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Hepatitis C among Vulnerable Populations: A Seroprevalence Study of Homeless, People Who Inject Drugs and Prisoners in London

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Abstract

Injecting drugs substantially increases the risk of hepatitis C virus (HCV) infection and is common in the homeless and prisoners. Capturing accurate data on disease prevalence within these groups is challenging but is essential to inform strategies to reduce HCV transmission. The aim of this study was to estimate the prevalence of HCV in these populations. We conducted a cross-sectional study between May 2011 and June 2013 in London and, using convenience sampling, recruited participants from hostels for the homeless, drug treatment services and a prison. A questionnaire was administered and blood samples were tested for hepatitis C. We recruited 491 individuals who were homeless (40.7%), 205 drug users (17%), and 511 prisoners (42.3%). Eight percent of patients (98/1207, 95% CI: 6.7%-9.8%) had active HCV infection and 3% (38/1207, 95% CI: 2.3%-4.3%) past HCV infection. Overall, one quarter (51/205) of people recruited in drug treatment services, 13% (65/491) of people from homeless residential sites and 4% (20/511) prisoners in this study were anti-HCV

positive. 77 of the 136 (56.6%, 95% CI: 47.9%-65%) of HCV infected participants identified had a history of all three risk factors (homelessness, imprisonment and drug use), 27.3% (95% CI: 20.1%-35.6%) had 2 overlapping risk factors, and 15.4% (95% CI: 10.6%-23.7%) one risk factor. Drug treatment services, prisons and homelessness services provide good opportunities for identifying hepatitis C infected individuals. Effective models need to be developed to ensure case identification in these settings that can lead to effective treatment and efficient HCV prevention.

Keywords: hepatitis C, drug users, prisoner, homeless, vulnerable

Introduction

Since the discovery of Hepatitis C Virus (HCV) in 1989, the virus has become recognised as the leading cause worldwide of chronic liver disease. Although data on prevalence of HCV in many countries are still not available, the most recent estimate from WHO (World Health Organization) is 1%, representing about 71 million people infected (1). Worldwide, 1.34 million deaths were caused by viral hepatitis (1).

In high income countries, the burden of hepatitis C is mainly within marginalised populations such as People Who Inject Drugs (PWID), people who are homeless and prisoners – though it can be difficult to accurately assess disease prevalence. Several studies have estimated the prevalence of hepatitis C in PWID (2-9), with fewer studies reporting the prevalence of HCV among prisoners (10-13), people who are homeless (14-17), and migrants from countries at high risk of HCV (18). Better estimates, which could support the development of targeted strategies to reduce HCV infection and transmission in these populations, is needed.

A recent national unlinked anonymous survey demonstrated that London had the highest proportion of detectable antibodies to Hepatitis C (anti-HCV prevalence) among PWID (5). The city also had the most laboratory reports of hepatitis C infection nationally (19). Further, it has been identified as having the greatest number and proportion of homeless in England - with one in 25 lacking a permanent home (20). This emphasises the need for further epidemiological work to characterise the burden of disease among marginalised populations in London.

The recent introduction of DAA (Direct-Acting Antiviral) treatment provides the opportunity to substantially reduce the global burden of hepatitis C. These drugs combine high rates of clinical effectiveness with few treatment side-effects - increasing their tolerability. This is of particular importance in vulnerable patients such as PWIDs, the homeless and prisoners, who may be unable to tolerate long-term treatment with the older drugs such as interferon-based therapy (21-23).

In this study we sought to estimate the prevalence of, and risk factors for, HCV infection in individuals susceptible to HCV by virtue of being homeless, in contact with drug treatment services or in prison in London.

Methods & Participants

Study Population

We undertook a cross sectional study between May 2011 and June 2013 in London, United Kingdom. This was part of a previously published study where the primary aim was to determine the prevalence of latent tuberculosis infection, though participants were also tested for blood borne viruses (24). Subjects were recruited from 39 homeless hostels and 20 drug treatment services through the National Health Services Find and Treat (F&T) Service (25) – a specialist outreach team with the main aim of tackling TB in people who are homeless, vulnerable migrants, and drug or alcohol users. The service screens almost 10,000 high-risk people every year, covering every London borough. The homeless hostels and drug treatment services recruited in this study were representative of those within the city.

511 inmates were also recruited from a category B prison (one that does not require maximum security, but with inmates still recognised as being 'high risk' and requiring significant security measures to ensure they do not escape) in London by a separate team (of research staff) employed by the study. The physical geography of the prison meant that we were unable to access and recruit many prisoners to this study who were undergoing drug detoxification, as they were located in a separate prison wing.

Patients were eligible for inclusion in the study if they were aged > 18 years, had the capacity to consent and were identified as homeless (lived in homeless hotel), had a history of drug use (using services from drug treatment centres) or were inmates in the prison at the time of the study. Participants recruited from convenience sample were required to complete and sign

a consent form. A questionnaire was administered by researchers employed by the study to collect demographic information (i.e. age, sex, ethnicity, country of birth), information on previous HCV test results, smoking status and risk behaviours and their duration including: history of imprisonment, homelessness, and drug taking (types of drugs, drug use duration, and needle sharing).

Laboratory Testing

Venous blood samples were taken from participants and tested at the Royal Free Hospital for hepatitis C. Anti-HCV antibody was detected using Vitros chemiluminescence assay (Ortho Clinical Diagnostics). HCV-RNA was detected using PCR Assay or Abbott M2000 Real-Time Hepatitis C assay. When samples were found to be reactive with anti-HCV but negative for HCV-RNA, further confirmation was done using Recombinant Line Immunoassay (INNO-LIA, Innogenetics) or Immuno Blot Assay (RIBA, Chiron). Patients were categorised as currently infected with HCV (had active HCV infection) if they had a positive HCV-RNA and a positive antibody-HCV test. Patients with past infection were identified when they had a negative HCV-RNA and a positive antibody-HCV test. HCV antibody positive infections included those with active and past infections. Ethical approval for this study was obtained from the East of England – Essex National Research Ethics Service Committee (reference number 10/H0302/5).

Samples were also tested for latent tuberculosis infection (LTBI), hepatitis B and HIV. Latent tuberculosis was measured using QuantiFERON-TB Gold gamma interferon release assay (Cellestis, Australia) and defined positive if the TB specific antigen response was >0.35

IU/ml and there was no evidence of active disease on clinical assessment. HIV infection was assessed using the Architect combined HIV antibody/p24 antigen chemiluminescence assay (Abbott Diagnostics). Hepatitis B was detected by the Architect immunoassay (Abbott Diagnostics, Germany). Hepatitis B current infection was defined as HBsAg positive, anti-HBc positive, anti-HBs negative. Hepatitis B past infection was defined as HBsAg negative, anti-HBc positive, anti-HBs positive or anti-HBs negative.

Statistical Analysis

From this study, we assessed the proportion of participants who had HCV active (currently infected) and past infection. A descriptive analysis was conducted to investigate the relationship between HCV status and the following variables: participants' age, sex, ethnicity, history of homelessness and imprisonment, alcohol, drug use, smoking and needle sharing behaviour. We undertook univariate and multivariate logistic regression to identify factors associated with HCV infection and identified if there were any interaction between variables. A forward stepwise method was used to determine the best model for multivariate logistic regression. These analyses produced adjusted odds ratios (OR) and 95% confidence intervals (95% CI) for past or chronic HCV infection for the range of putative risk factors. Venn diagrams were also created to show the proportion of individuals with overlapping risk factors for HCV relating to ever being homeless, using drugs and imprisonment. Data were analysed using Statistical Package for Social Sciences SPSS version 20.0 (SPSS Inc., Chicago, USA) and the proportional Venn diagram was generated by Venn Diagram Plotter (PPNL).

Results

1207 participants were recruited during the study period, including 511/1207 from prison (42.3%), 491/1207 from homeless hostels (40.7%), and 205/1207 from drug treatment centres (17%) (Table 1). More than 90% (1093/1203) of participants were male and over half were aged 30-49 years (614/1204). 19% (228/1204) were aged 50 years or older, with 65.8% (794/1205) being UK-born. Almost three-quarters (885/1207) reported they had been in a UK prison at some point in the past and 60% (693/1157) homeless at least once in their lives. Common behaviours among participants included smoking (980/1207, 81.2%); problem alcohol use (408/1207, 33.8%) and drug use. Almost half reported having either smoked heroin/crack and/or injected drugs in their life time (529/1205, 43.9%).

Overlapping risk factors were common among all three groups. For example, among participants recruited in prison, 173/511 (33.9%) had a history of drug-use and 138/511 (27%) homelessness (Appendix 1). Among those recruited in homeless hostels, 194/491 (39.5%) also had a history of drug use and 263/491 (53.6%) imprisonment. Of the participants recruited in the drug treatment centres, 116/205 (56.6%) had a history of homelessness and 122/205 (59.5%) imprisonment.

HCV Infection

Laboratory testing demonstrated that, 98/1207 participants (8.1%, 95% CI: 6.7%-9.8%) were currently infected with hepatitis C and 38/1155 (3.2%, 95% CI: 2.4%-4.5%) had evidence of hepatitis C past infection. This suggests that (38/136) 28% (95% CI: 20.8%-36.4%) of HCV infected individuals had cleared the virus spontaneously (none had previously been treated

for hepatitis C). Co-infection was common. For example, amongst those with active hepatitis C, 57/98 (58.2%, 95% CI: 47.8%-67.9%) were co-infected with hepatitis B virus, 21/98 (21.4%, 95% CI: 14.0%-31.1%) had LTBI and 3/98 (3.1%, 95% CI: 0.8%-9.3%) had HIV (Figure 1). Hepatitis C co-infection among patients with past infection and HCV antibody positive infection can be seen in Appendix 2.

Overall, 24.9% (51/205) of participants recruited in drug treatment service, 13.2% (65/491) of individuals recruited through hostels and 3.9% (20/511) prisoners were HCV antibody positive (Table 1). In addition, further analysis of overlapping risk factors found that 56.6% (77/136) of antibody positive HCV infected participants had a history of all three of homelessness, drug used and imprisonment (Figure 2), 27.3% (37/136) had 2 of these risk factors and 15.4% (22/136) one risk factor. When we analysed drug use behaviour in the three recruitment sites (homeless residential sites, drug treatment services, and prison), as expected drug treatment services had the highest number of people injecting drugs and sharing needles (14.6%, 29/199), compared to people in homeless shelters (6.0%, 27/448), and prisoners (3.7%, 19/511) (Figure 3).

HCV Risk Factors

Risk factors for HCV Infection

80% (109/136, 95% CI: 72.3% - 86.3%) of participants with evidence of past and current HCV infection reported injecting drug use. The univariate analysis suggested that several factors were associated with increased risk of HCV infection including: age ≥30 years, a history of homelessness, imprisonment outside UK, illicit drug use, duration of injecting,

smoking and alcohol drinking behaviour. Non-white ethnicity (both UK born non-white and non-UK born non-white) decreased the risk of infection (Table 2). In the adjusted analysis, only longer duration of injection drug use (2-9 years, 10 years or greater), being aged more than 30 years, and UK born non-white ethnicity were strongly associated with HCV infection (though in the latter case as a negative association) (Table 2).

Compared to 18-29 year olds, the odds of infection were five-fold greater in participants who were 50 years or older (OR=5.55, 95% CI: 2.25-13.70). Those who were born in UK and non-white were less likely to be infected with HCV (OR=0.38, 95% CI: 0.15-0.99) compared to those who were born in UK and white. The odds of HCV infection were very strongly associated with duration of injecting (OR=12.62, 95% CI: 6.22-25.57 for those who injected drugs less than 1 year, OR=50.04, 95% CI: 24.80-100.95 for those who injected drugs for 2-9 years, and OR=67.34, 95% CI: 32.29-140.46 for those who injected drugs more than 10 years compared to the odds of infection in those who were non-injectors).

Risk factors for HCV Spontaneous Clearance

38/136 participants with evidence of past HCV no longer had detectable HCV RNA (28%). In the univariate analysis, HCV infected individuals who had a history of injecting drugs with sharing needles (OR=0.22, 95% CI: 0.07-0.75) or without sharing needles (OR=0.28, 9%% CI: 0.09-0.87) were less likely to achieve clearance than non-injectors. In the multivariate analysis, only illicit drug use with needle sharing reduced the likelihood of achieving spontaneous viral clearance (OR=0.27, 95% CI: 0.08-0.95).

Risk factors for HCV in those who reported not injecting drugs

As 20% of HCV cases in this study occurred in people who reported not having used drugs, we undertook a separate analysis of risk factors for HCV in those not reporting injecting drugs. Univariate analysis suggested that several factors were associated with HCV infection among non-injectors including: age 30-49 years old (OR=10.35, 95% CI: 1.36-79.11), age >50 years old (OR=20.07, 95% CI: 2.57-156.66), history of imprisonment (OR=0.43, 95% CI: 0.20-0.94), history of homelessness for over a year (OR=2.90, 9%% CI: 1.03-8.12), and alcohol problems (OR=3.59, 95% CI: 1.61-8.01). Multivariate analysis showed that alcohol problems (OR=2.92, 95% CI: 1.24-6.89), age 30-49 years old (OR=8.29, 95% CI: 1.06-64.73), and age more than 50 (OR=13.85, 95% CI: 1.67-114.85) increased the risk of HCV infection among individuals who were not injecting drugs (Table 3).

Discussion

This study confirmed the high prevalence of HCV-antibody positive infection when screening in drug treatment services (25%), homeless services (13%) and prison (4%). The risk in prisoners was likely underestimated due to the exclusion of those located in the detoxification wing of the prison who were difficult to access within this study. There was a very high degree of overlap between these three populations. The risk was driven primarily by injecting drug use. Past or active HCV infection was found in 27% of those injecting less than a year, 56% injecting between one and 10 years and 70% for over 10 years compared to 3% of those who reported never having injected. Nevertheless 20% of past or active HCV infections were in this latter population, and here HCV infection was more likely in older people and those who had alcohol problems, possibly reflecting differential reporting of injecting drug use in these groups.

28% of study participants with HCV antibody no longer had detectable HCV RNA suggesting spontaneous clearance (none had been treated). Clearance was least likely in those who reported needle sharing. This supports the hypothesis that spontaneous clearance rates are low in PWIDs because of reinfection.

The strength of our study is that we were able to recruit vulnerable populations in London by capitalising on a well-established network in large part through the F&T service. The questionnaire we used was piloted with the target population. Furthermore, this study was performed by a team with considerable experience of working with vulnerable populations, which we believe maximised the study sample's representativeness. A major challenge when undertaking studies recruiting hard to reach populations is selection bias. We could only recruit individuals who were in contact with drug treatment services, homeless shelters or prison. The use of this convenience sample, may have affected our estimates of HCV prevalence as people not in contact with services may have a higher burden of undiagnosed HCV. In prison testing was alongside an initiative to screen for active TB using radiography. Since prisoners undergoing drug detoxification were located in another part of the prison (who were unable to access easily the testing facility), our estimates of disease prevalence exclude these higher risk prisoners. Furthermore, we only assessed inmates in one London prison which may not be representative of the 14 prisons in London, despite it being the third largest in the city. Another challenge was the use of self-reported history of homelessness, drugs used, and imprisonment. This approach may be affected by recall bias or reluctance to report these risk factors.

Our study results are susceptible to recruitment bias as 60% of participants reported being homeless at least once in their lifetime, and half of it came from those who were recruited from homeless shelters. Although this could potentially affect our estimates, we also examined other risk factors for each vulnerable population. Missing data were a potential limitation, though given that less of 5% of data were missing, we could adjust for this using pairwise deletion to maximise the data analysis. In addition, information bias might have occurred because the definition of an alcohol problem used in this study was whether participants had ever been concerned about their drinking or had a health worker express concern about their alcohol consumption, thus we could not measure objectively how much alcohol was being consumed or its actual consequences.

Our estimate of the prevalence of HCV among PWID's is comparable to the prevalence estimate reported by Public Health England (approximately 50% in England, 32% in Northern Ireland and 47% in Wales) (26). A multi-centre study published in 2007 reported a wide range of HCV prevalence among PWID across England varying from 27% in Middlesborough, 34% in Exeter, 51% in Reading, 54% in Plymouth, 65% in Bristol, 66% in Central Manchester, to 74% in Greater Manchester, with a total of 1058 participants (27). Possible explanations for the variation in prevalence estimates include differences in how individuals were identified, study population age and injecting behaviour, such as duration (28) and frequency of injection drug-use (29), as well as needle sharing (30) or sharing drug preparation equipment behaviour (31, 32). Despite the wide-range of prevalence estimates, these studies highlight the importance of focusing efforts on PWIDs if we are to reduce the burden of HCV (33). It should be noted though that our study also identified homeless hostels as an important site to screen for HCV as many homeless have a history of injecting drug use, though may not be currently known to drug treatment services.

Our study showed that 13.2% of people who are homeless were infected with HCV. This was similar to work conducted in Oxford in 2002 (26.5%) (34); as well as pooled prevalence estimates from a meta-analysis of 43 studies reported in 2012 (20.3%) (35). Whilst we recruited individuals from homeless hostels where the prevalence of PWID was 17.8%, the Oxford study recruited street homeless who were not in contact with homeless shelters services. These individuals were likely to be even more vulnerable, supported by the fact that more than half of the participants in this study were PWIDs. This again highlights the importance of intersecting risk factors and provision of better services and access to the service in London. The study demonstrates that screening homeless people for HCV is worthwhile, but the fact that none of those identified had been treated shows the need for increased efforts to ensure treatment.

As discussed earlier, our study is likely to have underestimated the prevalence of HCV in prison populations (3.9%) because it largely excluded prisoners undergoing drug detoxification. It was low compared to a study conducted in a Scottish prison where the prevalence was 19% (36) or a cross-sectional study in Dartmoor prison where the prevalence was 12.6% (37). In the Scottish study, 53% of prisoners had injected drugs, whereas in our study only 8.6% of prisoners were PWIDs (36).

Being homeless, PWID and imprisoned may increase vulnerability to infection. For example, Homeless Drug Users (HDUs) have been described as experiencing ‘double jeopardy’ given the large number of life and health issues they encounter (38). Over half of the individuals in our study had a history of homelessness, drug use and imprisonment. A study in South Wales that recruited participants from treatment services, needle and syringe exchange services,

homeless hostels and the streets, showed that being homeless increased the risk of HCV about 4 fold (OR=4.41, 95% CI: 1.6-12.5) (39). Furthermore, work by Vescio, et.al. estimated risk of infection with HCV among inmates who were PWIDs to be 24 times than non-PWID inmates (40).

We found that 50.7% of HCV infected individuals had co-infection with other blood borne viruses (HBV or HIV) - which is likely to be driven by needle sharing behaviour (41). A study performed in two Spanish prisons showed a high prevalence of HCV-HBV co-infection (42.5%) and HIV-HBV-HCV coinfection (37.3%), with mono-infections being less common (overall 13%) (42). Needle sharing is the major risk for HCV co-infection (41); though sexual activity and duration of injection are also associated with HCV-HIV coinfection (43). 6.6% of HCV patients were coinfected with LTBI only (14% had triple infection of HCV and LTBI and HIV/HBV).

Our study suggested injecting drug use with longer duration (2-9 years, 10 years or more) were the strongest risk factors for HCV infection - confirming the well-established link between HCV and (past and ongoing) injection drug use (7, 32, 44, 45). The importance of a longer duration of injecting is supported by Lamden (46) who found that injecting drugs for more than 3 years increased the risk of acquisition of HCV up to 3 fold (47); and also Miller, who reported that injecting drugs for 2-3 years doubled the risk of infection. This increased up to 10 fold if the duration of injection were more than 6 years (7).

Some studies also have investigated the association between age and the risk of infection. Nyamati et.al found age over 40 years (14) increased the HCV risk almost 5 fold. However this compares to Miller's work which suggested that older age increased the risk 1.29 times over background (7).

The specific association between country of birth - ethnicity and HCV infection is not well understood, and may be confounded by other factors such as the prevalence of injecting drug use. In our study, 22% of UK born-white were PWID compared to only 0.1% among UK born non-white group. More studies are needed to better explain the racial differences in HCV infection.

Overall, using a convenience sample of participants in specific settings within London, our study provides evidence of a high burden of HCV among PWIDs and homeless populations, as well as a higher prevalence among prisoners compared to the general population. The high degree of overlap of these populations argues for HCV screening and the need for treatment services to engage with these groups. Our findings also support the requirement for an accessible screening program, intensive case management, preventative interventions, and ongoing support to reach and treat infected individuals in vulnerable population. In addition, treatment with the new highly-effective therapies should be prioritised for these groups, as they have a considerable risk of onward transmission to others (48). The high level of infection emphasises the importance of drug treatment and harm minimisation activities to reduce the danger of injecting in these settings. Outreach services for vulnerable groups such as those provided by the Find & Treat tuberculosis team should also include HCV screening.

This study has highlighted the strong association of injecting drug behaviour and its duration with HCV infection. It is important, therefore, to intervene early to minimise risk of transmission. Given that 20% of hepatitis C infected patients in our study did not report a history of injecting drug use, it seems reasonable to screen in these settings regardless of reported behaviour. The advent of DAAs offers new opportunities to expand treatment but integrated models of screening for blood borne viruses, managing addiction as well as infections need to be developed and evaluated. Future research should focus on how screening, treatment and prevention services can be integrated for vulnerable populations to maximise treatment access and reduce reinfection. The aspiration of eradicating HCV is unlikely to be achieved without such integrated services.

Author's Declaration of Personal Interest:

DNA, RWA, AH, SH, LP, GF, EG, AMG, ML, TMcH declare that they have no relevant conflicts of interest. AS is clinical lead for the Find and Treat service including the mobile digital X-ray unit.

Declaration of Funding Interest:

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Table 1. Characteristics of participants

Characteristics		n	HCV-current infection	%	HCV-past infection	%	Total HCV infection	%
All		1207	98	8.1	38	3.2	136	11.3
Research Sites	Homeless Residential Site	491	51	10.4	14	2.9	65	13.2
	Drug Treatment Service	205	31	15.1	20	9.8	51	24.9
	Prison	511	16	3.1	4	0.8	20	3.9
Sex	Male	1093	86	7.9	32	2.9	118	10.8
	Female	110	11	10.0	6	5.5	17	15.5
Age group	18-29 years	362	8	2.2	2	0.6	10	2.8
	30-49 years	614	66	10.8	26	4.2	92	15.0
	50+ years	228	23	10.1	10	4.4	33	14.5
Country of birth & Ethnicity	UK-white	542	60	11.1	26	4.8	86	15.9
	UK-others	231	11	4.8	1	0.4	12	5.2
	Non UK-white	187	22	11.8	7	3.7	29	15.5
	Non UK-others	199	4	2.0	4	2.0	8	4.0
Have been in UK prison	Yes	885	74	8.4	29	3.3	103	11.6
	No	322	24	7.5	9	2.8	33	10.3
Have been in prison outside UK	Yes	83	12	14.5	4	4.8	16	19.3
	No	1069	70	6.6	31	2.9	101	9.5
Time spent homeless	Never	464	20	4.3	10	2.2	30	6.5
	< 1 year	350	29	8.3	10	2.9	39	11.1
	> 1 year	237	30	12.7	13	5.5	43	18.1
	Yes (unknown duration)	106	3	2.8	3	2.8	6	5.7
Illicit drug use	Neither	676	7	1.0	9	1.3	16	2.4
	Ever smoked heroin/crack only	317	8	2.5	2	0.6	10	3.2
	Inject drugs - no needle sharing	128	47	36.7	17	13.3	64	50.0
	Inject drugs with needle sharing	84	35	41.7	10	11.9	45	53.6
Duration of injecting	Non-injectors	993	15	1.5	11	1.1	26	2.6
	Injecting for <1 year	67	15	22.4	3	4.5	18	26.9
	Injecting for 2-9 years	61	23	37.7	11	18.0	34	55.7
	Injecting for ≥10 years	57	29	50.9	11	19.3	40	70.2
Smoker	Yes	980	93	9.5	35	3.6	128	13.1
	No	227	5	2.2	3	1.3	8	3.5
Has alcohol problem	Yes	408	45	11.0	19	4.7	64	15.7
	No	799	53	6.6	19	2.4	72	9.0

Table 2. Univariate and Multivariate Logistic Regression Risk Factor Analysis of Hepatitis C

Risk Factors		All HCV Infection		HCV Clearance	
		Univariable OR	Multivariable OR	Univariable OR	Multivariable OR
Sex	Female	1		1	
	Male	0.67 (0.398, 1.16)		0.68 (0.23, 2.90)	
Age group	18-29 years	1	1	1	
	30-49 years	**6.20 (3.19, 12.08)**	**3.00 (1.33, 6.76)**	1.58 (0.31, 7.92)	
	50+ years	**5.92 (2.86, 12.28)**	**5.55 (2.25, 13.70)**	1.74 (0.31, 9.69)	
Country of birth & Ethnicity	UK-white	1	1	1	1
	UK-non white	**0.29 (0.16, 0.54)**	**0.38 (0.15, 0.99)**	0.21 (0.03, 1.71)	0.23 (0.03, 1.95)
	Non UK-white	0.97 (0.61, 1.53)	1.78 (0.96, 3.31)	0.73 (0.28, 1.93)	0.80 (0.29, 2.19)
	Non UK-non white	**0.22 (0.11, 0.47)**	0.89 (0.36, 2.19)	2.31 (0.54, 9.94)	1.66 (0.32, 8.56)
Ever been in prison	No	1		1	
	Yes	1.16 (0.77, 1.76)		0.85 (0.33, 2.16)	
Ever been in prison outside UK	No	1		1	
	Yes	**2.31 (1.29, 4.15)**		0.75 (0.23, 2.52)	
Roughsleeping/homeless	Never	1		1	
	< 1 year	**1.81 (1.10, 2.97)**		0.69 (0.24, 1.96)	
	> 1 year	**3.20 (1.95, 5.26)**		0.87 (0.32, 2.36)	
	Unknown Duration	0.86 (0.35, 2.13)		2.00 (0.34, 11.76)	
Illicit drug use	Neither	1		1	1
	Ever smoke heroin/crack only	1.34 (0.60, 2.99)		0.19 (0.03, 1.22)	0.23 (0.04, 1.53)
	Inject drugs - no needle sharing	**41.78 (22.80, 76.56)**		**0.28 (0.09, 0.87)**	0.38 (0.11, 1.27)
	Inject drugs with needle sharing	**48.70 (25.23, 93.99)**		**0.22 (0.07, 0.75)**	**0.27 (0.08, 0.95)**
Duration of injecting	Non-injectors	1	1	1	
	Injecting for <1 year	**13.90 (7.14, 27.10)**	**12.62 (6.22, 25.57)**	0.27 (0.06, 1.18)	
	Injecting for 2-9 years	**48.49 (25.51, 92.16)**	**50.04 (24.80, 100.95)**	0.65 (0.23, 1.88)	
	Injecting for ≥10 years	**87.24 (43.83, 173.63)**	**67.34 (32.29, 140.46)**	0.52 (0.18, 1.47)	
Smoker	No	1		1	
	Yes	**4.12 (1.99, 8.58)**		0.63 (0.14, 2.76)	
Has alcohol problem	No	1		1	
	Yes	**1.88 (1.31, 2.70)**		**1.18 (0.56, 2.49)**	

Table 3. Univariate and Multivariate Logistic Regression Risk Factor Analysis of Hepatitis C among Non-Injecting Drugs Individuals

Risk Factors		HCV antibody positive infection	
		Univariable OR	**Multivariable OR**
Sex	Female	1	
	Male	1.16 (0.27, 5.00)	
Age group	18-29 years	1	1
	30-49 years	**10.35 (1.36, 79.11)**	**8.29 (1.06, 64.73)**
	50+ years	**20.07 (2.57, 156.66)**	**13.85 (1.67, 114.85)**
Ethnicity	UK-white	1	
	UK-others	0.14 (0.02, 1.04)	
	Non UK-white	0.99 (0.35, 2.79)	
	Non UK-others	0.93 (0.35, 2.47)	
Ever been in prison	No	1	
	Yes	**0.43 (0.20, 0.94)**	
Ever been in prison outside UK	No	1	
	Yes	**0.44 (0.20, 0.99)**	
Roughsleeping/homeless	Never	1	1
	< 1 year	1.77 (0.63, 4.93)	1.11 (0.39, 3.17)
	> 1 year	**2.90 (1.03, 8.12)**	1.18 (0.39, 3.52)
	Unknown Duration	1.26 (0.26, 6.14)	0.64 (0.13, 3.23)
Smoker	No	1	
	Yes	1.55 (0.53, 4.55)	
Alcohol Problem	No	1	1
	Yes	**3.59 (1.61, 8.01)**	**2.92 (1.24, 6.89)**

Figure 1. HCV Infection and Coinfection among Participants with HCV Current (Active) Infection

Figure 2. Overlapping Characteristics among Being Homeless, PWIDs and Have Been in Prison

Figure 3. Drug Use Behaviour among participants recruited in homeless residential sites, drug treatment services and prison