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RESEARCH REPORT

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Effectiveness of a safe inhalation pipe provision intervention on health risk practices and engagement in services for people who use crack in England: Findings from a quasi-experimental study

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Abstract

Aims: To evaluate the effectiveness of a safe inhalation pipe provision (SIPP) intervention on use of someone else's pipe, homemade pipes and ash-based filters, injecting, respiratory symptoms and engagement with drug services among people who use crack-cocaine in England.

Design: Non-randomised pre-post intervention evaluation with non-equivalent control groups using cross-sectional surveys 6 months apart (February 2023–July 2024). Survey data were linked to drug service records to measure attendance. Intervention uptake was monitored at point of contact.

Setting: Two independent drug services and one national provider (Change Grow Live, CGL), a sex worker organisation and peer networks delivered SIPP in Bristol, Nottingham and Mansfield. CGL provided treatment as usual in Birmingham, Coventry and Warwickshire.

Participants: Adults aged ≥18 years who had smoked or injected crack in the past 28 days recruited at baseline (n = 733) and endline (n = 738).

Interventions: Drug services and peer networks distributed SIPP kits (glass pipe, gauzes, mouthpieces and push-stick) over six months. Drug service providers received e-learning on harm reduction to promote safer crack use, including use of other people's pipes. Comparison sites delivered treatment as usual.

Measurements: Primary outcome was use of someone else's pipe in the past 28 days. Secondary outcomes included: use of homemade pipes and improvised ash-based filters, injecting, acute injuries, respiratory symptoms (28 days) and drug service engagement

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(six months). Frequency (days) of using someone else's pipe, homemade pipes and injecting was also assessed.

Results: Participants had a median age of 42 years and 30% were female at baseline; the proportion female at SIPP sites fell to 21% at endline. At endline, participants in intervention sites were less likely than those in comparison sites to smoke with someone else's pipe [203/502 (40.5%) vs. 112/236 (47.5%); adjusted odds ratio (AOR) = 0.65, 95% confidence interval (CI) = 0.46–0.92]. They were less likely to use homemade pipes (AOR = 0.25, 95% CI = 0.15–0.42), ash-based filters (AOR = 0.57, 95% CI = 0.35–0.93) or inject (AOR = 0.50, 95% CI = 0.33–0.73). They reported 2.98 fewer days using someone else's pipe (95% CI = −4.17 to −1.79), 3.36 fewer days injecting (95% CI = −4.69 to −2.04) and 5.57 fewer days using homemade pipes (95% CI = −7.21 to −3.94). There was no evidence for differences in respiratory symptoms (AOR = 1.13, 95% CI = 0.81–1.59) or attendance at drug services measured via data linkage (AOR = 1.04 95% CI = 0.72–1.50). Self-reported attendance was lower in intervention sites, but intervention monitoring suggest SIPP provision facilitated first-time contact with services.

Summary: Safer inhalation pipe provision appears to be associated with reductions in high-risk crack-cocaine use practices and may create opportunities for engagement with drug services.

KEYWORDS

crack cocaine, drug service engagement, harm reduction, quasi-experimental study, safer smoking equipment

INTRODUCTION

Globally, cocaine use is increasing from an estimated 17 million people using the drug in 2013 to 25 million in 2023 [1]. Crack-cocaine (crack), a smokable freebase form, is becoming increasingly prevalent in Europe: between 2018 and 2023, first-time treatment presentations increased by 35%, with 9000 people seeking treatment in 2023 [2]. In England an estimated 180 000 (95% confidence interval, 95% CI = 315 168–367 910) people use crack, with the prevalence increasing by 22% between 2016 and 2020 [3]. Among these people, more than 50 000 (95% CI = 42 282–64 018) use crack without opioids and are therefore less likely to engage with drug services. Pharmacotherapy for cocaine use is only available in six countries globally and only in limited forms; no such treatment is available in the UK [4, 5].

Most countries worldwide prohibit the provision of safer smoking equipment for stimulants, including crack [4]. As a result, pipes are often improvised, shared or made from unsafe materials, thereby increasing the risk of injury [6]. While evidence for acquisition of hepatitis C (HCV) through sharing of pipes is mixed [7, 8], safer smoking equipment has been associated with reduced pipe sharing, lower injecting frequency and, as a result, reduced opportunities for transmission [9, 10]. Sharing pipes may increase viral transmission, including SARS-Cov-2, among people with high rates of pulmonary disease [11].

The provision of injecting equipment and foil for heroin smoking has been associated with reduced injecting and related harms among people who use heroin [12–14]. In the context of fentanyl use in the USA, smoking opioids has also been linked to lower risks of mortality, overdose and skin and soft tissue infections, compared with injecting [15, 16]. While foil can be used for crack smoking, it is uncommon and impractical. Knowledge of crack-related harm reduction is limited and drug services provide relatively little information on reducing crack-related harms [11, 17]. Opioid substitution therapy (OST) and injecting equipment provision prevent viral hepatitis and HIV transmission and facilitate access to wider health and social care [12, 14]. As no pharmacological equivalents to OST exists for crack use, recommended psychological and psychosocial interventions are often unavailable and poorly engaged with [17, 18]. Although decorative glass pipes can be purchased in the UK for smoking, they are often made of poor-quality glass and easily broken [19]. The provision of safer smoking equipment for crack use is a practical necessity and can provide a valuable point of contact for engagement, risk reduction and referral to broader care [9, 10, 20].

Evidence on safe inhalation interventions is limited but growing, particularly in Canada where equipment and information are widely distributed [21]. Observational evaluations suggest reductions in pipe sharing, use of unsafe home-made devices and injecting, alongside a greater awareness of crack-related health risks and service engagement [9, 10, 22–24]. However, the absence of control groups and differences in legal and service contexts limit the transferability of findings to the UK, where the provision of safe inhalation equipment for crack use remains prohibited. To address this evidence gap, we co-developed a safer crack inhalation intervention and service provider training with people who use crack and drug

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services, and conducted a mixed-methods evaluation of its impact on crack use practices (use of someone else's crack pipe, use of home-made pipes and ash-based filters, injecting), respiratory symptoms and service engagement among people who use crack in England [17].

METHODS

Study design

We conducted two cross-sectional surveys among people who use crack across six locations (sites) in England 6 months apart: baseline (February–July 2023) and endline (February–July 2024). Six services (defined as clusters) delivered safe inhalation pipe provision (SIPP) across three sites, including drugs services in Bristol (Bristol Drugs Project), Nottingham City (the Health Shop) and Mansfield, Nottinghamshire (Change Grow Live, CGL), two peer networks in Bristol and Nottingham City, and POW, a sex worker organisation in Nottingham City (herein intervention sites). Four drug services in Birmingham, Coventry, Leamington Spa and Nuneaton, Warwickshire (all CGL) delivered treatment as usual as well as one peer network in Birmingham led by the Hepatitis C Trust (herein comparison sites). SIPP began after the conclusion of the baseline data collection. Intervention sites were selected following police approval for SIPP. Comparison sites were purposively selected to be comparable in demographic characteristics and numbers of service users (1645 in intervention sites and 2274 in comparison sites at time of selection), and in geography, while minimising contamination between sites. A detailed description of the methods has already been published [17].

Patient and public involvement

People with lived experience of crack use and service providers were involved as principal investigator, co-investigators, advisory group members and peer researchers in intervention design, study methods, data collection and interpretation [17, 25].

Intervention

The intervention aimed to promote safer crack use, improve workforce competency and increase contact with services. SIPP comprised the distribution of safer smoking equipment (a straight stem borosilicate glass pipe, steel gauzes, rubber mouthpieces and a wooden push-stick in a plastic case), accompanied by verbal harm reduction messages co-developed with peers (including risks of using home-made pipes, sharing pipes, benefits of using SIPP and engaging in services), alongside staff training on crack-related harms, risk reduction and client engagement. Provision was supported by a police letter of comfort exempting suppliers from prosecution for the purposes of the research. One kit per person per visit was distributed between July 2023 and February 2024. Peers distributed kits in an outreach model in public spaces where crack use took place, as well as opportunistically through personal contacts. An equipment instruction leaflet accompanied the kits, alongside an 'ethics card' informing that the intervention was time limited and research orientated, so as to manage client expectations regarding longevity. Further details of the intervention are reported elsewhere [17].

Eligibility criteria

Individuals aged over 18 years were eligible if they reported smoking or injecting crack in the past 28 days, spoke English and had capacity to consent.

Recruitment

Participants were recruited by staff and peer volunteers at participating services concurrently and opportunistically. In Birmingham, Bristol and Nottingham, local peer networks also recruited from community settings through existing networks and approaching individuals thought to be using in locations where crack use took place. All participants received £10 reimbursement in cash or voucher (Figure 1).

Data collection

Participants completed a structured questionnaire in English on a tablet (Open Data Kit 1.28.4) administered by an interviewer, with some self-completion. The questionnaire covered: demographic characteristics (age, ethnicity, gender identity); social exclusion (housing, arrest, incarceration); drug use (types, main route of administration, frequency, equipment sharing and reuse, injecting, people smoked crack with); drug service engagement (drug treatment use, outreach contact, key worker, opioid substitution therapy); and personal identifiers (date of birth, initials). Indicators were developed with peers and service providers and informed by comparable Canadian and UK surveys [17, 26–28].

During the 6-month delivery of SIPP, service providers completed a short monitoring form, recording: kit distribution; demographic characteristics; reason for service engagement; and personal identifiers (date of birth, initials). Peer distribution did not include monitoring forms to promote anonymity.

Data linkage

Minimal identifiers (date of birth, initials) were collected and used with an interview site code to link baseline participants with endline surveys, intervention monitoring data and drug service records. These data assessed follow-up rates and service engagement for the primary impact analyses.

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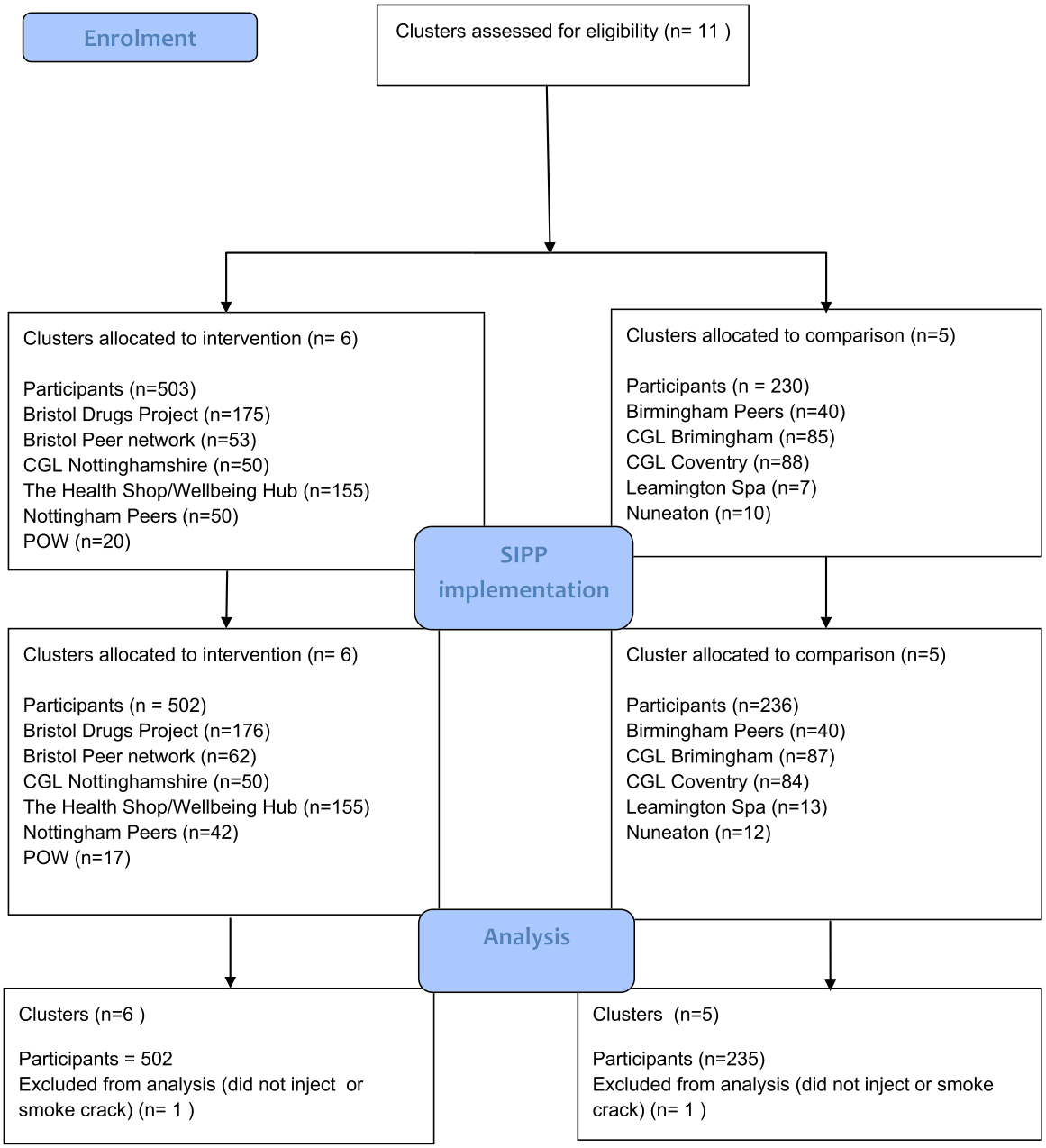

FIGURE 1 Flow chart of cluster and participant recruitment.

Outcomes

Our primary outcome was self-reported use of someone else's pipe for smoking in the past 28 days (yes/no).

Secondary self-reported outcomes included the following practices in the past 28 days (yes/no): use of home-made pipes; use of improvised ash-based filters; injecting any drug; injecting heroin with crack; acute injuries (presence of cuts/burns to mouth/lips and/or fingers); respiratory problems (yes/no to breathing problems, chest pain, coughing blood or phlegm linked to crack use). Frequency of practices in the last 28 days included: number of days injecting crack; days using someone else's pipe; and days using home-made pipes among the whole sample. Drug service presentation in the past 6 months (yes/no) was also measured.

Secondary outcomes derived from linked drug service records included: (i) presentation at services (yes/no); and (ii) total number of times people attended the service. Both were measured over a period of 6 months and commenced from the participant's endline survey interview date.

Confounders

Pre-specified confounders included: gender identity; time since first crack use (participant age minus self-reported age of first crack use); and baseline cluster-level prevalence of modelled outcome (aggregated across participants within each service) [29]. Additional covariates selected on the basis of observed imbalances and directed acyclic

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graph review included: ethnicity (racialised minority, including Asian, British Asian, Black, Black British, Arab, Hispanic/Latino, other, vs. white); frequency of crack use (daily vs. less than daily); primary residency in last 4 weeks (categorised as: homeless or sleeping on street; living in own or shared place; living in a hostel, squat, prison or rehab; and other/refused to say); smoking crack with a partner (yes vs. no); main method of crack use in the last 28 days (injecting vs. smoking); used a drug service or been visited by an outreach worker in past 6 months (yes/no) [30].

Statistical analyses

We compared participant characteristics by intervention and comparison sites at baseline and endline using medians and interquartile ranges for continuous data and percentages for categorical data. SIPP kit recipient characteristics from the monitoring data are also described. We report any variable with >5% missing data.

Adjusted intention-to-treat analyses estimated the relative probability of primary and secondary outcomes among participants at endline, adjusting for confounders, and the cluster-level summary outcome measure. Logistic regression models were used to estimate prevalence odds ratios for binary measures, and linear regression models were used to estimate mean differences for continuous measures with 95% confidence intervals. Participants recruited through services or peer networks implementing SIPP were classified as intervention participants, regardless of individual SIPP use, and those recruited from treatment as usual were classified as comparison participants. Potential contamination was assessed through self-reported use of SIPP kits at endline and information sought from local study staff to identify possible exposure to SIPP. Sample size calculations indicated that 306 participants in total were required to detect a 20-percentage-point difference in use of someone else's pipe with 90% power and 5% significance level. Recruitment was increased to 700 to support multi-variable analyses. All primary and secondary outcomes reported in the article were prespecified in the trial protocol, with the exception of analyses for injecting any drug (yes/no), injecting heroin with crack (yes/no) and frequency of attendance at drug services, which were conducted *post hoc* [17].

Secondary analyses

Sensitivity analyses comprised cluster-level analysis to assess the robustness of findings to cluster-level variation and per-protocol analysis in which intervention participants who did not report SIPP use were re-classified to the comparison group [29]. Twelve clusters included the participating drug services, sex worker organisation and three peer networks.

All analyses were conducted using Stata/SE 18.0 (StataCorp LLC, College Station, TX, USA) with the code attached (supplementary materials). $P < 0.05$ was considered statistically significant.

Ethics

Written informed consent was obtained for the baseline and endline surveys. The evaluation was approved by the London School of Hygiene & Tropical Medicine's Research Ethics Committee (ref. 28102).

RESULTS

A total of 733 participants were recruited at baseline (503 SIPP, 230 comparison) and 738 participants were recruited at endline (502 SIPP, 236 comparison). Among those recruited at baseline, 156 were linked to an endline survey. At baseline 30% were female, 14% racially minoritised and the median age was 42 years. Compared with comparison sites, SIPP site participants were older, more often female, homeless and used crack daily. Participant characteristics were broadly similar at endline, although the proportion of women declined in SIPP sites. Full characteristics are presented in Table 1.

Crack use practices and drug service engagement pre- and post-SIPP

At baseline, the use of someone else's pipe in the past 28 days was similar across SIPP and comparison sites. Use of a home-made pipe was higher in SIPP sites while use of ash as an improvised filter was more common in comparison sites. Acute injuries and respiratory problems were similar across all sites and were unchanged at endline.

At endline, participants in SIPP sites were less likely to report the use of someone else's pipe, the use of home-made pipes, using ash as an improvised filter and injecting any drugs, compared with those in comparison sites. Among people who injected crack, the frequency of injecting declined in SIPP sites but increased in comparison sites. There was little change over time in acute injuries, respiratory symptoms and use of heroin with crack.

Self-reported and linked measures indicated lower overall engagement with drug services among SIPP participants than among comparison participants at both time points; however, the median number of service contacts increased over time among SIPP participants (Table 1).

The use of intervention-type pipes among comparison participants was uncommon, except in Birmingham, where 34/87 participants reported using a similar pipe. Follow-up indicated these reports referred to locally available glass pipes rather than SIPP kits. Analyses excluding Birmingham yielded similar findings.

Implementation of SIPP

Table 2 summarises characteristics and use of SIPP kits among clients of drug services in SIPP sites between July 2023 and February 2024. Overall, 3382 monitoring surveys were completed: 1891 in Bristol, 1282 in Nottingham and 209 in Mansfield, where surveys were offered least consistently. The median number of surveys completed

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TABLE 1 Characteristics of people using crack by survey round and Safe Inhalation Pipe Provision study arm, England, 2024.

	Baseline		Endline	
	Intervention	Comparison	Intervention	Comparison
Characteristic	*n* (%)	*n* (%)	*n* (%)	*n* (%)
Total	503 (100)	230 (100)	502 (100)	236 (100)
Recruitment route				
Drug treatment service	400 (79.5%)	190 (82.6%)	398 (79.3%)	196 (83.0%)
Peer network	103 (20.5%)	40 (17.4%)	104 (20.7%)	40 (17.0%)
Age, years, median (IQR)	42 (37–48)	41 (36–45)	42 (37–48)	43 (37.5–47.5)
Gender				
Cisgender male	349 (69.4%)	171 (74.3%)	385 (76.7%)	180 (76.3%)
Cisgender female	154 (30.6%)	57 (24.8%)	115 (22.9%)	55 (23.3%)
Transgender/non-binary	<10	<10	<10	<10
Racial/ethnic identity				
Ethnically and/or racially minoritised	69 (13.7%)	28 (12.2%)	76 (15.1%)	35 (14.8%)
White only	434 (86.3%)	202 (87.8%)	426 (84.9%)	201 (85.2%)
Primary current residency				
Homeless or sleeping on the street	104 (20.7%)	28 (12.2%)	144 (28.7%)	47 (19.9%)
Hostel, squatter, prison, rehab	132 (26.2%)	51 (22.2%)	124 (24.7%)	49 (20.8%)
Own place, shared place	250 (49.7%)	146 (63.5%)	216 (43.0%)	137 (58.0%)
Other/refused to say	17 (3.4%)	5 (2.2%)	18 (3.6%)	3 (1.3%)
Years since first crack use (median IQR)	22 (12, 27)	20 (10,26)	21 (12, 27)	20 (9, 25)
Ever been in prison (yes vs. no)	361 (71.8%)	157 (68.3%)	359 (71.5%)	163 (69.1%)
Use of drug service in past 6 months				
Used drug service, self-reported	331 (65.8%)	178 (77.4%)	337 (67.1%)	211 (89.4%)
Used drug service (via linkage) yes/no	282 (56.1%)	161 (70.0%)	313 (62.4%)	167 (70.8%)
Number of drug service engagements (via linkage) median (IQR)	0 (0–7)	5 (0–9)	1 (0–9)	4 (0–8)
Newly registered at a drug service (via linkage) yes/no	31 (6.2%)	61 (26.5%)	30 (6.0%)	68 (28.8%)
Currently on OAMT (yes vs. no)	295 (58.6%)	155 (67.4%)	268 (53.4%)	172 (72.9%)
Crack use practices in past 28 days	*n* = 498	*n* = 229	*n* = 501	*n* = 236
Uses crack daily (yes vs. no)	293 (58.2%)	113 (49.1%)	242 (48.2%)	90 (38.1%)
Smoking only	344 (68.4%)	169 (73.5%)	391 (77.9%)	169 (71.6%)
Any injecting	159 (31.6%)	61 (26.5%)	111 (22.1%)	67 (28.4%)
Injecting any non-prescription drug (yes vs. no)	176 (35.0%)	64 (27.8%)	133 (26.5%)	76 (32.2%)
Used someone else's pipe (yes vs. no),	226 (45.4%)	96 (41.9%)	203 (40.5%)	112 (47.5%)
Days using someone else's pipe, median (IQR)	0 (0–4)	0 (0–7)	0 (0–3)	0 (0–10)
Using home-made pipes (yes vs. no)	371 (74.5%)	131 (57.2%)	337 (67.3%)	197 (83.5%)
Days home-made pipes were used, median (IQR)	11 (0–28)	3 (0–28)	5 (0–20)	10 (2–28)
Use of ash as filter[a] (yes vs. no)	121/371 (32.6%)	90/131 (68.7%)	76/501 (15.2%)	118/236 (50%)
Cuts or burns to fingers or mouth (yes vs. no)	243 (48.8%)	113 (49.3%)	233 (46.5%)	107 (45.3%)
Crack-associated respiratory issue days[b] (yes/no)	294 (58.4%)	143 (62.2%)	324 (64.5%)	143 (60.6%)
Crack use among people who injected crack	*n* = 159	*n* = 61	*n* = 111	*n* = 67
Injected heroin with crack past 28 days	152 (95.6%)	55 (90.2%)	107(96.4%)	64 (95.5%)
Days (in past 28) crack injected, median (IQR)	18 (4–28)	15 (4–28)	14 (4–28)	25 (7–28)

Abbreviation: OAMT = opioid agonist maintenance treatment.

[a]At baseline this question was asked only of those who reported using home-made pipes; this was changed at endline to ask everyone, irrespective of home-made pipe use.

[b]Respiratory issues defined as breathing problem, chest pain, coughing phlegm or blood.

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TABLE 2 Safe Inhalation Pipe Provision (SIPP) intervention coverage among drug treatment services from implementation monitoring data and endline survey.

Intervention sites	All *n* (%)	Bristol *n* (%)	Nottingham *n* (%)	Mansfield *n* (%)
Visits				
Total	3382	1891 (55.9%)	1282 (37.9%)	209 (6.2%)
Mean (range)	2.1 (1–46)	2.0 (1–46)	2.5 (1–41)	1.2 (1–4)
Median (IQR)	1 (1–2)	1 (1–2)	1 (1–3)	1 (1–1)
Individuals				
Total	1634	951	518	165
Age, years, median (IQR)	41 (35–48)	41 (34.5–48)	42 (37–48)	41 (37–47)
Female	385(23.6%)	212 (22.3%)	131 (25.3%)	42 (25.4%)
Ethnicity				
Ethnic/racialised minority	197 (12.1%)	50 (9.6%)	5 (3.0%)	142 (15.0%)
White	1423 (87.6%)	800 (84.5%)	466 (90.5%)	157 (96.9%)
First visit to DTS	182 (11.1%)	131 (13.8%)	42 (8.1%)	9 (5.4%)
Reason for visit among first visit				
SIPP	160 (88.0%)	117 (89.3%)	39 (92.8%)	4 (44.4%)
Needle exchange	11 (6.0%)	8 (6.1%)	1 (2.4%)	2 (22.2%)
OST	6 (3.3%)	4 (3.1%)	0 (0%)	2 (22.2%)
Other	5 (2.7%)	2 (1.5%)	2 (4.8%)	1 (11.1%)
Estimates of SIPP use				
Total endline survey participants	503	177	172	50
Self-reported SIPP use in last 28 days (endline) (yes/no)	299/501 (59.7%)	130/174 (74.7%)	85/171 (49.7%)	21/50 (42%)
Total in endline survey linked to implementation surveys	200 (39.7%)	91/177 (50.8%)	100/172 (58.1%)	9/50 (18%)
Used SIPP kit when smoked crack, among those linked	129/200 (64.5%)	66/91 (72.5%)	58/100 (58%)	5/9 (55.6%)

Abbreviation: OST = opioid substitution therapy.

per person was one across all sites. Overall, 1634 individuals were recorded as receiving SIPP equipment (median age 41 years; 23.6% female; 12.1% racialised minorities). Overall, 11.1% were first-time attenders at any drug service, with the highest number in Bristol (13.8%) and the lowest in Mansfield (5.4%). The majority reported SIPP as the reason for their first-time attendance (88%). Overall, 200 participants from the monitoring forms were linked to the endline survey (39.7%), with the highest number in Nottingham City (58.1%) and the lowest in Mansfield (18%). Among those linked, 129 (64.5%) reported using an SIPP kit. Invoices indicate that 5575 kits were ordered and fewer than 1000 remained in stock at the cessation of the intervention, suggesting an underestimation of kit distribution. We estimate that 300–400 kits in Bristol and up to 60 in Nottingham were distributed via peer networks [31].

Intervention effects

Individual-level analysis of outcomes

Adjusting for confounders, relative to participants at comparison sites, there was statistically significant evidence that SIPP site participants at endline had 35% lower odds of using another person's pipe (adjusted odds ratio, aOR = 0.65, 95% CI = 0.46–0.92, $P = 0.02$), 75% lower odds of using a home-made pipe (aOR = 0.25, 95% CI = 0.15–0.42, $P < 0.01$), 43% lower odds of using ash as an improvised filter (aOR = 0.57, 95% CI = 0.35–0.93, $P = 0.02$) and 50% lower odds of injecting any drugs (aOR = 0.50, 95% CI = 0.33–0.73, $P < 0.01$) (Table 3).

There was no statistically significant difference in the injection of crack with heroin (aOR = 0.91, 95% CI = 0.60–1.40, $P = 0.68$), in the reporting of cuts or burns to the mouth, lips or fingers (aOR = 0.98, 95% CI = 0.70–1.37, $P = 0.90$) or in respiratory problems (aOR = 1.13, 95% CI = 0.81–1.59, $P = 0.46$) between SIPP and comparison site participants.

SIPP site participants reported almost three fewer days of using someone else's pipe to smoke (coefficient = −2.98, 96% CI = −4.17 to 1.79, $P < 0.01$) and of injecting crack (coefficient = −3.36, 95% CI = −4.69 to −2.04, $P < 0.01$), and six fewer days using a home-made pipe (coefficient = −5.57, 95% CI = −7.21 to −3.94, $P < 0.01$), compared with participants at comparison sites.

The self-reported use of drug services was lower among SIPP site participants (aOR = 0.18, 95% CI = 0.10–0.32, $P < 0.01$), but we observed no statistically significant difference in service use through the data-linked measure (aOR = 1.04, 95% CI = 0.72–1.50, $P = 0.83$).

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TABLE 3 Effect of Safe Inhalation Pipe Provision (SIPP) availability on primary and secondary outcomes among people using crack at endline.

			Individual-level analysis			Cluster-level analysis		
Relative risk for SIPP arm vs. comparison arm	**SIPP**	**Comparison**	**aOR**	**95% CI**	***P***	**aPR**	**95% CI**	**P**
Last 28 days								
Used someone else's crack pipe (yes/no)[a,b,c]	203/501 (40.5%)	112/236 (47.5%)	0.65	0.46–0.92	0.02	0.78	0.48–1.25	0.26
Use of home-made pipe (yes/no)[a,b,c]	337/501 (67.3%)	197/236 (83.5%)	0.25	0.15–0.42	<0.01	0.88	0.71–1.09	0.22
Injecting any non-prescription drugs (yes/no)[a,d]	133/502 (26.5%)	76/236 (32.2%)	0.50	0.33–0.73	<0.01	0.64	0.34–1.24	0.16
Injecting heroin with crack (yes/no)[a]	110/502 (62/15)	67/236 (37.8%)	0.91	0.60–1.40	0.68	0.84	0.69–1.02	0.07
Cuts, burns to mouth or fingers related to smoking crack (yes/no)[a,c]	233/501 (46.5%)	107/501 (45.3%)	0.98	0.70–1.37	0.90	0.82	0.50–1.32	0.36
Use of ash to hold crack when smoking (yes/no)[a,c]	76/501 (15.2%)	118/236 (50%)	0.57	0.35–0.93	0.02	1.32	0.43–4.07	0.58
Respiratory problems when smoking crack[e] (yes/no)[a]	324/502 (64.5%)	143/236 (60.6%)	1.13	0.81–1.59	0.46	0.82	0.58–1.16	0.22
Use of drug service (self-reported) in past 6 months (yes/no)[a]	337/502 (67.1%)	211/236 (89.4%)	0.18	0.10–0.32	<0.01	0.67	0.53–0.85	<0.01
Use of drug service (data linkage) during SIPP implementation (yes/no)[a]	313/502 (62.4%)	167/236 (70.8%)	1.04	0.72–1.50	0.83	0.97	0.69–1.36	0.85
New registration at a DTS (data linkage) during SIPP (yes/no)[a,c]	30/502 (6.0%)	68/236 (28.8%)	1.44	0.48–4.30	0.51	1.01	0.12–8.73	0.99

	Mean (SD)	**Mean (SD)**						
Mean difference for SIPP versus comparison	***n* = 501**	***n* = 236**	**Coefficient**			**Coefficient**		
Days used someone else's pipe in last 28 days[a,b,c]	3.1 (6.4)	6.2 (9.6)	−2.98	−4.17 to −1.79	<0.01	−3.63	−6.34 to −0.92	0.01
Days used home-made pipe in last 28 days[a,b,c]	10.0 (10.9)	13.3 (11.4)	−5.57	−7.21 to −3.94	<0.01	−2.57	−5.95 to 0.81	0.12
Days injecting crack (with or without other drugs) in last 28 days[a,d]	3.2 (7.7)	5.3 (10.1)	−3.36	−4.69 to −2.04	<0.01	−3.22	−6.33 to −0.12	0.04
Times visited a drug service during SIPP implementation (data linkage)[a]	8.1 (17.4)	5.6 (6.5)	2.91	0.68–5.14	0.01	3.13	−4.72 to 0.99	0.38

Abbreviations: aOR = adjusted odds ratio; aRR = adjusted prevalence ratio; DTS = Data Treatment Service.
[a]Adjusted for baseline site-level summary of this outcome; endline individual-level gender, time since first crack use, housing, ethnicity, using crack daily.
[b]Adjusted for endline individual-level smokes with a friend or partner.
[c]Adjusted for endline individual-level main route of crack administration.
[d]Adjusted for endline individual-level used DTS/street outreach in past 6 months.
[e]Defined as breathing problems, chest pain, coughing phlegm or blood, self-reported as being related to smoking crack.

There was some evidence that new registrations at a drug service were higher among SIPP site participants (aOR = 1.44, 95% CI = 0.48–4.30, *P* = 0.51). Among participants attending services, those in SIPP sites attended more frequently (coefficient = 2.91, 95% CI = 0.68–5.14, *P* = 0.01).

Cluster-level analysis of study outcomes

We found similar but smaller reductions in study outcomes when conducting cluster-based analysis. The probability of using someone else's pipe was 22% lower (adjusted prevalence ratio, aPR = 0.78, 95% CI = 0.48–1.25, *P* = 0.26) among participants at SIPP sites. Participants recruited in SIPP areas used someone else's pipe for 3.6 fewer days (coefficient = −3.63, 95% CI = −6.34 to −0.92, *P* = 0.01) and had, on average, three fewer days injecting crack (coefficient = −3.22, 95% CI = −6.33 to −0.12, *P* = 0.04). Self-reported use of a drug service in the past 6 months was 33% lower among participants in SIPP sites (aPR = 0.67, 95% CI = 0.53–0.85, *P* < 0.01).

Per-protocol analysis

We found similar but smaller reductions in our efficacy analysis of study outcomes among those self-reporting the use of SIPP at endline. The probability of using someone else's pipe was 24% lower among participants using SIPP (aOR = 0.76, 95% CI = 0.55–1.04) and the use of home-made pipes was 72% lower (aOR = 0.28, 95% CI = 0.19–0.40). Participants using SIPP had 1.97 fewer days using someone else's pipe (95% CI = −3.05 to −0.87 days) and used home-made pipes for 7.85 fewer days (95% CI = −9.26 to −6.44 days). The self-reported use of a drug service in the past 6 months was 55% lower among people using SIPP (aOR = 0.45, 95% CI = 0.31–0.65) (see supplementary table).

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DISCUSSION

The SIPP intervention was associated with reductions in several high-risk practices over a period of 6 months, including use of someone else's crack pipe, use of home-made pipes, use of ash as an improvised filter and injecting any drug. The frequency of these practices also declined. While self-reported use of drug services was lower among SIPP participants, attendance at services was more frequent during the implementation of SIPP. No effect was observed on respiratory problems or acute injuries.

These findings are consistent with evidence from Canada and Mexico showing that safer inhalation interventions reduce risk practices among people who use crack, where consistent access to equipment is provided [9, 22, 32]. The reduction in injecting is particularly important, highlighting the potential of safer inhalation interventions for HIV/HCV prevention [9, 10, 23]. We found no evidence of improvement in respiratory health despite the reductions in practices linked to respiratory harms. This may reflect the short implementation period, the high prevalence of tobacco, heroin, cannabis and spice (synthetic cannabinoid) smoking across the sample, and the effects of unstable housing on poor respiratory health. Our process evaluation suggests that the long-stemmed pipes were harder to use when lung function was already poor, particularly affecting women and older participants [33, 34].

Peer involvement in the study design and delivery of pipes was a central feature of SIPP and is key to building trust and engaging the community [35]. We identified areas for improvement in the kits including less dense steel gauzes, slimmer pipes and more discrete case options. These findings informed the subsequent co-design of a new SIPP kit. Despite mixed acceptability the uptake of SIPP equipment was strong, and the coverage measured via monitoring forms is likely to be underestimated owing to unrecorded peer distribution and inconsistent form completion across sites.

Although overall service engagement did not increase, participants at SIPP sites who attended services did so more frequently, consistent with international evidence [6, 9, 10]. Implementation data also indicated first-time visits and registrations increased at SIPP sites. Although many were already engaged in services, the kits and provider training facilitated the disclosure of, and support for, crack use [31].

Strengths and limitations

The strengths of this study include the community–academic collaboration, large multi-site sample, inclusion of a comparison group and the use of linked drug service records to measure service engagement. Limitations include the reliance on self-reported measures, although such measures among people who use drugs are generally reliable, particularly with computer-assisted instruments [36, 37]. The service engagement measure may underestimate attendance because recording practices vary across interventions depending on whether they are structured (e.g. OST) or low threshold (e.g. needle syringe programmes). Although we sought to recruit a random sample from service users, this was not feasible given the high levels of homelessness and the precarity of the participants. Our convenience sample may not be representative of the wider population of people who use crack.

The lack of random allocation of intervention sites is a further limitation. Although intervention and comparison sites were purposively selected to be broadly comparable with national caseloads and with each other, differences in service provision (including OST availability), relationships with communities, social services and police may have influenced outcomes. The reliance on local police approval may have introduced selection bias, particularly given that supportive relationships with the police, absence of arrest, harassment or detention of people using drugs is integral to accessing services [38]. While letters of comfort required high-level approval, they may not have reflected variable local policing [31]. We tried to account for differences in services through cluster-level analysis, not specified in the original protocol and consequently under-powered. While many analyses were non-significant, the consistent direction of effect across analyses is encouraging.

The SIPP kits were used to smoke multiple substances, including heroin and spice, in addition to crack [31]. The reduction in injecting suggests that SIPP may support the transition from injecting to smoking, a lower risk route of administration linked to reduced mortality and overdose risk in the context of fentanyl use [15, 16]. These findings have international relevance given the widespread availability of high-potency synthetic opioids across North America and the increasing concern regarding their emergence in other regions, including Europe and parts of Africa, alongside recent outbreaks of HIV linked to injecting [1, 39–41]. Despite positive findings, legislative and political barriers continue to restrict the implementation of innovations in harm reduction in the UK and elsewhere, including the USA [13, 42–44].

Our evaluation provides the first UK evidence that SIPP is a feasible, effective intervention that reduces high-risk crack use practices and supports engagement with services, with clear relevance to international harm reduction approaches. Despite these findings, legislative barriers continue to restrict implementation. The wider provision of safer inhalation equipment should be considered a core part of evidence-based strategies to reduce drug-related harms, including overdose risk.

AUTHOR CONTRIBUTIONS

Lucy Platt: Conceptualization; investigation; funding acquisition; writing—original draft; methodology; writing—review and editing; supervision; formal analysis; validation; data curation. **Caitlynne McGaff:** Data curation; investigation; writing—review and editing; formal analysis; project administration; supervision; software. **Sujit D. Rathod:** Investigation; writing—review and editing; data curation; formal analysis; software; methodology; validation. **Vivian Hope:** Methodology; conceptualization; investigation; funding acquisition; writing—review and editing; supervision; validation. **Casey Sharpe:** Investigation; writing—review and editing. **Mat Southwell:**

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DECLARATION OF INTERESTS

We have no competing interests to declare.

DATA AVAILABILITY STATEMENT

The data sets generated and/or analysed during the current study are not currently publicly available because the study is being finalised and the data set is being prepared for archiving. The data will be available from the corresponding author, upon reasonable request.

CLINICAL TRIAL REGISTRATION

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