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HCV seropositivity in inmates and in the general population: an averaging approach to establish priority prevention interventions

P Roux,[1,2,3] L Sagaon-Teyssier,[1,2,3] C Lions,[1,2,3] L Fugon,[1,2,3,4] P Verger,[1,2,3] M P Carrieri[1,2,3]

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[1]INSERM UMR912 (SESSTIM), Marseille, France
[2]Université Aix Marseille, IRD, UMR-S912, Marseille, France
[3]ORS PACA, Observatoire Régional de la Santé Provence Alpes Côte d'Azur, Marseille, France
[4]AIDES, Tour Essor, Pantin, France

Correspondence to
Dr P Roux;
perrine.roux@inserm.fr

ABSTRACT

Objectives: Despite the fact that a considerable portion of hepatitis C virus (HCV) positive individuals are viraemic, the risk of transmitting HCV to others is context dependent. Prison is a particularly risky environment as HCV prevention tools are often unavailable. Using data from a cross-sectional study conducted in centres for HCV testing in southeastern France, we aimed to compare the patterns of risk factors in HCV-positive inmates with those in the general population.

Setting: 26 centres for HIV/HCV testing in southeastern France (23 in the general population and 3 in prison).

Primary outcome measure: HCV seropositivity measured with ELISA test.

Methods: A propensity score method to ensure that the general and inmate populations could be compared and a multimodel averaging to estimate the degree (strong, weak, none) of the association of a number of specific factors with HCV seropositivity in each group.

Results: Among the 52 082 participants, HCV infection prevalence was 1.5% and 5.2% in the general (n=46 125) and inmate (n=5957) populations, respectively. In both populations, 'drug injection without snorting' and 'drug injection with snorting' were very strongly associated with HCV seropositivity. Among inmates, 'drug snorting alone' (OR (95% CI) 2.21 (1.39 to 3.52) was also a strong correlate while tattoos, piercings (OR (95% CI) 1.22 (0.92 to 1.61)) and the sharing of toiletry items (OR (95% CI) 1.44 (0.84 to 2.47)) were weak correlates.

Conclusions: The pattern of risk factors associated with HCV seropositivity is different between the general and prison populations, injection and snorting practices being more prevalent in the latter. Access to prevention measures in prisons is not only a public health issue but also a human right for inmates who deserve equity of care and prevention.

Strengths and limitations of this study

- This study confirms that hepatitis C virus (HCV) transmission risk behaviours exist in prisons, including drug use by injection and snorting, tattoos, piercings and the sharing of toiletry items.
- These important findings suggest that a combination of needle and syringe programmes, access to opiate maintenance treatment, and harm reduction tools for drug snorting should remain the priority combined intervention strategy for controlling HCV in prisons.
- This study is a regionally representative cross-sectional survey. However, it is not representative of the whole of metropolitan France.
- Moreover, the sample population is not representative of the general population, given that clients referred to HIV/HCV testing centres may have more at-risk behaviours.

INTRODUCTION

Hepatitis C virus (HCV) infection is a major public health concern with an estimated infected population of 130–170 million people worldwide[1] causing approximately 350 000 deaths each year.[2] Several epidemiological studies in different contexts have identified at-risk populations with a higher prevalence of HCV infection than the general population.[3] Injecting drug users are known to be the population most at risk of HCV infection, with a prevalence estimated between 60% and 80%.[4 5] The smoking, snorting[6 7] and, in particular, the intravenous use[8 9] of cocaine is also a well-established HCV infection risk factor (as it is associated with more frequent unsafe injecting practices).[10] Injecting and snorting practices in the prison environment create a greater risk as needle exchange programmes (NEP) are, in general, absent and snorting kits unavailable.[11 12] In addition, the prevalence of HCV infection is higher in drug-using inmates than in non-incarcerated drug users. A meta-analysis investigating HCV incidence in inmates in US correctional facilities and the

general population found that the incidence in the former was 75 times higher than in the latter in 2006, but 25 times lower than among non-incarcerated injection drug users (IDUs).[13] Another meta-analysis hypothesised that the high incidence of HCV in prisons may come from the high prevalence rates of HCV among people entering prison.[14] Other practices such as tattooing and piercing in prisons, homes and other potentially non-sterile settings are also suspected of being HCV transmission risk factors.[15]

Prevention responses (both in legal and public health contexts) inside and outside the prison setting differ for at-risk practices such as tattooing, injecting drug use and snorting. Identifying the correlates of HCV seropositivity in prison and non-prison settings would help public health authorities and policymakers implement more efficient and effective measures to limit HCV transmission in people incarcerated and in those released.

A large survey conducted on 65 903 persons in southeastern France gave us the opportunity to compare the patterns of HCV seropositivity correlates in the general population with those of people in prisons who had access to HCV testing. More specifically, using an approach where the prison and general populations were made comparable in terms of the main sociodemographic characteristics explored, and then ranking the potential factors of HCV seropositivity in each context, we aimed to evaluate priority prevention interventions to improve the overall positive prevention of HCV.

METHODS

Population and data collection

A surveillance system for the HCV was implemented from 2004 to 2010 in southeastern France. Data were collected from 22 Centers for HIV/HCV diagnosis and prevention (CDAG) and 4 Medical Centers (CES). Seventeen CDAGs were located in towns, 2 in hospitals and 3 in detention centres. In prison, individuals willing to be tested for HIV or HCV had access to 1 of the 3 CDAG centres for HIV or HCV testing following the same protocol as that for the general population.

In all 26 centres, serological HCV tests were systematically proposed to clients when at least one risk factor was identified (injecting drug use, blood exposure, use of a sharp object with blood, etc) or were performed at the request of a client. Every client with a positive ELISA test for HCV was considered HCV positive. When a high level of transaminases was detected with the positive ELISA, a PCR was performed.

Each client completed a self-administrated questionnaire according to the centre's routine practice which included:

(1) sociodemographic characteristics: gender, year and country of birth, employment, education level; (2) history of drug use: year of first drug use, route of administration (snorting, injection, other), type of drugs used (heroin, cocaine, other), sharing injection material and being prescribed opioid maintenance treatment (Subutex, Méthadone); (3) other potential risk factors for HCV transmission: transplant or blood transfusion, current incarceration, haemodialysis, endoscopy, blood exposure accident, tattoo or piercing, invasive clinical medical care during a stay in an at-risk country, sexual intercourse with an HCV positive partner, sharing toiletry accessories with an HCV positive partner; (4) history of incarceration.

A medical questionnaire was filled in by the centre's physician, including the result of the participant's serological test, presumed HCV transmission group (when the HCV test result was positive) and possible HIV and/or HBV coinfection.

An anonymous identification number was used to cross-reference information contained in the self-administrated and medical questionnaires.

It is important to note that, in France, these 'free and anonymous' centres for HIV and HCV testing are covered by confidentiality laws which protect individuals from being identified. All data recorded in this context are completely anonymous. Therefore, anonymity was guaranteed for our study participants from the general and prison populations. No ethical approval was needed for this study.

Statistical analysis

The prevalence of HCV in the prison population and in the general population, as well as their 95% CI, was computed by calendar year.

The first step was to assess the extent to which both populations were different in terms of their main sociodemographic and behavioural characteristics, using the χ^2 test or the Fisher test (for categorical variables) and a Mann–Whitney test (for continuous variables; table 1).

Significant differences between the prison and general population samples obliged us to implement statistical techniques to reduce the sampling bias (see below). The next step was to study the factors associated with each HCV positive sample.

Controlling for sampling bias

Significant differences between the characteristics of the prison and general population samples introduced a large selection bias that could have compromised the inferences based on our estimations. Consequently, we implemented a propensity score matching method to reduce this bias[16] by first creating a propensity score to represent the relationship between multiple characteristics and the matching outcome: being in the prison group (treatments) or not (controls). This was performed by using logistic regression. The final single score estimated was used for creating a balanced data set (ie, comparable between the prison and general population groups). The variables for this matching method were: year of test, gender, secondary school certificate, endemic HCV level in native country, history of drug use and age. It is important to note that the matching

Table 1 Sociodemographic and behavioural characteristics of participants tested for HCV infection in the prison population and in the general population, 2004–2010 (n=52 082)*

	Prison population (n=5957)	General population (n=46 125)	p Value†	Total
Positive HCV test, n (%)				
Yes	308 (5)	668 (1)	$<10^{-3}$	976 (2)
No	5544 (95)	45 402 (99)		50 946 (98)
Age, median (IQR)	28 (23–37)	29 (23–44)	$<10^{-3}$	29 (23–43)
Sex, n (%)				
Men	5537 (93)	24 389 (53)	$<10^{-3}$	29 926 (58)
Women	406 (7)	21 500 (47)		21 906 (42)
Employment, n (%)				
Worker or retired	2522 (43)	23 216 (51)	$<10^{-3}$	25 738 (50)
Unemployed or student	3300 (57)	21 937 (49)		25 237 (40)
Secondary school certificate, n (%)				
No	5455 (96)	28 506 (64)	$<10^{-3}$	33 961 (68)
Yes	237 (4)	15 805 (36)		16 042 (32)
Endemic HCV level in native country, n (%)				
Low‡	4511 (79)	37 306 (86)	$<10^{-3}$	41 817 (85)
Medium or high§	1186 (21)	5997 (14)		7183 (15)
History of drug use, n (%)				
Yes	2299 (39)	12 588 (29)	$<10^{-3}$	14 887 (30)
No	3648 (61)	31 205 (71)		34 853 (70)
Drug injection without snorting, n (%)				
Yes	74 (1)	268 (1)	$<10^{-3}$	342 (1)
No	5868 (99)	43 290 (99)		49 158 (99)
Drug snorting without drug injection, n (%)				
Yes	1756 (30)	8723 (20)	$<10^{-3}$	10 479 (21)
No	4186 (70)	34 835 (80)		39 021 (79)
Drug snorting with drug injection, n (%)				
Yes	327 (6)	771 (2)	$<10^{-3}$	1098 (2)
No	5615 (94) bv	42 787 (98)		48 402 (98)
Haemodialysis, n (%)				
Yes	82 (1)	357 (1)	$<10^{-3}$	439 (1)
No	5831 (99)	42 934 (99)		48 765 (99)
Tattoo/piercing, n (%)				
Yes	2511 (42)	17 887 (40)	$<10^{-3}$	20 398 (40)
No	3417 (58)	26 953 (60)		30 370 (60)
Sexual intercourse with an HCV+ person, n (%)				
Yes	82 (2)	1032 (2)	$<10^{-3}$	1114 (2)
No	4592 (79)	31 342 (70)		35 934 (71)
Did not know	1118 (19)	12 396 (28)		13 514 (27)
Sharing toiletry items, n (%)				
Yes	100 (2)	2168 (5)	$<10^{-3}$	2268 (4)
No	4976 (85)	31 466 (70)		36 442 (72)
Do not know	799 (13)	11 343 (25)		12 142 (24)
Year, n (%)				
2004	734 (12)	7642 (17)		8376 (16)
2005	684 (11)	7358 (16)		8042 (15)
2006	652 (11)	6090 (13)		6742 (13)
2007	738 (12)	6444 (14)	$<10^{-3}$	7182 (14)
2008	1053 (18)	6429 (14)		7482 (14)
2009	1112 (19)	6534 (14)		7646 (15)
2010	984 (17)	5623 (12)		6607 (13)

*Participants tested for HCV.
†p: χ^2 or Mann-Whitney test.
‡Low-endemic area: France, DOM-TOM, north European countries, North and South America.
§Medium-endemic area: north and sub-Saharan African countries, Asia, Pacific and Asian—subcontinent; high-endemic area: Middle East countries.
HCV, hepatitis C virus.

outcome was different from the main outcome of this study. Accordingly, using the same socioeconomic factors did not cause the overestimation demonstrated in other studies.[17]

Ranking the HCV risk factors

We first studied the association between being HCV positive and sociodemographic characteristics and other risk factors separately for the prison and general population participants tested in screening centres using the χ^2 test or the Fisher test (for categorical variables) and a Mann-Whitney test (for continuous variables). We then studied variables associated with being diagnosed HCV positive, using a multimodel averaging method which employed both a Poisson regression model and the Akaike information criterion (AIC) for weighting models, according to the contribution of each variable in explaining the risk of HCV. We tested the following variables: drug snorting without injection, drug injection without snorting, drug injection and snorting, tattoo/piercing, sexual intercourse with an HCV+ person, sharing toiletry items, haemodialysis, endemic HCV level in native country and history of incarceration (for general population participants). Each model evaluated using the multimodel averaging method was adjusted for the year of test, gender and age.

This averaging multimodel approach, described in a previous article,[18] overcomes the inherent uncertainty linked to the process of selecting a final model using standard regression procedures. Furthermore, it enables the ranking of explanatory variables according to their relative importance using Akaike weights. Using this approach, several model specifications are first estimated (there are as many models as possible combinations between the explanatory variables) and a final model computed by using the average-weighted parameters and SEs obtained from the different model specifications.[19] HCV risk factors are ranked according to their relative importance weights (values between 0 and 1): a weight close to 1 indicates strong evidence for a real relationship with the dependent variable.[20] The ranking of the explanatory variable is based on the following weights' classification: (0–0.5)=no evidence; (0.5–0.75)=weak evidence; (0.75–0.90)=positive evidence; (0.95–0.99)=strong evidence; (0.99–1)=very strong evidence.[21] All the analyses were performed using SPSS and R.

RESULTS

Total sample

During the study period, 65 892 screening tests were performed, and 53 062 individuals agreed to participate. Among the latter, 980 had no medical data. Finally, our study group consisted of 52 082 (79%) participants who filled in a self-administrated questionnaire and had complete data from a medical questionnaire: 46 125 (77%) in the general population and 5957 (98%) in prison.

Among the study group, the prevalence of HCV infection during the whole study period was 1.4% in the general population and 5.3% in prison inmates. Prevalence per calendar year (figure 1) decreased overtime in the general population, varying from 1.8% in 2004 to 1.2% in 2010. A greater reduction was seen in prisons from 7.9% in 2004 to 3.5% in 2010.

Table 1 describes the study group's characteristics distinguishing inmates (n=5957) from the general population (n=46 125).

Participants in the prison sample were more likely to be younger, male and not have a secondary school certificate than participants in the general population. In addition, a higher rate of inmates had been born in a country with a medium or high endemic HCV level. A history of drug use was more frequent in the prison population. In addition, more inmates reported drug injection and/or drug sniffing. Moreover, a higher number of inmates had had haemodialysis, tattoos or piercings. However, more people reported having shared toiletry items in the general population sample than in the prison sample. Regarding the year of the test, before 2008 there were more HCV tests in the general population than in prisons, but fewer after 2008.

Balanced characteristics between the prison and general population samples

Table 2 shows the matched samples after implementing the propensity score matching method: 82% of the 6065 prison participants found a matching counterpart in the general population, resulting in a final sample of 9954 participants included in the analyses. After matching, inmates and individuals from the general population remained different regarding drug snorting alone and drug snorting with drug injection, but no longer regarding drug injection alone. A history of sexual intercourse with an HCV+ person was more probable in the general population. In addition, sharing toiletry items remained more prevalent in the general population than in prison inmates.

Comparison of HCV infection correlates between the prison and general populations

Table 3 shows the correlates of HCV infection in the inmate (n=4977) and general population samples (n=4977).

In the former, 'drug injection without snorting' and 'drug injection with snorting' were very strongly associated with HCV. 'Drug snorting alone' was also a strong correlate. Tattoos and/or piercing and sharing toiletry items were weak correlates of HCV infection in prison.

In the general population, drug injection alone and drug injection with drug snorting were also associated with HCV seropositivity, the strength of the associations being similar to those found for the prison population. However, drug snorting alone was only a weak correlate. Tattoos and/or piercing and sharing toiletry items were not associated with HCV seropositivity in the general population.

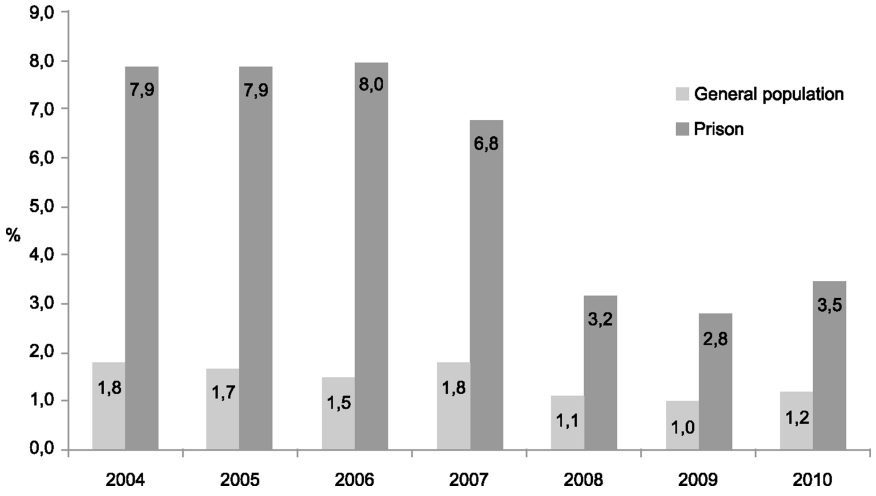

Figure 1 Prevalence of HCV positive test for each calendar (2004–2010) year in the general population (n=46125) and in the prison population (n=5957).

DISCUSSION

This is the first study to be conducted in a large and regionally representative population of those willing to be tested for HCV or HIV which compares the prevalence of HCV in incarcerated individuals and in the general population in southeastern France, a region which together with the 'Ile-de-France' administrative district in northern France has the highest prevalence of HCV[22] in the country. In addition, it is also the first study in France to compare the pattern of correlates of HCV seropositivity in inmates with those in the general population in order to provide indications about possible interventions for preventing HCV in the two environments. Moreover, this comparison was made using the propensity score method, by 'matching' the prison sample with its general population counterpart. This allowed us to accurately assess the relative weight of each risk factor for HCV in both settings. The results of the study can be summarised under the following three headings: comparisons of HCV seroprevalence in inmates and in the general population, ranking correlates of HCV seroprevalence per population (inmates vs general population), and consequences for HCV prevention in prisons and in the general population. First, a consistently higher percentage of HCV-positive individuals was found in the prison population (5.2%) than in the general population (1.5%). This is not surprising given that incarcerated populations are at higher risk of being HCV positive compared with the general population.[23] A survey conducted in 2003 in 88 French prisons indicated a prevalence rate of 6.9%[24] compared with 0.53% in the general population over the same period.[25] Worldwide prevalence rates of HCV prevalence in inmates range from 2% to 58%.[26] In addition, our findings showed that the HCV prevalence per calendar year from 2004 to 2010 in southeastern France decreased slightly in the general population. However, in the prison setting, the decline was much greater. This may be linked to the possibility that new incarcerated drug users are less likely to be HCV positive than before. Indeed, the number of police arrests and subsequent incarceration for cannabis use (not used by sniffing or injection) has increased in France in recent years, with three times more arrests in 2010 than in 1995.[27]

Our findings demonstrated that the relative weight of each risk factor on HCV seropositivity differed to some extent between the prison and general populations. This suggests that injection and sniffing practices are not only more frequent in HCV-positive inmates but are also associated with greater risk, due to promiscuity and the lack of effective preventive measures in the prison setting.

In other words, these results confirm that HCV infection may occur in circumstances strongly influenced by the environment and the availability of HCV prevention interventions. Besides injecting drug use and drug snorting—two well-known factors associated with positive HCV testing in both populations—we found specific factors in the prison population which deserve attention, including tattoos, piercings and the sharing of toiletry items with an HCV positive partner.

In both populations, the factor most strongly associated with HCV infection was injecting drug use, whether accompanied or not by snorting. This result has been widely demonstrated in several other contexts.[26] It also corroborates a meta-analysis of studies conducted in prison showing that IDUs were approximately 24 times more likely to be HCV positive than non-IDUs.[14] In addition, it is known that the infectivity of HCV is high and that the risk of hepatitis C infection from sharing needles/syringes is similar to that estimated for the sharing of other injection paraphernalia (cotton, filters, etc).[28] This fact strongly suggests the need for tailored preventive programmes to combat the HCV epidemic, as current access to NEP is inadequate in the general population and largely (or totally) absent in prisons in France.[29 30]

Interestingly, one of our study's main results is that drug snorting was associated with HCV infection in the prison and general populations, the evidence for this being strong for the former and weak for the latter. It has been suggested that intranasal transmission of HCV

Table 2 Sociodemographic and behavioural characteristics of participants tested for HCV infection in the prison population and in the general population after matching the data (n=9954)

	Prison screening centre (n=4977)	General population screening centre (n=4977)	p Value*	Total (%)
Positive HCV test, n (%)	255 (5)	106 (2)	$<10^{-3}$	361 (4)
Mean, age median (IQR)	28 (23–37)	28 (23–37)	0.72	28 (23-37)
Sex, n (%)				
Men	4640 (93)	4636 (93)	0.87	9276 (93)
Women	337 (7)	341 (7)		678 (7)
Employment, n (%)				
Worker or retired	2174 (44)	2647 (54)	$<10^{-3}$	4821 (49)
Unemployed or student	2759 (56)	2267 (46)		5056 (51)
Secondary school certificate, n (%)				
No	4761 (96)	4767 (96)	0.77	9528 (96)
Yes	216 (4)	210 (4)		426 (4)
Endemic HCV level in native country, n (%)				
Low†	4159 (84)	4161 (84)	0.96	8320 (84)
Medium or high‡	818 (16)	816 (16)		1634 (16)
History of drug use, (%)				
Yes	1931 (39)	1903 (38)	0.56	3834 (39)
No	3046 (61)	3074 (62)		6120 (62)
Drug injection without snorting, n (%)				
Yes	59 (1)	54 (1)	0.66	113 (1)
No	4915 (99)	4885 (99)		9800 (99)
Drug snorting without drug injection, n (%)				
Yes	1484 (30)	1292 (26)	$<10^{-3}$	2776 (28)
No	3490 (70)	3647 (74)		7137 (72)
Drug snorting with drug injection, n (%)				
Yes	270 (5)	160 (3)	$<10^{-3}$	430 (4)
No	4704 (95)	4779 (97)		9483 (96)
Haemodialysis, n (%)				
Yes	74 (2)	33 (1)	$<10^{-3}$	107 (1)
No	4882 (98)	4714 (99)		9596 (99)
Tattoo/piercing, n (%)				
Yes	2152 (43)	2130 (43)	0.98	4282 (43)
No	2816 (57)	2790 (57)		5606 (57)
Sexual intercourse with an HCV+person, n (%)				
Yes	71 (2)	136 (3)		207 (2)
No	3865 (80)	3126 (64)	$<10^{-3}$	6991 (72)
Did not know	898 (18)	1636 (33)		2534 (26)
Sharing toiletry items, n (%)				
Yes	89 (2)	224 (5)	$<10^{-3}$	313 (3)
No	4201 (86)	3379 (69)		7580 (77)
NSP	620 (12)	1309 (27)		1929 (20)
Year, n (%)				
2004	616 (12)	615 (12)		1231 (12)
2005	601 (12)	596 (12)	0.99	1197 (12)
2006	530 (11)	546 (11)		1076 (11)
2007	638 (13)	634 (13)		1272 (13)
2008	890 (18)	894 (18)		1784 (18)
2009	915 (18)	912 (18)		1827 (18)
2010	787 (16)	780 (16)		1567 (16)

*p: χ^2 or Mann-Whitney test.
†Low endemic area: France, DOM-TOM, north European countries, North and South America.
‡Medium-endemic area: north and sub-Saharan African countries, Asia, Pacific and Asian—subcontinent; high-endemic area: Middle East countries.
HCV, hepatitis C virus.

through contaminated drug-sniffing paraphernalia is a potential source of viral infection.[31] Intranasal drug use has been reported in many correctional settings[32] and consequently may be an increasingly important HCV risk factor.[33] The absence of sterile sniffing kits also makes it a greater risk factor in prisons than in the

Table 3 Factors associated with an HCV positive test in participants tested in the prison population and in the general population, 2004–2010 (n= 4977) using an averaging approach

	Prison screening centre		General population screening centre	
Explanatory variables	**IRR (95% CI)**	**Akaike weights (level of evidence)**	**IRR (95% CI)**	**Akaike weights (level of evidence)**
Drug snorting without injection				
No	1		1	
Yes	2.21 (1.39 to 3.52)	0.99 (strong)	2.12 (1.05 to 4.29)	0.75 (weak)
Drug injection without snorting				
No	1		1	
Yes	32.25 (20.07 to 51.84)	1 (very strong)	47.07 (24.24 to 91.4)	1 (very strong)
Drug injection with snorting				
No	1		1	
Yes	30.91 (21.25 to 44.95)	1 (very strong)	30.31 (17.24 to 53.32)	1 (very strong)
Tattoo/piercing				
No	1		1	
Yes	1.22 (0.92 to 1.61)		1.13 (0.74 to 1.72)	
Sexual intercourse with an HCV+ person				
No	1		1	
Yes	1.21 (0.66 to 2.2)	0.50 (weak)	1.9 (0.86 to 4.2)	0.30 (no)
				0.35 (no)
Do not know	0.9 (0.62 to 1.31)	0.18 (no)	1.27 (0.75 to 2.14)	
Sharing toiletry items				
No	1		1	
Yes	1.44 (0.84 to 2.47)		1.38 (0.69 to 2.75)	
Do not know	0.7 (0.47 to 1.06)	0.65 (weak)	0.72 (0.41 to 1.26)	0.40 (no)
Haemodialysis				
No	1		1	
Yes	0.91 (0.32 to 2.58)	0.27 (no)	0.45 (0.06 to 3.39)	0.35 (no)
History of incarceration				
No			1	
Yes	–	–	0.93 (0.55 to 1.58)	0.28 (no)
Endemic HCV level in native country				
Low*	1		1	
Medium or high†	0.79 (0.51 to 1.23)	0.40 (no)	1.36 (0.81 to 2.29)	0.41 (no)
Year‡				
2004	1		1	
2005	0.92 (0.6 to 1.39)		0.82 (0.46 to 1.47)	
2006	0.9 (0.59 to 1.38)		0.66 (0.33 to 1.31)	
2007	0.94 (0.61 to 1.45)		0.52 (0.24 to 1.1)	
2008	0.58 (0.35 to 0.94)		0.38 (0.19 to 0.74)	
2009	0.37 (0.21 to 0.65)		0.19 (0.07 to 0.56)	
2010	0.51 (0.31 to 0.84)		0.38 (0.17 to 0.84)	
Gender‡	1		1	
Man	1.04 (0.63 to 1.72)		0.39 (0.09 to 1.64)	
Woman				
Age‡	1.07 (1.05 to 1.08)		1.06 (1.04 to 1.09)	

*Low endemic area: France, DOM-TOM, north European countries, North and South America.
†Medium endemic area: north and sub-Saharan African countries, Asia, Pacific and Asian—subcontinent; High endemic area: Middle East countries.
‡All possible models were adjusted for all eligible variables.
HCV, hepatitis C virus.

general population. Harm reduction tools are being used and prevention messages provided to the general population but not to prison inmates.

In our study, despite the weak evidence, 'tattoos and/or piercings' were nevertheless another factor associated with HCV seropositivity, found only in the prison setting. This result is consistent with several studies showing that incarcerated inmates getting tattoos in prison were more likely to be HCV positive than those who did not.[14 15] Other studies have also shown that tattooing and prison

stays were both independently associated with HCV infection.[34] However, our study is the first to show tattooing as a correlate of HCV in the prison population but not in the general population.

The risk associated with sharing toiletry items is interesting since it suggests that this practice reflects the inadequacy in the current prison sanitary conditions,[35] the risk being that it may be a route for HCV transmission.

Although it is difficult to say whether individuals in prison settings who test positive for HCV have been infected in the correctional system or not, our study underlines that HCV positive individuals are characterised by risk practices which can facilitate HCV transmission in prisons. Moreover, our ranking and quantifying risk factors in the prison population and in the general population are of major importance for interventions for the positive prevention of HCV.[36] Effective preventive interventions including needle exchange programmes, methadone maintenance treatment, substance abuse/behavioural counselling, and snorting kits, which can be effective in controlling HCV, especially if they are combined, are widely available to the general population in most industrialised countries but not in correctional systems. Indeed, the WHO principle of equity of access to prevention services in the prison population and in the general population is often violated in prisons.[29] In addition, it is known that illicit drug injection and sexual violence[37] as well as other at-risk behaviours, such as tattooing, are common in prisons and jails.[26] The risk and benefits of legal tattooing in prison should be discussed and pilot studies implemented.[38]

Some limitations should be acknowledged. First, this study encompasses almost all the centres for HIV and HCV testing for the PACA region (south-eastern France). Furthermore, it is a regionally representative cross-sectional survey. However, it is not representative of the whole of Metropolitan France. Moreover, the sample population is not representative of the general population, given that clients referred to HIV/HCV testing centres may have more at-risk behaviours. However, it is known that people who present the highest risk for HCV transmission are less likely to go to testing centres.[39] It is interesting to note that almost all the incarcerated participants (98%) had both the completed self-administered and medical questionnaire, unlike only 77% in the general population. This may be due to the prison context where individuals have more time to fill in questionnaires. A possible limitation is that the information collected about at-risk practices was self-reported. However, the validity and reliability of self-reports about drug use have already been established in many studies which used similar methods. The use of lifetime at-risk practices and not recent at-risk practices or at-risk practices within correctional facilities may be a limitation. However, we know that the prison setting may exacerbate at-risk behaviours, especially in terms of drug use and HCV transmission. Accordingly, those who reported more at-risk behaviours in their lifetime were more likely to have had recent at-risk behaviours in prison. Another limitation is that although testing HCV positive indicates that the participant has been infected, he/she may nonetheless be clear of the infection. Half of the HCV positive prisoners have an active infection and can transmit the virus.[11] Finally, as screening was anonymous, we are unable to say whether the same individual was tested more than once, and so this could not be taken into account in the statistical analysis. The matching of the prison population and the general population may have partially addressed such correlated events (eg, the same person being tested in prison and in the general population).

Our findings suggest that a combination of needle and syringe programmes, access to opiate maintenance treatment, and harm reduction tools for drug snorting should remain the priority intervention for controlling HCV. [40]

As in other countries, French prisons have not yet recognised the importance of accessing effective prevention strategies to reduce blood-borne infection transmissions in correctional settings. This is because prevention initiatives regarding drug use in prisons are implemented from a repressive perspective and not from a public health perspective.[30] However, our results showed the importance for decision-makers to introduce more harm reduction interventions in prison, especially interventions targeting HCV transmission.

Access to such interventions in prisons is not merely a public health issue but a human right for inmates who deserve equity of care and prevention.

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