseline, the proportion who had injection-related abscesses was similar (8.5 vs. 4.2%, $p > 0.30$). At 3 months follow-up of first use of the SIF, the proportion of 26 participants who used drugs outdoors, used non-sterile equipment, shared equipment and had abscesses were comparable to baseline (all $p > 0.30$; data not shown).
Debeck et al. 2011 [51]	Vancouver, Canada	Prospective cohort	1090 PWID who used SIF[a]	Regular ($\geq$ weekly vs. < weekly) SIF use at baseline; Contact with addictions counsellor (at least once before event or censor date) at the SIF (both measured through SIF database)	Self-reported uptake of addiction treatment (all treatment modalities including residential treatment and methadone maintenance therapy); self-reported injection cessation for ≥ 6 months	In multivariable Cox regression analyses, regular SIF use (AHR = 1.33; 95% CI 1.04–1.72) and having contact with the addiction counsellor within the SIF (AHR = 1.54; 95% CI 1.13–2.08) were independently and positively associated with initiation of addiction treatment. Enrolment in methadone maintenance therapy (AHR = 1.57; 95% CI 1.02–2.40) and other addiction treatment (AHR = 1.85; 95% CI 1.06–3.24) were positively associated with injection drug use cessation.
Marshall et al. 2011 [52]	Vancouver, Canada	Pre-post ecological	290 decedents; median age (IQR) 40 (32–48) years; 21% female	Establishment of SIF (2 years after vs. 2 years prior to SIF opening)	Fatal overdose (measured by coroner records)	Fatal overdose decreased by 35.0% within 500 m from the SIF from 253.8 to 165.1 deaths per 100,000 person-years ($p = 0.048$) in the 2 years after the opening of the SIF vs. the 2 years prior to the SIF opening, compared to a 9.3%

Table 2 (continued)

Authors	Location	Study design	Participants	Exposure(s)	Outcome(s)	Main findings
						reduction in fatal overdose from 7.6 to 6.9 per 100,000 person-years in the rest of the city ($p = 0.490$). These rate changes were significantly different ($p = 0.049$).
Pinkerton et al. 2011 [53]	Vancouver, Canada	Mathematical simulation	Estimated 5000 PWID in population	Operation of SIF	Annual number of HIV infections and associated costs	The SIF prevents an estimated average of 5.6 infections year (90% CI 4.0–7.6), reducing HIV incidence by an estimated 6–11% among local PWID and averting more than $CAD 1 million in future HIV-related healthcare costs, and accounting for an estimated $200,000–$400,000 in savings per year after considering the SIF's operating costs.
Andresen and Jozaghi 2012 [7•]	Vancouver, Canada	Mathematical simulation	Estimated 5000 PWID in population	SIF operation	Cost-benefit ratios	Mathematical modelling estimated that the SIF prevents 22 incident HIV infections per year, providing an average cost-benefit ratio of 3.09:1.
Lloyd-Smith et al. 2012 [54]	Vancouver, Canada	Prospective cohort	1083 PWID who used SIF[a]	Referral to hospital by a SIF nurse (yes vs. no), measured by linkage to SIF database	ED use for CIRI (yes vs. no), measured by linkage to local hospital ED database	In multivariable Cox regression analyses, referral to hospital by SIF nurses was independently and positively associated with ED use for CIRI among females (AOR = 4.48; 95% CI 2.76–7.30) and males (AOR = 2.97; 95% CI 1.93–4.57).
Donnelly and Mahoney 2013[b] [55]	Sydney, Australia	Time series	N/A	Establishment and operation of SIF	Police-recorded trends in criminal incidents of robbery, theft and illicit drug offences	Incidents of robbery and theft incidents declined over time in neighbourhood of SIF since it was established (consistent with the rest of Sydney) (all $p < 0.001$). Possession of illicit substances remained stable from May 2001 (when SIF opened) to 2008 but increased from 2009 onwards in both the neighbourhood of the SIF and in the rest of Sydney. A similar trend was documented with crime rates per 100,000 population. There were no changes in trends of drug-related incidents occurring in the 50 m. of the SIF during the study period.

Table 2 (continued)

Authors	Location	Study design	Participants	Exposure(s)	Outcome(s)	Main findings
Vecino et al. 2013 [56]	Barcelona, Spain	Pre-post ecological	N/A	Establishment of SCFs (after vs. before)	Monthly-averaged publicly discarded syringes (collected by local services)	After the opening of two SCFs, there was a significant reduction in the average monthly number of publicly discarded syringes (from 13.13 in 2004 to 3.19 in 2012).
Jozaghi and Vancouver Area Network of Drug Users 2014 [57]	Vancouver, Canada	Mathematical simulation	Estimated 4330 people who smoke crack cocaine	Operation of an unsanctioned supervised inhalation room (SIR)	Benefit-cost and cost-effectiveness ratios for the SIR based on prevention of incident HCV infections	The SIR prevented an estimated 57 incident cases of HCV infection per year, providing average annual savings of $CAD 1.8 million per year with an average benefit-cost ratio of 12.1:1 and a marginal cost-effectiveness ratio ranging from $CAD 1705 to 97,203.
Kinnard et al. 2014 [58]	Copenhagen, Denmark	Cross-sectional	41 PWID who used SIF; median age (IQR) 37 (30; 43) years; 9.8% female	Opening of the SIF (after vs. before)	Self-reported perceived changes in syringe disposal practices and injection-related risk behaviours	In total, 24 participants (58.5%) reported changing syringe disposal practices (with 23 reporting change from not always to always disposing safely) after the SIF opening ($p < 0.001$). 75.6% reported reductions in injection risk behaviours after SIF opening (63.4% less rushed injecting; 56.1% fewer outdoor injections; 53.7% stopped syringe sharing; 43.9% cleaned injection sites more often).
Skelton et al. 2016 [59]	Sydney, Australia	Series cross-sectional	SIF staff and clients	Smoking cessation care organizational change intervention at the SIF (after vs. before)	Self-reported receipt of smoking cessation care at the SIF (among SIF users); self-reported smoking cessation care strategies (among SIF staff)	In the post intervention period, more SIF users reported receiving smoking cessation care ($p < 0.05$), and more SIF staff reported providing verbal advice regarding smoking cessation, offer of free nicotine replacement therapy, referral to a physician and follow up to check on smoking cessation progress (all $p < 0.01$).
Toth et al. 2016 [60]	Copenhagen, Aarhus and Odense, Denmark	Cross-sectional	154 PWUD who used at least one of five SCFs; 10% <30 years; 25% female	Self-reported receipt of education in hygienic injection practices at SCF; Self-reported referral to medical help by SCF staff	Self-reported use of SCF to access clean injection equipment (yes vs. no); Self-reported receipt of treatment for condition (yes vs. no)	Those who had received education on hygienic injection practices at a SCF were more likely to access SCFs for clean injection equipment vs. those who had not received such education (68.8 vs. 25.9%, $p = 0.024$). Those advised to seek medical help by staff for a medical condition were more likely to receive treatment for the condition than who were not

Table 2 (continued)

Authors	Location	Study design	Participants	Exposure(s)	Outcome(s)	Main findings
Lysyshyn et al. 2017 [61]	Vancouver, Canada	Cross-sectional	472 drug checks for fentanyl at the SIF	Result of drug test for fentanyl at the SIF (positive vs. negative), measured using a test strip designed for urine testing	Disposal of drugs; reduced dose of drugs; Experienced overdose at the SIF (all yes vs. no), all measured by SIF staff	advised to seek treatment for a condition (51.3 vs. 25.7%, $p = 0.003$). Receiving a positive fentanyl result was associated with increased drug dose reductions (37 vs. 8%; $p < 0.05$) but not disposals of drugs (9 vs. 8%, $p > 0.05$). A positive fentanyl result was also associated with overdosing at the SIF (9 vs. 2%; $p < 0.05$).

N/A not applicable; *SCF* supervised drug consumption facility, *SIF* supervised injection facility, *SIR* supervised inhalation room, *PWUD* people who use illicit drugs, *PWID* people who inject drugs, *HCV* hepatitis C virus, *ED* emergency department, *CIRI* cutaneous injection-related infection, *SD* standard deviation, *GEE* generalized estimating equations

[a] Median age (IQR): 38.4 (32.7–44.3), 29% female

[b] Not peer reviewed

study found that frequent SIF clients were more likely to experience an overdose within the SIF, likely due to their greater exposure time at the facility [21]. Finally, a study conducted in Vancouver examined the association between frequent SIF use and recent non-fatal overdose among PWID and produced null results [36].

1b. Drug-Related Risk Behaviours

Nine studies evaluated the relationship between SCFs and levels of drug use or drug-related behaviours that may increase risk of infectious disease transmission and other harms [23, 25, 26, 28, 35, 40, 50, 58, 62]. Of these, four studies examined the relationship between SCF use and syringe sharing [23, 25, 40, 50], three of which provided evidence of an inverse association [23, 25, 40]. For example, a cross-sectional study of PWID in Vancouver found that regular SIF users were 70% less likely to report borrowing or lending used syringes, despite the fact that SIF users and non-users reported similar levels of syringe sharing prior to the establishment of the SIF in retrospective analyses [23]. Two studies (conducted in Demark and Vancouver) demonstrated an association between SCF use and decreased likelihood of other types of unsafe injection behaviours, including reusing of syringes, injecting outdoors, and rushing injections, as well as an increased likelihood of safe behaviours such as using clean water for injecting, cooking or filtering drugs, and safely disposing syringes [31, 58]. Only one small German study with a short follow-up period found no evidence of an association between SCF use and injection-related risks (e.g. public drug use; equipment sharing) [50]. This study also found that SIF use was not significantly associated with development of cutaneous injection-related infections, as was found in a prospective study conducted in Vancouver [35, 50]. With regard to drug use patterns, a study undertaken in Vancouver found no substantial changes in rates of relapse into injection drug use, ceasing injection, ceasing binge drug use, or participation in methadone maintenance therapy (MMT) after the SIF opened among a prospective cohort of PWUD [26]. As well, another prospective Vancouver study found that the rate of recent initiation into injection drug use among SIF users was markedly lower than the estimated background community-level rate of injection initiation [28].

1c. Other Health and Social Outcomes

Two prospective cohort studies from Vancouver examined health or social outcomes among PWUD other than overdose-related outcomes or drug-related behaviours [38, 41]. One of these found that SIF use was not significantly associated with employment in multivariable analyses [38]. The other study found that both use of SIF services

and time since recruitment from the SIF were independently and positively associated with consistent condom use among PWID with regular but not casual partners [41].

Objective 2: to Connect PWUD with Addiction Treatment and Other Health and Social Services

2a. Addiction Treatment

Four studies provided evidence of a positive association between SCF use and uptake of addiction treatment [27, 32, 34, 51]. For example, a prospective study of PWID in Vancouver found that at least weekly SIF use and contact with a SIF addictions counsellor were associated with more rapid entry into detoxification programmes [27]. A follow-up study demonstrated that rates of entry into detoxification programmes among SIF users increased by more than 30% in the year after compared to the year before the SIF was established [32]. Further, this study found that such enrolment in a detoxification programme was associated with earlier entry into MMT and other forms of addiction treatment, as well as subsequent declines in injections at the SIF [32]. An additional prospective study in Vancouver found that at least weekly SIF use was positively associated with enrolment in addiction treatment, which in turn was associated with an increased likelihood of injection cessation [51]. Similarly, a prospective study of PWID in Sydney found that frequent SIF use was positively associated with referral to addiction treatment, although analyses with addiction treatment uptake as the outcome produced null results [34]. In addition, a sole study examining barriers to treatment found that frequent SIF use was not significantly associated with inability to access addiction treatment among SIF users in Vancouver [47].

2b. Other Health and Social Services

Six studies examined the association between SCF use and utilization of health or social services other than addiction treatment [19, 39, 44, 46, 54, 60]. For instance, a recent multi-site cross-sectional study of SCF users in Denmark found that being advised to seek treatment for a medical condition by SCF staff was associated with an increased likelihood of receiving treatment [60]. Additionally, two separate prospective cohort studies of SIF users in Vancouver found that those referred to hospital by SIF nurses were more likely to access the emergency department and receive hospital care, respectively, for cutaneous injection-related infections [46, 54]. Further, the latter study also found that such referrals were associated with shorter durations of hospitalization [46]. Three studies (conducted in Canada, Germany and Denmark) demonstrated links between SCF use and utilization of education on safer drug use practices at SCFs [19, 39, 60], while

the German study also found an association between frequent SCF use and greater likelihood of accessing syringe exchange services, medical services and counselling at the SCF [19]. Another study, conducted in three cities in the Netherlands, found that SCF users had a higher level of awareness but a similar prevalence of uptake of a hepatitis B vaccination programme compared to non-users [44].

Two additional studies examined health-related outcomes associated with programmes offered within SCFs [59, 61]. A recent Vancouver study of a pilot drug checking program offered within Insite found that SIF clients who checked their drugs and received a positive result for fentanyl (a powerful opioid associated with elevated overdose risk) were more likely to reduce their doses but not to dispose of their drugs compared to those receiving negative results [61]. Another study found that the implementation of a smoking cessation organizational change intervention in the Sydney SIF was associated with an increased likelihood of receiving smoking cessation care among SIF clients [59].

Objective 3: to Reduce the Public Order and Safety Problems Associated with Injection Drug Use

3a. Public Drug Use and Publicly Discarded Injection Equipment

Five studies have demonstrated the role of SCFs in addressing public disorder associated with illicit drug use [5, 24, 29, 30, 56]. An ecological study employing a prospective data collection protocol found that the establishment of a SIF in Vancouver was associated with reductions in the number of people injecting drugs in public, publicly discarded syringes and injection-related litter, independent of changes in police presence and weather patterns [5]. Similarly, there were observed declines in publicly-discarded syringes and public injection in the neighbourhood of the SIF in Sydney after the facility opened [29, 30]. There were also increases in the proportion of residents who agreed with positive statements regarding SIFs (including that these reduce public injection and public disposal of used syringes), although opinions were mixed among business owners [24]. Another study found that the opening of SCFs in Barcelona, Spain, was associated with a significant reduction in the number of publicly-discarded syringes collected by local services [56].

3b. Crime

Six studies examined the association between SCF operation and drug-related crime [11, 22, 42, 45, 30, 55]. Of these, four were conducted in Sydney and found no changes in police-recorded thefts or robbery incidents, drug possession, drug dealing or illicit drug offences in the neighbourhood of the SIF after the facility was established

[22, 45, 30, 55]. Similar results have been observed in Vancouver. For example, a before and after study of local crime statistics found no increases in incidents of drug trafficking or assaults/robbery in the neighbourhood of the SIF after the facility opened [11]. In addition, a prospective cohort study of PWID in Vancouver demonstrated that frequent SIF use was not associated with recent incarceration in multivariable analyses [42].

3c.   Cost-Effectiveness

A total of six studies have evaluated the cost-effectiveness of SCFs, all of which were conducted in Vancouver [33, 43, 48, 53, 57, 63]. Five studies examined the economic impacts of Insite and found it to be cost-effective [33, 43, 48, 53, 63]. For example, a simulation study estimated that the SIF provides an excess of $CAD 6 million per year (due to averted overdose deaths and incident HIV cases) after considering the facility's annual operating costs [43]. Others have provided more conservative estimates, including a study estimating that the prevention of incident HIV cases and overdose deaths by the SIF provides an excess of $CAD 200,000–400,000 per year [53]. Additionally, a recent study of the cost-effectiveness of an unsanctioned peer-run SIR found that the facility saved an annual average of $CAD 1.8 million due to the prevention of incident cases of hepatitis C (HCV) infection [57].

Discussion

In the present systematic review, we identified consistent, methodologically sound evidence demonstrating the effectiveness of SCFs in achieving their primary health and public order objectives. Further, the available evidence does not support concerns regarding the potential negative consequences of establishing SCFs, including that these promote drug use or attract crime.

The prevention of drug-related overdose fatalities represents a significant public health challenge in many settings, particularly in North America, where opioid-related overdose deaths have reached epidemic levels and become a leading cause of accidental death in many jurisdictions [4]. Given that early, rapid and well-equipped overdose intervention is available within SCFs [8], and that these facilities have been shown to attract PWUD who possess risk factors for overdose (e.g. homelessness, high-intensity drug use) [8, 19, 21, 64–66], the broader expansion of SCFs in settings contending with overdose epidemics may afford opportunities to mitigate overdose-related morbidity and mortality. Indeed, compelling ecological and simulation studies included in this review have demonstrated the contributions of SCFs to reductions in overdose-related deaths, emergency department presentations and ambulance attendances [18, 20, 29, 37, 49, 52]. It is also noteworthy that

despite the millions of injections that have occurred within SCFs internationally over the past three decades, not a single overdose death has been recorded within a SCF [6•, 8]. In addition, although preventing non-fatal overdose is not a key objective of SCFs, frequent SCF use has not been found to increase non-fatal overdose risk, which challenges the contention that these facilities promote riskier drug use practices (e.g. taking higher doses) associated with overdose [36]. Although one report included in this review observed non-significant declines in opioid-related deaths in Sydney after the SCF was established, the authors note that this study was likely underpowered [29].

As described elsewhere [8, 20], methodological challenges have impeded efforts to examine the impact of SCFs on the incidence of infectious diseases such as HIV and HCV. However, the studies assessed herein indicate positive impacts of SCFs on reducing unsafe injection practices associated with infectious disease transmission among higher-risk PWUD. For example, several studies have demonstrated associations between SCF use and reductions in syringe sharing [23, 25, 40], with a previous meta-analysis of three studies undertaken in Canada and Spain providing a pooled estimate of a 70% decreased likelihood of syringe sharing among SCF users [67]. Studies also suggest that SCFs contribute to declines in other unsafe injection practices such as reusing syringes, injecting outdoors or rushed injecting [31, 58], as has been found in descriptive studies of SCFs that were ineligible for this review [18, 68–79]. In addition to the provision of sterile injection equipment on site, there are several other mechanisms through which SCFs may reduce such behaviours. For example, SCFs often become a key source of sterile syringes for external use [80], which is notable given the well-documented impact of syringe exchange services in reducing risk of HIV and HCV transmission [81, 82]. Moreover, SCFs have been shown to increase access to safer injection education [19, 39, 60] and to decrease the need to rush injections due to fear of arrest [80]. Collectively, these findings provide strong evidence to support the expansion of SCFs as an infectious disease prevention strategy.

While concerns persist that SCFs may increase illicit drug use and discourage PWUD from seeking addiction treatment, such concerns are not supported by existing evidence. Indeed, the establishment of SCFs has not significantly altered community drug use patterns such as rates of injection initiation, relapse or cessation [26, 28]. Further, several studies demonstrate the role of SCFs in facilitating entry into addiction treatment programmes [27, 32, 34, 51] and subsequent injection cessation and/or reduced injecting at SCFs [32, 51]. Thus, these facilities appear to support rather than undermine the goals of addiction treatment.

In addition to addiction treatment, the research assessed in this review also suggests that SCFs provide opportunities for PWUD to access co-located services, including nursing,

counselling and syringe exchange services [19, 44, 59–61], while also facilitating critical early medical intervention for the treatment of complex conditions such as cutaneous injection-related infections [19, 46, 54, 60]. Similarly, descriptive studies have found that SCFs may help to connect PWUD with other on-site services, including basic supportive services (e.g. food, personal care facilities), HIV testing, mental health care and naloxone training and distribution programmes [9, 83]. Further, the integration of SCFs and other low-threshold services into existing HIV/AIDS healthcare programmes has been shown to improve access to and engagement with HIV treatment and care among PWUD [84–86]. Recent qualitative work has provided insights into how SCFs foster a supportive and welcoming environment characterized by social acceptance and belonging in which PWUD feel comfortable engaging with SCF staff regarding health needs [86, 87]. Thus, although PWUD are known to commonly experience barriers in accessing conventional healthcare services [88, 89], the available data suggests that SCFs may help to mitigate such barriers in mediating access to a range of internal and external health and social resources for higher-risk drug-using populations.

Studies assessed in this review also indicate that SCFs are largely successful in achieving their objective of reducing public disorder associated with illicit drug use through declines in public injection and discarded drug use-related paraphernalia [5, 29, 30, 56]. These findings are consistent with those observed in descriptive studies showing declines in self-reported public drug use among SCF users [18, 29, 74, 77, 78]. Further, as has been found in descriptive studies undertaken in the Netherlands and Switzerland [72, 90–92], the implementation of SCFs in Vancouver and Sydney did not appear to contribute to increases in drug dealing or drug-related crime [11, 22, 30, 45, 55]. Additionally, there is some evidence from Sydney to suggest increasing public acceptance and support of these facilities over time, although support was somewhat inconsistent among business owners [24]. This largely aligns with descriptive work conducted elsewhere suggesting mixed support in terms of public opinion of SCFs [9, 93], but that this tends to increase with time [8, 9, 20]. Finally, despite not being an explicit objective, economic evaluations undertaken in Vancouver indicate that SCFs also offer an additional public benefit of reducing the burden of costs on the public healthcare system [33, 43, 48, 53, 57, 63].

Overall, high-quality scientific evidence derived from the observational and simulation studies included in this review demonstrates the effectiveness of SCFs in meeting their primary public health and order objectives. Although randomized controlled trials (RCTs) are typically defined as the 'gold standard' for yielding level-one evidence on the effectiveness of a given intervention, it should be noted that RCTs of SCFs have been deemed unethical due to a lack of clinical equipoise and therefore have not been conducted [8, 94, 95]. However, reliance on hierarchies of evidence to guide public heath decision

making has been contested in recent years [96–98]. Indeed, there has been growing acknowledgment that, like observational studies, RCTs often suffer from notable methodological weaknesses, including limited external validity, and that while RCTs may provide evidence that effectively serves the needs of clinical medicine, this is not necessarily the case in the realm of public policy [96, 98]. This is particularly relevant to decisions concerning complex public health interventions, as evidence of effectiveness in 'real-world' contexts and attention to considerations such as health equity and human rights may be of equal or greater relevance to public health goals than controlled study of intervention efficacy [98]. Further, assigned level of evidence is not necessarily indicative of methodological quality, and therefore well-designed observational research can arguably provide a level of evidence that meets or exceeds that derived from RCTs [96–98]. Thus, given that it will not be possible to obtain evidence from RCTs on SCFs, decisions regarding the implementation of these facilities should instead be informed by the best available evidence derived from scientifically-viable studies, which clearly demonstrates the positive impacts of SCFs in improving public order and advancing the health and human rights of socially marginalized PWUD.

Directions for Future Research

Although the available evidence suggests that SIFs improve the health of PWUD and reduce community concerns associated with illicit drug use, several important research opportunities remain unexplored. First, despite evidence of the short- and medium-term health impacts of SCFs, rigorous research on the long-term impacts of SCFs on the health of PWUD is lacking. For example, while previous work has found that SCF use increases the likelihood of short-term injection cessation [51], it is not known if SCF use has an impact on sustained injection cessation or cessation of drug use altogether. An additional area of evaluation that has not received adequate attention is the impact of SCFs on hospitalization among PWUD. Although previous research indicates that referral to hospital by SCF nurses facilitates hospital treatment for cutaneous injection-related infections [46], little is known about how SCF use might affect acute hospital bed use for other conditions.

There is also a need for research to evaluate SCF programming that aims to improve their responsiveness to the needs of vulnerable and underserved subpopulations of PWUD. For example, with the exception of SCFs operating in Geneva and Barcelona [99], SCFs in most settings are legally prohibited from accommodating individuals who require manual assistance with injections, despite the fact that this subpopulation accounts for an estimated one third of PWID [100], is comprised largely of women and people with disabilities [100] and is disproportionally vulnerable to an array of serious harms including overdose, HIV infection and violence

[101–103]. A qualitative evaluation of an unsanctioned, peer-run SCF in Vancouver that offered manual assistance with injections found that the provision of this service in a regulated environment helped to reduce risk for the above-mentioned harms [104]. Nonetheless, further research on the potential benefits of offering assisted injection within SCFs may help to strengthen the case for legal reforms to allow for the wider adoption of this practice. In addition, although SCFs have previously been shown to provide protection from street-based drug scene violence for some women PWUD [105], other women may avoid SCFs due to perceived threats of violence [106]. In an effort to address such concerns, women-only SCFs have been implemented in several settings, including in Hamburg, Germany, and another is planned to open in Vancouver, Canada [107, 108]. While research undertaken in Hamburg found that the overwhelming majority of women-only SCF clients felt safer and more comfortable using drugs and approaching staff at this SCF [108], studies should further explore the ability of this form of tailored service to engage and support the health of structurally vulnerable drug-using women.

An additional research opportunity is to evaluate the health and social impacts of SIRs, which accommodate people who inhale drugs. Although SIRs are presently operating in some European cities [108] and recent qualitative research indicates that these facilities have potential to promote safer smoking practices and reduce health-related harms [60, 109•, 110], the health and community outcomes specific to SIRs have not been thoroughly evaluated. As SIRs remain underutilized in many settings [107, 108], further inquiry in this area may provide critical information to inform the broader implementation of these facilities.

Another notable knowledge gap concerns the role and impacts of novel SCF models, including those integrated into existing healthcare and social services. For instance, although there is evidence to suggest a high level of willingness to use an in-hospital SCF among PWUD [111] and a SCF recently opened in a hospital in Paris, France [112], few studies have investigated the effectiveness of this type of SCF model. However, recent qualitative research suggests that the provision of in-hospital SCFs could reduce instances of patients leaving hospital against medical advice, promote culturally safe care and prevent adverse outcomes associated with in-hospital drug use among PWUD [113]. Future studies should also investigate if the benefits of stand-alone SCFs will extend to SCFs integrated into existing shelters, supportive housing and community organizations that serve PWUD, as research on such integrated SCF services is lacking. A related recommendation is to further examine the uptake and potential outcomes associated with services co-located with SCFs, including on-site addiction treatment and low-threshold housing [114]. As well, given the limited geographic coverage of fixed-site SCFs [52, 64], studies should evaluate how the implementation of mobile SCFs might improve the responsiveness of SCF programming to the needs of PWUD, particularly those who reside in settings with geographically dispersed drug scenes or who experience social-structural barriers to attending fixed SCFs (e.g. sex workers working in remote locations; women who avoid SCFs due to previous experiences of violence) [106, 107, 115].

A final recommendation is the continued assessment of peer-run SCFs, which are prohibited in many settings despite evidence of their ability to engage and reduce harms among PWUD who may encounter social-structural and programmatic barriers in accessing SCFs operated by healthcare professionals [9, 104, 107, 110]. Specifically, future studies should seek to better characterize preferences for, engagement with and outcomes associated with peer-run SCF models, as this may help to further elucidate the role of these facilities in complementing or extending the reach of conventional SCF programmes.

Limitations

A number of limitations common to observational studies apply to many of the studies included in this review. First, it is possible that the findings of the studies assessed herein are explained by residual confounding. In addition, most studies relied on non-random samples of PWUD in resource-rich settings and therefore findings may not be generalizable to other contexts. Further, as previous work has indicated that SCFs attract socially marginalized and higher-risk PWUD [8, 19, 21, 64–66], observed measures of the health benefits of SCF use may be biased towards the null. Finally, a limitation of this review is that despite our comprehensive search strategy, it is possible that we neglected to include some relevant literature, particularly non-English literature, not indexed in the databases searched for this review.

Conclusions

In summary, while SCFs remain under-utilized in many settings worldwide, high-quality scientific evidence suggests that these effectively achieve their primary public health and order objectives with a lack of adverse impacts, and therefore supports their role as part of a continuum of services for PWUD. However, further studies are needed to better understand the potential long-term health impacts of these facilities. In addition, future research should continue to investigate innovations in SCF models and programming, including efforts to tailor SCFs to the needs of vulnerable subpopulations of PWUD, in order to optimize the effectiveness and extend the reach and coverage of this form of harm reduction intervention.

Compliance with Ethical Standards

Conflict of Interest The authors have no conflicts of interest to declare.

Humans and Animal Rights All reported studies/experiments with human or animal subjects performed by the authors have been previously published and complied with all applicable ethical standards (including the Helsinki declaration and its amendments, institutional/national research committee standards and international/national/institutional guidelines).

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