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Factors associated with skin and soft tissue infections among people who inject drugs in the United Kingdom: A comparative examination of data from two surveys

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ABSTRACT

Background: People who inject drugs (PWID) are at high risk of injection-related skin and soft tissue infections (SSTI). If not treated promptly, these can lead to serious health complications, which are a considerable healthcare burden. Data from two community surveys, with different approaches, were used to assess SSTI prevalence and associated factors among PWID to inform intervention implementation.

Methods: Data were analysed from two surveys, a national surveillance survey (n = 2,874; 2017–18) of infections among PWID in the United Kingdom (UK) and an in-depth survey (n = 455; 2018–19) of SSTI among PWID based in London, UK. Multivariable logistic regression models were constructed to ascertain the factors associated with self-reported SSTI.

Results: High prevalence of SSTI were reported in both samples: 52 % of participants from the national surveillance survey reported having SSTI within the preceding 12 months and 65 % of the London sample reported a lifetime history of SSTI. The factors associated with SSTI in both surveys were similar, including older age; number of years injecting; number of attempts required to inject into the vein; injecting into the hands, feet, groin or neck and re-using or sharing needles/syringes.

Conclusions: The number of PWID reporting SSTI in the UK is concerningly high. The two surveys used different recruitment approaches but found similar associations. We provide strong evidence of a relationship between venous access difficulty and SSTI. To stem the increase of SSTI and related complications in the UK, it is crucial that interventions attend to the underlying causes of venous damage among PWID.

1. Introduction

People who inject drugs (PWID) constitute an extremely vulnerable population with high levels of morbidity and premature mortality. Skin and soft tissue infections (SSTI) disproportionally affect PWID with global lifetime prevalence estimates ranging from 6% in Australia, through 27% in the USA to 69% in Ireland (Larney et al., 2017; Maloney, 2010; Salmon, 2009). They are also a common factor leading to hospitalisation, for example, a study found SSTI accounted for 64% of infections among PWID admitted to a hospital in Miami, USA (Tookes et al., 2015). Despite the high global prevalence of SSTI, public health policy and associated harm reduction interventions for PWID have largely focused on preventing overdoses, and on the prevention and treatment of blood borne viruses (Boucher et al., 2017), with elimination targets in place for viral hepatitis and HIV (UNAIDS, 2017; World Health Organisation, 2016). The development of associated prevention and treatment interventions have been comparatively neglected.

Bacterial SSTI in PWID have been increasing in the UK since 2012/13, with yearly increases in hospital admission data reported, especially in those aged 45–55 years old (18 % increase in admissions per year) (Lewer et al., 2017). Laboratory surveillance of methicillin-sensitive and methicillin-resistant *Staphylococcus aureus* (MSSA/MRSA) and Group A streptococci (GAS), common bacteria found in SSTI, has also shown a spike in infections (Public Health England, 2019a). Several outbreaks of GAS and MRSA have been reported in England, with a

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large number of cases reported in prisons, among the street homeless and/or PWID (Bundle et al., 2017; Kwiatkowska et al., 2018; Packer et al., 2019; Public Health England, 2019a). The cause of the recent increase in SSTI is not clear but is likely to be multifactorial, with possible factors including an aging cohort of PWID, the impact of austerity on services, increased homelessness, and changes in drug use (Harris et al., 2020; Public Health England, 2019a)

Bacterial SSTI in PWID are most commonly found on the arms, legs, buttocks or groin, corresponding to common drug injection sites (Hope et al., 2008). SSTI are often characterised by the presence of pus (specific to abscesses) or tenderness, swelling and redness (cellulitis). In addition, poor vein health as a consequence of injecting drug use can lead to chronic ulceration, particularly on the legs, which significantly impact on PWID mobility and quality of life (Hope, 2010). PWID experience multiple barriers to care access, such as lack of material resources, reluctance to disclose drug use, competing priorities and stigma (Miller Lloyd et al., 2020; Neale et al., 2008), with many self-treating their infections and/or delaying treatment seeking (Gilbert et al., 2019; Roose, 2009). This can result in increased disease severity and prolonged inpatient hospitalisation (Gilbert et al., 2019). Complications associated with chronic or severe SSTI include septic arthritis, septicaemia, osteomyelitis, endocarditis and AA amyloidosis (del Giudice, 2004; Harris et al., 2018). High levels of hospital admissions as a result of SSTI complications place an unnecessary burden on health care services; estimates of costs to the NHS are in the region of £77 million per annum (Marks et al., 2013).

Given the significant and increasing personal and healthcare burden of injecting-related SSTI, there is urgent need to develop acceptable, accessible and effective preventative interventions. Understanding the factors associated with SSTI among PWID in the UK is crucial to inform understanding of the rise in infections and implement effective interventions. Factors associated with SSTI are geographically variable, given geographical differences in drug form, type, preparation and administration practices (Ciccarone et al., 2016; Ciccarone and Harris, 2015; Public Health England, 2019b). Although previous studies have examined the risks and associations with SSTI, using a range of time frames and measures, none have compared data from surveys which, when analysed together, provide both wide geographical coverage and in-depth examination of SSTI. In this analysis we combine data from two separate studies; one an in-depth survey exploring injecting practices and other factors associated with SSTI among PWID in London and the other, a larger bio-behavioural surveillance study of infections and harms among PWID across England, Wales and Northern Ireland. Our analysis was undertaken primarily to assess the generalisability of the in-depth survey findings to the wider population of PWID, but also to explore the similarities and differences in the factors associated with SSTI among PWID when their occurrence is measured over different times frames (lifetime and recently) so as to improve our understanding of the key associations. Considering the multiple recent outbreaks of SSTI in PWID mentioned above, our integrated analysis of both datasets is timely; facilitating an in-depth exploration of factors associated with SSTI and their prevalence to inform implementation of population-specific interventions.

2. Materials & methods

2.1. Study sample recruitment and eligibility

Anonymised data from two distinct surveys were used; 1) The Unlinked Anonymous Monitoring (UAM) Survey of PWID and 2) The Care and Prevent Study ('Promoting skin and soft tissue infection care and preventing AA amyloidosis renal failure among people who inject drugs in the United Kingdom: a mixed-methods multi-phase study'). Methodological details for both have been previously published (Harris et al., 2018; Hope et al., 2014a; Public Health England, 2019c).

The UAM survey recruits PWID through a reflective sentinel sample of specialist services for PWID, such as needle/syringe programmes or addiction treatment centres (these services are widely provided throughout the UK), throughout England, Wales and Northern Ireland. Service users aged 18 and older, who have ever injected drugs, are eligible to participate annually in this surveillance study and those who agree to take part are offered an acknowledgement as well as a £4 voucher in compensation (£5 within London). Participants provide a dried-blood spot sample, which is tested for antibodies against HIV, hepatitis B and hepatitis C (HCV), and for HCV RNA, and self-complete a short questionnaire which includes a single question on the symptoms of an SSTI (a swelling containing pus (abscess), sore or open wound) at an injecting site in the previous year. The UAM survey has approval from Public Health England and the London Research Ethics Committee (98/2/051). Analysis was limited to data from the 2017 and 2018 surveys for respondents who reported injecting during the past year and who had answered questions on SSTI symptoms (n = 2,874). Those who had not injected in the past year, and those who took part in 2018 who had already participated in the survey in 2017 were excluded (i.e. duplicates were excluded by only including the first participation in the two-year period, with repeats identified through reported year of last participation).

Survey data from the Care and Prevent (C&P) Study, which recruited participants from drug treatment centres, homeless hostels and outreach services across London, were used. People were eligible to participate in the survey if they had ever injected psychoactive drugs, were aged 18 and over, and were assessed as able to provide informed consent. Those who agreed to participate completed a detailed researcher-administered, computer-assisted survey focused on SSTI and provided a urine sample for proteinuria urinalysis. Ethical approvals were obtained from the London Bridge Research Ethics Committee [17/LO/0872] and the LSHTM Observational Research Ethics Committee [12021]. Survey participants received a £10 voucher as reimbursement for their time. In total, 455 PWID completed the survey between October 2017 and March 2019. Participants were asked to identify if they had ever had a SSTI and were provided with photographs of mild, moderate and severe abscesses, cellulitis and leg ulcers to aid their recall, ensure correct SSTI identification and provide a comparative measure to assess SSTI severity. In addition, participants were asked to self-report whether they had ever been diagnosed with HCV. Both surveys collected similar or identical data on drug-use, injecting practices, sociodemographic characteristics and healthcare use. As the C&P survey asked about lifetime prevalence of SSTI, data analysis was not restricted to those who reported injecting in the previous year and included the entire sample of PWID.

The possibility of someone participating in both studies is very low due to very limited overlap in the locations used for recruitment recruited. The majority (87 %) of UAM survey recruitment sites were located outside of London, whereas all C&P recruitment sites were located in London. Although both surveys recruited participants in London, recruitment sites were focused in different areas and utilised different services.

2.2. Analytical methods

Demographic and background characteristics of both samples were compared using descriptive statistics. Both univariable and multivariable logistic regression models were used to investigate the crude and adjusted associations of demographic variables and factors associated with SSTI, respectively. We present estimates of odds ratios (OR), 95 % confidence intervals and tests of significance for each variable of interest. Multivariable regression models were built using a manual forward stepwise selection process to build separate models for each dataset to identify the factors associated with reporting SSTI. As opposed to a single combined model, two separate models were built to allow for flexibility and variability of different correlates in each dataset. Shortlisting for inclusion in the multivariable models was

dependent on where there was evidence of an independent association with the outcome (LRT p-value ≤0.05 in the UAM survey and ≤0.1 in the C&P survey) and/or a suggested confounding effect from the minimally adjusted models. Since a test for confounding does not exist, an arbitrary ≥10 % difference in adjusted ORs was used as the definition of confounding in these analyses. All shortlisted variables were iteratively inserted into the a priori model (which included age, and gender). Following insertion, each variable's impact on the crude OR of all other factors already built into the model was assessed to identify confounding. Likelihood Ratio Tests (LRTs) were also performed to assess the variable's contribution to the model as an independent risk factor. At each forward step, retention in the model was dependent on the factor having the largest confounding effect or strongest evidence of being an independent risk factor. Assessment for multicollinearity in both models was performed through the comparison of the standard errors (SEs) of coefficients on the log scale to those of the unadjusted models. Variables which showed an increase of > 10 % were further investigated and individually removed to assess the nature of collinearity. Provided there was no a priori reason for its inclusion, identified collinearity between pairs was controlled for by removing the variables with the least confounding effect and the greatest change in SE from the model.

3. Results

The characteristics of both samples were broadly similar. Both populations were skewed with respect to age, with 68 % and 57 % of participants aged 35 years or more in the UAM survey and the C&P survey, respectively, and more than two-thirds of participants identified as male in both studies (71 % in UAM and 75 % in C&P). Homelessness was common in both samples, with 78 % of the C&P study sample reporting a history of street homelessness and 50 % of participants from the UAM survey reporting homelessness (both street and hostels) in the past year. Testing of DBS samples collected in the UAM survey found 27 % had previously been infected with HCV (antibody positive and RNA negative) and 29 % were currently infected with HCV (antibody and RNA positive). Higher prevalence of HIV was found in UAM participants recruited in London (6.4 %) than in the overall sample (1.3 %). In C&P, 54 % of participants self-reported a previous HCV diagnosis and 5.7 % reported a HIV diagnosis, corresponding to higher HIV prevalence in London found in UAM participants.

SSTI prevalence was high in both samples; 52 % of UAM participants reported having a SSTI symptom in the previous year and 65 % of C&P participants reported an SSTI during their lifetime. In relation to the photographs provided, 33 % of the C&P participants described their worst SSTI as mild, 41 % as moderate and 26 % as severe. In both studies, SSTI were least often reported in those who had been injecting for less than one year (29 % and 28 % in UAM and C&P, respectively), and they were most commonly reported among those who had made four or more attempts (needle insertions) to achieve a successful injection (66 % for UAM, 85 % for C&P).

Univariable analyses uncovered similar factors associated with SSTI in both surveys. Participants who were aged 35+ years; had a current or previous HCV infection; reported injecting for three or more years; injected heroin or heroin and crack cocaine in combination; injected into their hands, feet, neck, groin or other body sites other than their arms or legs; and made more than one attempt at achieving an injection (UAM: last injection, C&P: typical injection), had increased odds of reporting SSTI (Tables 1 and 2).

Following adjustment for potential confounding, we found the following factors were associated with increased odds of reporting SSTI or symptoms of SSTI in both samples: older age; injecting for three or more years; injecting into the hands, feet, neck, groin or other body sites other than their arms or legs; and making more than one attempt at achieving an injection. Sharing of needle/syringes was associated in UAM and reuse of needle/syringes in the C&P; these practices have

Table 1
Distribution of associated factors and Crude Odds Ratios for SSTIs: UAM Survey, England, Wales and Northern Ireland, 2017–2018.

Variables of Interest	N	SSTIs in past year (%)	OR	95 % CI	P-value
Total	2,874	1,486 (52)	–	–	–
Demographics & General Health					
Age					
< 25	89	32 (36)	Ref.	–	
25 – 34	809	412 (51)	1.9	1.2 – 2.9	0.008
35+	1,946	1,020 (52)	2.0	1.3 – 3.1	
Gender					
Male	2,046	1,018 (50)	Ref.	–	0.001
Female	818	461 (56)	1.3	1.1 – 1.5	
Born in United Kingdom					
Yes	2,667	1,379 (52)	1.2	0.8 – 1.6	0.38
No	172	83 (48)	Ref.	–	
Hepatitis C Test Result					
Negative (antibody negative)	1,182	551 (47)	Ref.	–	< 0.001
Current Infection (antibody and RNA positive)	826	473 (57)	1.5	1.3 – 1.8	
Past Infection (antibody positive, RNA negative)	788	427 (54)	1.4	1.1 – 1.6	
Not tested/insufficient sample	78	35 (45)	0.9	0.6 – 1.5	
HIV Test Result					
Negative	2,837	1,465 (52)	Ref.	–	0.64
Positive	36	20 (56)	1.2	0.6 – 2.3	
Overdosed in past year					
No		1,092 (49)	Ref.	–	< 0.001
Yes	531	319 (60)	1.6	1.3 – 1.9	
Taken Part in Transactional Sex					
Never		694 (47)	Ref.	–	< 0.001
Yes, but not in past year	150	84 (56)	1.4	1.0 – 2.0	
Yes, in past year	147	101 (68)	2.5	1.7 – 3.6	
Homeless (Street or Hostels)					
No	584	280 (47)	Ref.	–	0.17
Yes, but not in past year	833	431 (52)	1.2	0.9 – 1.4	
Yes, in past year	1,410	741 (53)	1.2	1.0 – 1.1	
Ever Imprisoned					
No	880	418 (48)	Ref.	–	0.01
Yes	1,929	1,017 (52)	1.2	1.1 – 1.5	
Drug Injection and Preparation					
Years injecting					
< 1 year	85	25 (29)	Ref.	–	< 0.001
1 – 3 years	188	80 (43)	1.8	1.0 – 3.1	
3+	2,506	1,316 (53)	2.7	1.7 – 4.3	
Main drug Injected in past year					
Opiates, Cocaine, Crack and Combinations	1,980	1,053 (53)	2.0	1.3 – 3.0	< 0.001
Amphetamine-like drugs	98	36 (37)	Ref.	–	
Shared spoons for mixing in past month					
No	1,581	791 (50)	Ref.	–	< 0.001
Yes	626	382 (61)	1.6	1.3 – 1.9	
Shared filters in past month					
No	1,624	814 (50)	Ref.	–	< 0.001
Yes	588	366 (62)	1.6	1.4 – 2.0	
Injecting Frequency, Sites and Hygiene					
Days injecting in past month					
0 – 4 days	595	288 (48)	Ref.	–	0.053
5 – 9 days	291	161 (55)	1.3	1 – 1.8	
10 – 20 days	359	190 (53)	1.2	0.9 – 1.6	
20+ days	907	502 (55)	1.3	1.1 – 1.6	

(*continued on next page*)

Table 1 (*continued*)

Variables of Interest	N	SSTIs in past year (%)	OR	95 % CI	P-value
Body Sites injected in past month					
Arms or Legs only	783	367 (47)	Ref.	–	< 0.001
Hands or Feet	447	247 (55)	1.4	1.1 – 1.8	
Groin, Neck or Other	989	569 (58)	1.5	1.3 – 1.9	
Typical Number of attempts to achieve last injection					
1	1,157	438 (38)	Ref.	–	< 0.001
2	623	341 (55)	2.0	1.6 – 2.4	
3	395	255 (65)	3.0	2.4 – 3.8	
4+	623	408 (66)	3.1	2.5 – 3.8	
Shared Syringes in past year					
No	1,873	767 (41)	Ref.	–	< 0.001
Yes	429	255 (59)	2.1	1.7 – 2.6	

Abbreviations: N = number of individuals; OR = odds ratio; CI = confidence interval; Ref = reference group.

Note: Those who reported injecting into their hands or feet could also have injected into their arms or legs and those who reported injecting into their groin or neck, could also have injected into their hands, feet, arms or legs.

been shown to be closely associated (Hope et al., 2014b) and these two measures of equipment reuse both reflect constrained access to sterile needles and syringes. Additional variables were also associated with increased SSTI but were not common to both samples; i.e. having overdosed in the past year; increased number of days injecting in the past month; and receiving income through social welfare, or illicit activities (Table 3). Two variables common to both were associated in one survey but not the other. Main drug injected in past year was associated with SSTI in the UAM, but not significant in C&P, probably due to the lower power of the C&P study. The other was HCV status which was associated in C&P but not the UAM. This is likely to relate to this variable being measured differently, using self-reports of HCV diagnosis in C&P and laboratory assessment in UAM. There was no evidence of multicollinearity found during our analyses.

4. Discussion

Both samples found high prevalence of self-reported SSTI with commonalities in associated factors that indicate that SSTIs are related with venous access issues as well as hygiene. Lifetime prevalence estimates of SSTI from the C&P study (65 %) were higher than those in Australia (27 %) and Mexico (46 %) (Buchanan, 2006; Topp, 2008), but similar to the levels reported in the USA (68 %) and Ireland (69 %) (Biswanger, 2000; Maloney, 2010). UAM reported prevalence of SSTI in the previous year (52 %) was higher than comparable studies, with 37 % the highest reported (to our knowledge) in a sample of 864 PWID from the California, USA (Fink et al., 2013). Multivariable analyses illustrate common associations with SSTI in both surveys: older age; number of years injecting; injecting into the neck and/or groin; making more than one attempt to achieve an injection. And markers of constrained needle and syringe supply (i.e. sharing or reuse).

The association with markers of constrained needle and syringe supply, that is sharing in UAM Survey and reuse in C&P, highlights the need to improve the provision of needle and syringe programmes (NSPs) in the UK. New sterile injection equipment, and access to other materials such as clean water and swabs, are key to maintain hygienic injection practice, and so to reduce incidence of SSTI (Harris et al., 2020). While NSPs are widely provided throughout the UK, their provision over the last decade has been impacted by austerity with this increasingly focused on community pharmacies with fewer specialist services (Britsh Medical Association, 2018; Local Government Association, 2018). Our data indicates coverage is currently insufficient, and there is also probably inequity in access (Public Health

Table 2
Distribution of associated factors and Crude Odds Ratios for SSTIs: Care and Prevent Study, London, 2018–2019.

Variables of Interest	N	Ever SSTIs (%)	OR	95 % CI	P-value
Total	455	296 (65.0)	–	–	–
Demographics & Sexual Health/Behaviour					
Age					
< 25	58	26 (45)	Ref.	–	< 0.001
25 – 34	155	82 (60)	2.1	1.1 – 3.8 1.7-	
35 +	242	188 (72)	3.1	5.6	
Gender					
Male	341	220 (65)	Ref.	–	0.68
Female	114	76 (67)	1.1	0.7 – 1.7	
Ethnicity					
White/White British	336	226 (67)	1.5	0.9 – 2.4	0.12
Black/Asian/Mixed/Other	89	52 (58)	Ref.	–	
Diagnosed Hepatitis C					
Yes	244	191 (78)	3.6	2.4 – 5.5	< 0.001
No	211	105 (50)	Ref.	–	
Diagnosed HIV					
Yes	26	15 (57.7)	0.7	0.3 – 1.6	0.42
No	429	281 (65.5)	Ref.	–	
Ever Street Homeless					
Yes	355	234 (66)	1.2	0.8 – 1.9	0.47
No	100	62 (62)	Ref.	–	
Main Income Source					
Regular/Temporary Job/ Family Support	44	22 (50)	Ref.	–	0.03
Social Welfare/Illicit Activities/Other	386	257 (67)	2.0	1.1 – 3.7	
Drug Injection and Preparation					
Years injecting					
One year or less	57	16 (28)	Ref.	–	< 0.001
2 – 4 years	70	33 (47)	2.3	1.1 – 4.8	
4 + years	328	247 (75)	7.8	4.2 – 14	
Main Drugs Injected in past year					
Opiates, Cocaine, Crack and Combinations	266	184 (69)	2.5	0.9 – 6.8	0.07
Amphetamine-like drugs	17	8 (47)	Ref.	–	
Ever Re-use Filters					
No, Never/Yes, Occasionally	346	221 (64)	Ref.	–	0.01
Yes, Often	89	70 (79)	2.1	1.2 – 3.6	
Main Dissolvent in past year					
Citric Acid	237	162 (68)	1.0	0.5 – 2.0	0.98
Other	44	30 (68)	Ref.	–	
Injecting Frequency, Sites and Hygiene					
Typical Injecting Frequency					
Once per week	57	25 (44)	Ref.	–	< 0.001
2–7 times per week	125	78 (62)	2.1	1.1 – 4.0	
> once a day	273	193 (71)	3.1	1.7 – 5.5	
Most common Body Site Injected in past year					
Arms or Legs	88	17 (19)	Ref.	–	< 0.001
Hands or Feet	115	77 (67)	8.5	4.4 – 16	
Neck, Groin or Other	252	202 (80)	16	9.1 – 31	
Typical Number of attempts to achieve typical injection					
1	202	101 (50)	Ref.	–	< 0.001
2	82	57 (70)	2.3	1.3 – 3.9	
3	58	42 (72)	2.6	1.4 – 5.0	
4 +	108	92 (85)	5.8	3.2 – 10	
Typical injection-type					

(*continued on next page*)

Table 2 (*continued*)

Variables of Interest	N	Ever SSTIs (%)	OR	95 % CI	P-value
Venous	438	284 (64)	Ref.	–	0.62
Intramuscular/Subcutaneous	17	12 (71)	1.3	0.5 – 3.8	
Typically Wash Hands Before Injecting					
Never/Sometimes	321	213 (66)	1.2	0.8 – 1.8	0.37
Always	134	83 (62)	Ref.	–	
Typically Wipe Skin with Alcohol before Injecting					
Never/Sometimes	248	168 (67)	1.3	0.9 – 1.9	0.19
Always	207	128 (62)	Ref.	–	
Ever Reuse Needles/Syringes					
Always	149	40 (78)	4.1	2.0 – 8.6	< 0.001
Sometimes	255	186 (73)	3.0	2.0 – 4.7	
Never	51	70 (47)	Ref.	–	

Abbreviations: N = number of individuals; OR = odds ratio; CI = confidence interval; Ref = reference group.

England, 2019d); NSP provision urgently needs to be improved.

Age and length of time injecting are highly correlated with each other (Dwyer et al., 2009; Fink et al., 2013; Hope et al., 2008; Tempalski et al., 2013). The association of SSTI occurrence with age is therefore likely to reflect the impact of long-term injecting and in particular, the hardening/narrowing of veins (venous sclerosis), which often occurs after injecting for many years (Maliphant and Scott, 2005). Difficulty injecting into sclerotic veins can lead to unintentional subcutaneous injection (or 'missed hits') (Rhodes et al., 2007) and require an increased number of attempts to achieve an injection. Difficulty accessing peripheral veins also precipitates transitions to more risky injection sites, such as the femoral vein in the groin or the jugular vein in the neck (Ciccarone and Harris, 2015; Darke et al., 2001). In both samples, a high proportion of participants reported injecting into the femoral or jugular vein in the past year (UAM: 45 %; C&P: 55 %) and making four or more attempts before achieving an injection (UAM; 22 %, C&P: 24 %). As reported in previous studies, our analysis produced strong multivariable associations between SSTI, multiple injection attempts and injecting in the femoral or jugular vein (Harris and Rhodes, 2012; Hope et al., 2017). It is also possible that there is an element of reverse causality at play, as transitioning to these other body sites and higher numbers of missed injections may be a result of SSTI already present in the arms or legs.

In both samples, and in accordance with the literature, women more often reported an SSTI than men, however, due to limited power, the association was not significant in the C&P sample and was thus not listed as an association found in both surveys (Fink et al., 2013; Hope et al., 2008; Lloyd-Smith et al., 2005; Spijkerman et al., 1996). Increased susceptibility to risk is likely due to an interplay of physical and social factors. Women may experience loss of peripheral venous viability earlier in their injecting trajectory than men, due to a finer venous structure (Huxley, 2007). Difficult venous access, as previously stated, can precipitate unintentional and intentional subcutaneous injection as well as transitions to deeper veins, such as the jugular and femoral veins, injection into which carries a greater infection risk (Lloyd-Smith, 2009; Topp, 2008). Women are particularly vulnerable to adverse consequences of identification as a person who injects drugs (such as loss of children, family support and/or sex-work income) and may transition early to injecting into less visible sites such as the groin (Harris and Rhodes, 2013). Gendered power dynamics can exacerbate risk of unsafe injecting, with women more likely than men to have limited control over drug purchase, injection equipment supply, drug injection preparation or administration (Hope et al., 2010; Morris et al., 2018). This can increase the likelihood of receiving injecting assistance and using injecting equipment after others (Wood, 2003). Sex work is

Table 3
Adjusted Odds Ratios of associated factors for SSTIs: Both Datasets.

Variables in Multivariable Model	UAM Survey			Care & Prevent Study		
	AOR	(95 % CI)	LRT	AOR	(95 % CI)	LRT
Demographic & Health Variables						
Age						
< 25	Ref.	–	< 0.001	Ref.	–	0.02
25 – 34	3.9	1.7 – 8.9		2.2	1.0 – 5.2	
35 +	4.4	2.0 – 10.0		3.2	1.4 – 7.1	
Gender						0.10
Male	Ref.	–	0.01	Ref.	–	
Female	1.4	1.1 – 1.7		1.4	0.8 – 2.6	
Overdosed in past year						
No	Ref.	–	0.003		Φ	
Yes	1.5	1.2 – 2.0				
Diagnosed Hepatitis C						0.002
No		ϖ		Ref.	–	
Yes				2.2	1.3 – 3.7	
Main Income Source						0.05
Regular Job/ Temporary Work/Family Support		Φ		Ref.	–	
Social Welfare/ Other/Illicit Activities				2.2	1.0 – 4.9	
Drug Injection and Preparation Variables						
Years injecting						
< 1 year	Ref.	–	0.004	Ref.	–	0.10
1 – 3 years	2.0	0.8 – 4.8		1.5	0.6 – 3.7	
3 +	3.0	1.4 – 6.5		2.2	1.0 – 4.9	
Main Drug Injected in past year						
Amphetamine-like	Ref.	–	0.04		ϖ	
Opiates, Cocaine, Crack and Combinations	1.7	1.1 – 2.8				
Injecting Frequency, Sites and Hygiene Variables						
Main Injection Site on Body in past year						
Arms or Legs	Ref.	–	< 0.001	Ref.	–	< 0.001
Hands or Feet	1.0	0.7 – 1.5		6.2	2.9 – 13	
Neck, Groin or Other	1.6	1.2 – 2.3		10	4.9 – 20	
Typical Number of attempts to achieve injection						
1	Ref.	–	< 0.001	Ref.	–	0.04
2	2.6	2.0 – 3.5		2.4	1.2 – 4.8	
3	3.7	2.7 – 5.2		1.7	0.8 – 3.7	
4 +	3.8	2.8 – 5.1		2.5	1.3 – 5.0	
Days injecting in past month						
0 – 5 days	Ref.	–	0.06		Φ	
6 – 10 days	1.4	1.0 – 2.0				
11 – 20 days	1.3	0.9 – 1.8				
20 + days	1.5	1.1 – 2.0				
Shared Needles/Syringes in past year						
No	Ref.	–	< 0.001		Φ	
Yes	1.7	1.3 – 2.3				
Reuse Needles/Syringes						
Never		Φ		Ref.	–	0.03
Sometimes/Always				2.1	1.2 – 3.7	

Φ Variable was not asked in the survey. **ϖ** Variable was asked but was not significant in the final model. **Abbreviations:** N = number of individuals; AOR = adjusted odds ratio; CI = confidence interval; LRT = likelihood ratio test p value; Ref = reference group. **Note**: In the UAM study, questions based on practices in the past month included a level with those who did not inject in the past month in order to retain the full set of observations for multivariable analysis.

more likely to be a viable income-generation avenue for women who inject drugs. Sex work among women is associated with more frequent injecting, and therefore SSTI risk (Kerr et al., 2016). However, as sex work may be undertaken to financially support high levels of injecting (Morris et al., 2018) it is spurious to imply a causal link.

The majority of participants in both samples report injecting heroin or a heroin/crack cocaine combination. Amphetamine or sole injection of powder cocaine was relatively rare. Preparation of heroin and/or crack cocaine for injection in the UK, requires use of an acidifier with water to render these base drugs into an injectable solution. The C&P study has previously shown that overuse of an acidifier for injection was common, with 30 % using a whole sachet of acid or more (Harris et al., 2019). There is a likely causal pathway between acidifier overuse and venous damage, which in turn precipitates SSTI risk (Ciccarone and Harris, 2015; Harris et al., 2019). Amphetamine-like drugs, with limited SSTI risk, are water-soluble and do not need to be prepared using an acid (Ciccarone, 2011).

The substantial similarity of the associations with factors related to venous damage in both samples, such as numerous repeat injection attempts, reinforced the significance of these factors in influencing SSTI development and the need for interventions addressing venous health (Harris et al., 2019). High comparability of associations in both samples strengthen their generalizability across the UK and so our confidence in understanding the factors associated with SSTI that impact PWID.

The association between SSTI and repeat injection attempts – something that may be easy for services to ask about – suggests a possible avenue for identification of those with vascular access problems and/or poor injection technique for the offer of interventions. Interventions offered should address, besides general injection hygiene, the importance of vein health and include advice to improve this, e.g. to reduce acid use, rotate injection sites, and recommendations to reduce the number of injection attempts.

4.1. Limitations

Although the sample size of the UAM Survey was larger than C&P, both were adequately powered. However, the smaller C&P study sample and the differences in a number of the questions asked prevented a combined analysis approach. Both data sources may be subject to reporting bias as self- reports of SSTI symptoms were used, although this was minimised in the C&P study, which used photos of typical symptoms in the survey. However, previous studies have indicated that self- reporting of SSTI is a reliable method to establish prevalence (Morrison et al., 1997). As we used data from cross-sectional studies, we were not able to investigate temporal relationships between factors associated with and SSTI and indeed we could not eliminate the possibility of reverse causality. Systemic differences in questions asked between surveys limited interpretation and thus require caution when being compared. Finally, we cannot exclude the possibility of participant duplication between both studies, although, as addressed in the methods, this is unlikely.

4.2. Conclusion

The results of this study highlight a high prevalence of SSTI amongst PWID in the UK. Injecting- related SSTI are largely preventable, yet are a significant burden, both in terms of the suffering experienced by PWID and economic and health system costs. Together, our two datasets provide strong evidence of an association between difficulties with venous access and SSTI occurrence and reiterate the importance of providing easy access to the materials needed for hygienic injection. A high proportion of respondents in both samples required multiple attempts to achieve an injection and transitions to injecting in deep veins, such as the femoral, were also common. There is a clear need to attend to the underlying causes of venous damage among PWID in the UK. As detailed elsewhere (Harris et al., 2019) overuse of acidifiers is a potentially modifiable risk factor. Asking about repeat injection attempts may be an easy to use approach for health services to identify those with vascular access problems and/or poor injection technique and so offer targeted interventions. Interventions should address, besides general injection hygiene, the importance of vein health, including advice on how to improve this.

Author contribution

The study was conceived by MH, VH and EH. UAM data collection tools were developed by VH and MH. UAM data collection was overseen by EH, CE and KS. UAM data management and cleaning was conducted by EH and CE. C&P data collection tools were developed by MH. C&P data collection was overseen by MH and TW. Data analysis for both surveys was conducted by JD, with input from EH, TW, MH and VH. The paper was drafted by JD with substantial input from MH, EH and VH. All authors read and commented on the final manuscript.

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Declaration of Competing Interest

No conflict declared.

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Appendix A. Supplementary data

Supplementary material related to this article can be found, in the online version, at doi:https://doi.org/10.1016/j.drugalcdep.2020.108080.

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