Title: Relationships between body art piercing acquisition, availability of body art facilities, and risk of hepatitis C acquisition among injection drug users

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ABSTRACT

Background: Body art piercing (BAP) is considered to be a risk factor for hepatitis C (HCV) infection on the basis of cross-sectional associations with HCV seropositivity among injection drug users. The temporal basis of the relationship has not been established.

Methods: Associations between HCV seropositivity, HCV incidence, recent BAP and BAP facility availability were evaluated among IDUs in Montreal, Canada, followed biannually between 2004 and 2008. Statistical models included individual and neighbourhood covariates. Logistic regression was used for analysis of HCV seropositivity. Cox proportional hazards regression was used for analysis of HCV incidence.

Results: Of 784 IDUs, 73% were seropositive for HCV. In multivariate logistic regression, HCV seropositivity was associated with BAP availability (OR: 1.32 95% Confidence Interval (CI):1.1,1.6) but not recent BAP. Of 145 initially HCV-negative participants, 52 seroconverted to HCV for an incidence of 27.7/100 person-years (95%CI: 20.9,36.0). Crude Hazard Ratios (HR) for the association between HCV infection and BAP variables were: recent BAP, HR 0.98 (95%CI: 0.4,2.7) and BAP facilities availability, HR 1.43 (95%CI: 1.1,1.9). After accounting for individual and neighbourhood factors, crude associations between HCV infection and recent BAP and BAP facilities availability were: HR recent BAP, 0.96, 95%CI: 0.3,2.7; and HR BAP facilities availability, 1.21, 95%CI:0.9,1.7.

Conclusion: BAP facility availability is a marker of neighbourhood disadvantage associated with HCV seropositivity. Longitudinal analyses accounting for behaviour risk factors and neighbourhood characteristics do not support a temporal association between BAP acquisition, BAP facility availability, and HCV infection among IDUs.

INTRODUCTION

Body piercing and tattoos have been used for thousands of years. Contemporary body art involves puncturing the skin for tattooing or body piercing, collectively referred to as body art piercing (BAP). BAP is still today most often associated with marginal groups. It is prevalent among those reporting previous drinking and recreational drug use (Lauman & Derick, 2006), and among prisoners with a history of injection drug use (IDU) (Hellard, Hocking, Crofts, 2004). In recent decades however, BAP has grown in popularity among the general population in developed countries (Armstrong, Koch, Saunders, Roberts & Owen, 2007). In the United States, a national probability sample survey of 253 women and 247 men between 18 to 50 years of age estimated that 24% of men and women had tattoos and 14% had body piercing (Lauman & Derick, 2006).

Since BAP involves needles and blood, it carries risks, ranging from infectious, allergic, or granulomatous complications in connection with the tattoo pigment (Kazandjieva & Tsankov, 2007) to the acquisition of systemic blood-borne infections such as HIV and viral hepatitis (Armstrong, 2005). Relations between BAP and hepatitis C (HCV) infection in marginal populations have been the focus of several studies in recent years. BAP has been reported as associated with HCV seropositivity among street youths (Roy et al, 2001), sex trade workers, veterans (Briggs et al, 2001; Luksamijarulkul & Deangbubpha, 1997) and drug users. (Scheinmann et al, 2007) In studies that accounted for injection drug use, BAP has been linked to HCV prevalence among prisoners in Australia (Hellard et al, 2004), Norway (Holsen, Harthug & Myrmel, 1993), and Germany (Backmund, Meyer, Wachtler & Eichenlaub, 2003).

IDUs are the population most at risk for HCV transmission in the developed world (Baldo, Baldovin, Trivello & Floreani, 2008). Among IDUs, syringe sharing is the strongest determinant of HCV seroconversion (Hagan et al, 2001). Hence for IDUs the relative contribution of BAP to HCV acquisition may be modest. The availability of BAP facilities to IDUs, many of whom live in high-risk inner-city areas is, however, a potentially relevant exposure that could pattern HCV risk.

Blood-borne virus infections and high-risk injection behaviour among IDUs are not distributed homogeneously within city boundaries (Maas et al, 2007). Individual injection drug use patterns have been found to be associated with living in an economically disadvantaged neighbourhood (Galea et al, 2003). Social disorder and neighbourhood crime are also associated with spatial variation in risk for blood-borne infections (Cooper, Moore, Gruskin & Krieger, 2005; Latkin, Williams, Wang & Curry, 2005). Neighbourhood socioeconomic disadvantage and social disorder are related (Bernard et al, 2007) and are themselves associated with other environmental influences including quality of housing and roadways (Bernard et al, 2007), availability of public and commercial services (Daniel, Kestens & Paquet, 2009), and, potentially, availability of BAP facilities.

In this study, we assessed for IDUs living in an urban setting and participating in a cohort study whether recent BAP acquisition and the availability of BAP facilities were associated with having, and developing HCV. We proposed that BAP acquisition may be associated with HCV prevalence and incidence. Using models that specified key individual and neighbourhood factors we further hypothesized that HCV seropositivity would be associated with the availability of BAP facilities, even accounting for other neighbourhood factors, but that HCV incidence would

be more strongly associated with neighbourhood disadvantage and social disorder than with access to BAP.

METHODS

Study population

The study population was drawn from the St. Luc Cohort, an open cohort of IDUs established in Montreal in 1988, to study determinants of HIV transmission (Bruneau et al, 2001). Cohort recruitment criteria include being 18 years of age or older and having injected drugs within the past month. In November 2004, the objectives of the cohort were expanded and a new cohort was assembled to examine the individual-related and contextual factors associated with HCV infection. IDUs already enrolled in the former cohort who had injected in the previous month and who were HCV antibody negative at their first follow-up visit after November 2004 were invited to participate, and accounted for 44% of the new cohort participants. Other cohort participants volunteered to participate in response to street-level recruitment or by word-of-mouth referral (30%), and through community programs (26%). All participants provided an informed consent as approved by the institutional review board of the Centre Hospitalier de l'Université de Montréal. Cohort visits were scheduled at 6-month intervals. Behavioural questionnaires were administered by trained interviewers with venous blood samples drawn at each visit for HIV and HCV antibody testing. Participants were asked to return for their serostatus test results two weeks after their interview at which time post-test counselling and referrals were provided. Participants were given a CAD $15.00 stipend at each interview to compensate for their time.

Seven hundred eighty-four cohort members were included in the HCV seropositivity analysis. One hundred forty-five participants, HCV-seronegative at enrolment, were followed up

at least once and included in the incidence analysis. All seroconverters had a documented negative HCV test at the time of enrolment and a subsequent positive HCV test during a follow-up visit. The first available questionnaire in the new cohort was used for analyses of seropositivity. For analysis of HCV incidence, information from each previous visit was used for seronegative participants whereas information from each previous visit for which HCV-samples were negative was used for seroconverters.

Measures

The main outcome variable was HCV infection detected by the presence of HCV antibodies. A positive HCV antibody test was determined by *enzyme immunoassay assay (Abbott Laboratories)* and confirmed by RT-PCR (Roche Diagnostic Systems). Specimens with indeterminate results were sent for confirmatory tests by dual EIA and/or RIBA (gold standard). Recent acquisition of a BAP was assessed by the following question: "Have you had a tattoo or body piercing in the past six months?" No information was available to assess the lifetime acquisition of BAP. Other individual-level covariates included age, gender, recent imprisonment, crack cocaine use and frequency of injections in the past month.

We used a geographic information system (Daniel & Kestens, 2007) to determine the availability of BAP facilities and the nature of the neighbourhood conditions to which IDUs were exposed. All BAP facility addresses on the Island of Montreal were located using a commercial directory and their coordinates determined using GeoPinpoint geocoding software (DMTI Spatial Inc, Markham, Ontario). IDU coordinates were determined as described in previous reports (Bruneau, Daniel, Kestens, Zang & Genereux, 2008; Genereux, Bruneau & Daniel, 2010). Briefly, IDUs were asked for the postal code corresponding to their dwelling place, defined as the place where he/she most often slept during the past 30-days. For participants with no fixed

address, postal codes were determined for the street intersection closest to where such IDUs had most often slept. Kernel density estimations (KDE) of BAP facilities were used to represent the availability of BAP facilities at each dwelling location. KDE involves transforming a point distribution into a continuous surface, thus providing density estimates at all locations of the territory. KDE has been used in health services research and was recently proposed to help quantify the risk environment in IDU research (Cooper, Bossak, Tempalski, DesJarlais & Friedman, 2009). For our purposes, we used a quartic decay function and a fixed bandwidth of 1,500 metres, assuming a 20-minute maximum walking distance as relevant range for non-null availability. This distance has previously been used as a service availability threshold among IDUs (Bruneau et al, 2008; Hutchinson, Taylor, Goldberg & Gruer, 2000).

Two other local residential neighbourhood variables were examined: i) the percentage of households below the low income cut-off before tax (LICO) for the census tract in which an IDU resides, based on 2006 Canada Census data; and ii) the number of total crimes against the person per 100 inhabitants for the police district in which an IDU resides, based on 2006 data from the Service de police de la Communauté urbaine de Montréal. The LICO is a measure of socioeconomic disadvantage established by Statistics Canada, representing income levels at which a household spends 20% more than the area average of before tax income on food, shelter and clothing (Zou, Forrester & Giulivi, 2003). The proportion of total crimes against the person was used as a measure of social disorder (Friedman et al, 2006; Latkin et al, 2005). These measures were expressed for the local residential neighbourhood, defined as a road network buffer of 500-metres calculated using ArcGIS network analyst (using a trim distance of 100 meters along the road network) for each participant postal code, resulting in a buffer around each participant's place of residence. A weighted average of the LICO and number of crimes within

the 500-metre buffer of each participant was calculated using census tract and police district data for areas over which the buffer overlapped, with weights corresponding to overlap area.

Analyses

Logistic regression (LR) was used to estimate crude and adjusted odds ratios (OR) and corresponding 95 percent confidence intervals (95%CI) for the relation between HCV seropositivity and individual and neighbourhood exposures. Cox proportional hazards regression was used to estimate crude and adjusted Hazard ratios (HR) and corresponding 95%CI to examine the relations between recent BAP acquisition, BAP availability, and incidence of HCV among subjects who were HCV negative at the entry in the cohort. BAP availability, crime and LICO measures were expressed at the level of individual IDUs for their specific local neighbourhood (defined, as noted, for a road network buffer of 500-metres around each dwelling place). Variability in BAP exposure was accounted for in analyses by introducing a spatial term of BAP density at each participant's dwelling place. Spatial autocorrelation measures were computed for all models' residuals to assess potential bias associated with spatial autocorrelation. Spatial autocorrelation was non significant; Moran's I ranged from 0.027-0.036 ($p>0.19$). As no spatial structure remained in model residuals, analyses were not biased by spatial autocorrelation. Individual exposure measures, except gender, were modelled as time-dependent covariates representing their most recent values. Four multivariable proportional hazards models were estimated. All four models included the exposures of primary interest, but different models adjusted their effects for a gradually extended set of covariates. The first model included recent acquisition of BAP, BAP availability and other all individual-level covariates; the second and third models included these same variables and either LICO (model 2) or crime

index (model 3). The final model included all individual and neighbourhood variables. All analyses were conducted using SAS® v 9.1.

RESULTS

Of 784 cohort participants included in the HCV seropositivity analysis, 571 (72.8%) had HCV. The majority were male (83.5%), with the mean age 38.1 years (SD=9.5). The average duration of injection drug use was 14.2 years (SD 9.6). Analyses of potential risk factors (Table 1) revealed few statistically significant correlates of HCV seropositivity. In univariate analyses, availability of BAP facilities was greater for HCV-seropositive IDUs compared to HCV-negative IDUs. HCV seropositivity was not associated with either the LICO or crime index.

Figure 1 illustrates the density of BAP facilities on the island of Montreal and the distribution of participants according to their HCV status. The highest density of BAP was in the inner-city area of Montreal. Forty-four IDUs reported having acquired a BAP in the six months prior to the study visit, with HCV-positive individuals having a lesser frequency of acquiring a new BAP. No correlation was observed between the kernel density estimate of BAP availability and recent BAP acquisition (r= -0.01; *P*=0.750). In the multivariable logistic model that adjusted for neighbourhood and individual characteristics (Table 1), the association between HCV seropositivity and recent BAP acquisition was not statistically significant.

Of 184 HCV-negative cohort members eligible for this investigation, 145 (79%) participants were followed up at least once between November 2004 and December 2008 and were included in incidence analyses (mean follow-up time 16 months (SD 11.4)). A total of 52 (28.2%) persons seroconverted to HCV during 187.7 person-years of observation, with the incidence rate 27.7 per 100 person-years (95% confidence interval (CI): 20.9, 36.0). The mean kernel density estimate of BAP availability for the dwelling place of HCV-incident IDUs was 0.9

BAP per square kilometre (inter-quartile range (IQR) = 1.8-0.1 (SD 0.9)). Positive correlations existed between BAP availability and the LICO (r = 0.33; $P < 0.0001$), and crime index (r= 0.47; $P < 0.0001$). As for analyses of seropositivity, BAP availability and recent BAP acquisition were not correlated (r= -0.05; P=0.545).

Table 2 provides the results of unadjusted (crude) Cox's regression analyses of associations between neighbourhood and individual variables, and risk of HCV seroconversion. Higher BAP availability was associated with increased risk of HCV seroconversion. Incident HCV was associated with neighbourhood disadvantage (LICO measure) and neighbourhood crime. Seventeen IDUs reported BAP acquisition at least once during the study period, and of these, six seroconverted to HCV, with the crude hazard ratio 0.98 (95% CI: 0.4-2.7). Recent imprisonment and a higher frequency of injection in the past month were significantly associated with an increased risk of HCV infection.

Risk factors associated with HCV incidence in univariate analysis were examined in multivariate models that sequentially adjusted for individual and neighbourhood variables respectively. As shown in Table 3, the association between availability of BAP facilities and HCV incidence hardly changed when adjusted for individual covariates, shifting from a Hazard Ratio (CI) of 1.43 (95%CI: 1.1, 1.9) to 1.44 (95%CI: 1.1, 1.9), and remained statistically significant. When neighbourhood variables were introduced in the model, the strength of the association decreased substantially and the adjusted effect of BAP facilities became marginally non-significant. On the other hand, the independent associations of HCV incidence with (i) the frequency of injections in the last month, and (ii) recent imprisonment, remained statistically significant even after adjustment for all individual and neighbourhood variables (model 4 in Table 3). Finally, the LICO and crime index remained statistically significant in multivariable

models that adjusted for all other variables (models 2 and 3, respectively). However, their effects became marginally non-significant when both variables were simultaneously adjusted for each other (model 4), due to their correlation (r (LICO,crime index) = 0.60).

DISCUSSION

In this study, we found substantial variation in BAP availability across Montreal Island. The inner-city of Montreal, characterized by the highest levels of socioeconomic disadvantage and crime of all boroughs in Montreal, not unexpectedly had the highest BAP availability (Savoie, Bédard & Collins, 2006). We observed no associations at baseline between HCV status and neighbourhood socioeconomic disadvantage (LICO) and social disorder (crime index), or with recent BAP acquisition or other recent risk behaviours. These results differ from those reported for studies of younger IDUs but are comparable to those from studies of longer duration and older IDUs (Backmund et al, 2003; Briggs et al, 2001). The lack of association between individual behaviours, neighbourhood factors and HCV positivity is consistent with what might reasonably be expected for a population of long-term IDUs, where HCV prevalence is close to saturation (Falster, Kaldor & Maher, 2009).

Conversely, the distribution of HCV cases among IDUs varied with the availability of BAP. Although we found no correlation between BAP availability and recent acquisition, the proportion of IDUs (5.6%) engaging in BAP over a 6-month period is much higher overall, compared to the general population. In national surveys, the lifetime prevalence of BAP was estimated at 8% in Australia (Makkai & McAllister, 2001) and 10% in England (Bone, Ncube, Nichols & Noah, 2008), with most BAP being acquired during early adulthood. Our data also indicate that HCV-seropositive IDUs were less likely to have recently acquired a BAP, as

compared to seronegative individuals. This finding is not unexpected, as HCV-positive subjects were on average 5 years older than HCV-negative subjects, and because BAP is more frequent among younger individuals. Another explanation is the possibility that knowledge of their HCV-positive status prevented IDUs from acquiring a new BAP to avoid transmitting HCV to others. Studies that have addressed the potential role of HCV or HIV disclosure in changing behaviours among IDUs have generally not, however, seen any corresponding impact on syringe sharing practices (Brogly, Bruneau, Lamothe, Vincelette & Franco, 2002; De et al, 2009). These findings suggest that BAP availability is a marker of neighbourhood disadvantage associated with HCV positivity among longer-term IDUs, independent of the concentration of socioeconomic disadvantage or social disorder, without being directly related, in this population, to BAP acquisition itself. The location of BAP facilities may have evolved to serve a population of marginal individuals, including older and chronic IDUs who are likely to be more frequently HCV-infected.

Results from our incidence analysis suggest that the availability of BAP facilities is simply one among other markers of adverse conditions that predict HCV acquisition in at-risk IDUs. The association between BAP availability and was substantially reduced and lost its statistical significance after adjustment for neighbourhood variables, indicating that the availability of BAP is not an independent predictor of HCV incidence.

Studies by Rhodes have determined that social situations, place-based or geographic influences not directly related to individual decision-making, can contribute to IDU risk (Rhodes, Singer, Bourgois, Friedman & Strathdee, 2005). We recently demonstrated that IDUs living in neighbourhoods with a high concentration of socioeconomic disadvantage in the inner-city of Montreal were more likely to report high-risk injection behaviour (Genereux et al, 2010).

Results from the current study further suggest a modest effect of socioeconomic disadvantage and social disorder in HCV transmission among IDUs.

As hypothesized, recent BAP acquisition was not associated with HCV seroconversion. Of note, among the 17 participants who acquired a BAP within six months of their most recent follow up, six seroconverted to HCV, and two IDUs reported having acquired their BAP while in prison. Whether obtaining a BAP invokes an independent risk, or is rather correlated with specific high-risk taking behaviours remains to be investigated. An investigation of this premise would command a very large sample size as the attributable risk for injection drug use is likely to be low.

Imprisonment in the past six months was independently associated with higher HCV incidence. It has been demonstrated that having injected while in prison predicts HIV and HCV infection (McGovern et al, 2006). Of 51 participants reporting recent imprisonment during the study period, just one reported having injected drugs while in prison. While this individual did seroconvert to HCV, this event occurred more than 18 months after his release from prison. Besides the documented risk associated with injection drug use while in prison, heightened vulnerability may play an important role in increasing high risk injection behaviours and HCV acquisition after release (van Haastrecht, Bax & van den Hoek, 1998).

Consistent with previous studies, the strongest independent predictor of HCV incidence was the frequency of injections in the past month (Tyndall et al, 2003). Importantly, the association between the frequency of injection and HCV incidence was not affected by adjusting in statistical models for other individual covariates, and/or for neighbourhood conditions, indicating its robustness in predicting HCV, in contrast to the effect of the BAP availability

which became non-significant after these adjustments.

Several limitations apply to this study. Participants were not randomly selected and thus cannot be considered representative of IDUs in Montreal. The sample is over-represented in terms of males and chronic cocaine-using IDUs, compared to Quebec provincial data on IDUs (Comité permanent de lutte à la toxicomanie, 2000). Further, this study was conducted in the specific setting of a French-speaking North-American urban city. If not having particular equivalents elsewhere this context might still serve as a reasonable representation of availability of BAP facilities relevant to IDUs in areas of drug use in different cities internationally. Even if our follow-up rates were high for a drug-using population, our data could have been influenced by losses to follow-up. No differences in age, gender, frequency of injection, recent incarceration and recent BAP acquisition were found between participants included in analyses and those lost to follow-up.

As demonstrated by several methodological papers, another potential type of selection bias might have occurred in our prospective analyses of HCV incidence because most cases were already prevalent at the time follow-up was initiated (Flanders & Klein, 2007; Hernan, Hernandez-Diaz & Robins, 2004). This type of differential selection bias may be less likely to apply, however, in studies such as occurs where subjects change exposure categories over time. In the present study, a weak correlation was found between exposure levels at different times (for example, we obtained r= 0.309 between BAP availability at the initial and the latest assessment, corresponding to less than 10% variance in the last BAP explained by the initial BAP). It is uncertain, therefore, as to whether those participants already seropositive at their baseline, and thus excluded from the prospective analyses of HCV incidence, would be more likely to belong to the 'exposed' or the 'un-exposed' during the study follow-up. Furthermore, this particular

selection bias (Flanders & Klein, 2007; Hernan et al, 2004) would induce bias toward the null and increase the risk of type II error. Therefore, such bias could not explain why we found systematically statistically significant independent effects of recent imprisonment and frequency of recent injections.

In summary, we found that HCV-positive IDUs were more likely to find BAP facilities in the vicinity of their local living place. BAP facility availability was not, however, independently associated with HCV seroconversion, when adjusted for individual and neighbourhood variables. BAP availability thus appears to be a marker of disadvantaging neighbourhood circumstances relevant to HCV-positive IDUs, but not an independent risk factor for HCV transmission. IDUs living in areas characterized by socioeconomic disadvantage and social disorder were at higher risk of developing HCV, regardless of their individual risk behaviours. While acknowledging the small sample size of our study, our results do not support a significant role for BAP acquisition in predicting HCV infection through individual risk behaviour in IDUs at high risk of infection. Local BAP facilities might serve, however, as key venues for the dissemination HCV prevention messages among hard-to-reach IDUs. Lastly, our results emphasize the need for HCV prevention in prison settings, especially for IDUs serving short-term sentences.

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CONFLICT OF INTERESTS

All authors declare no compete interests.

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Table 1. Unadjusted and covariate-adjusted associations between having hepatitis C virus (HCV) and availability of body art piercing facilities among 784 IDUs living on Montreal Island and participating in the St. Luc Cohort, 2004-2008.

Variables	HCV positive % or Mean (SD)	HCV negative % or Mean (SD)	Unadjusted (crude) association Odds Ratio	95% CI[a]	Multivariate[b] (covariate-adjusted association) Odds Ratio	95% CI
Availability of body art piercing facilities (n/km^2)	1.1 (1.0)	0.9 (0.9)	1.21	1.0, 1.4	1.32	1.1, 1.6
Recent body art piercing (past 6 months)						
No n = 740	95.8 (20.1)	90.6 (29.2)	1		1	
Yes n =44	4.2 (20.1)	9.4 (29.2)	0.42	0.2, 0.8	0.53	0.3, 1.0
Age (5-year increment)	39.7 (9.0)	33.6 (9.3)	1.45	1.3, 1.6		
Duration of injection (5-year increment)	16.1 (9.4)	9.2 (8.4)	1.60	1.4, 1.8	1.62	1.4,1.8
Gender						
Male n=653	84.7 (36.0)	80.3 (39.8)	1		1	
Female n=129	15.3 (36.0)	19.7 (39.8)	0.74	0.5, 1.1	0.93	0.6, 1.5

Imprisonment past 6 months						
No n=609	78.2 (41.3)	76.5 (42.4)	1		1	
Yes n=174	21.8 (41.3)	23.5 (42.4)	0.91	0.6, 1.3	1.00	0.7, 1.5
Crack cocaine last month						
No n=373	49.5 (50.0)	44.1 (49.7)	1		1	
Yes n=404	50.5 (50.0)	55.9 (49.7)	0.81	0.6, 1.1	0.76	0.5, 1.1
≥30 injection last month						
No n=328	42.2 (49.4)	40.8 (49.1)	1		1	
Yes n=456	57.8 (49.4)	59.2 (49.1)	0.95	0.7, 1.3	1.20	0.8, 1.7
LICO [c]						
(10 percentage increase)	42.2 (10.7)	42.0 (11.8)	1.01	0.9, 1.2	0.92	0.8, 1.1
Crime index [d]	2.8 (1.5)	2.7 (1.5)	1.04	0.9, 1.2	1.01	0.9, 1.2

[a] CI : Confidence Interval

[b]: covariate-adjusted model includes: recent body art piercing acquisition; duration of injection; gender; imprisonment past 6 months; crack cocaine last month; injection last month;

[c] LICO: Low-income cut-off (percentage households below the before-tax low income cut-off for the Census tract in which one resides)

[d] Crime index: number of total crimes against the person by 100 inhabitants for the Police district in which one resides

Table 2. Unadjusted estimated relative Hazard of hepatitis C virus (HCV) seroconversion according to individual and neighbourhood factors for n=145 initially HCV-negative injection drug users living on Montreal Island and participating in the St. Luc Cohort, 2004-2008.

Demographic, behavioural and social condition variables	Follow-up time Person years	Incidence rate /100 person years	Number of seroconversions	Hazard Ratio	95% CI[a]
Availability of Body Art Piercing facilities (n/km^2)	187.7	27.7 (20.9, 36.0)	52	1.43	1.1, 1.9
Recent body art piercing (past 6 months)					
No	158.0	29.1 (21.6, 38.5)	46	1	
Yes	29.7	20.2 (8.2, 42.0)	6	0.98	0.4, 2.7
Age (5-year increment)	187.7	27.7 (20.9, 36.0)	52	1.00	0.9, 1.2
Duration of injection (5-year increment)	187.7	27.7 (20.9, 36.0)	52	0.94	0.8, 1.1
Gender					
Male	144.4	30.5 (22.4, 40.5)	44	1	
Female	43.3	18.5 (8.6, 35.1)	8	0.63	0.3, 1.3
Crack cocaine past month					

No	67.9	25.0 (15.1, 39.3)	17	1	
Yes	119.8	29.2 (20.7, 40.2)	35	1.30	0.7, 2.3
≥30 injection last month					
No	50.1	18.0 (8.8, 33.0)	9	1	
Yes	137.5	31.3 (22.9, 41.7)	43	3.28	1.7, 6.2
Imprisonment past 6 months					
No	116.5	24.0 (16.3, 34.2)	28	1	
Yes	71.2	33.7 (22.2,49.3)	24	2.10	1.2, 3.7
LICO [b]					
(10 percentage increase)	187.7	27.7 (20.9, 36.0)	52	1.46	1.1, 1.9
Crime index [c]	187.7	27.7 (20.9, 36.0)	52	1.27	1.1, 1.5

[a] CI : Confidence Interval

[b] LICO: Low-income cut-off (percentage households below the before-tax low income cut-off for the Census tract in which one resides)

[c] Crime index: number of total crimes against the person by 100 inhabitants for the Police district in which one resides

Table 3. Covariate-adjusted associations between hepatitis C virus (HCV) seroconversion and body art piercing facility availability for n=145 initially HCV-negative injection drug users living on Montreal Island and participating in the St. Luc Cohort, 2004-2008.

	Model 1 Adjusted for individual covariates		Model 2 Adjusted for individual covariates and LICO [b]		Model 3 Adjusted for individual covariates and crime index [c]		Model 4 Full model	
	Hazard Ratio	95% CI [a]	Hazard Ratio	95% CI	Hazard Ratio	95% CI	Hazard Ratio	95% CI
Availability of Body Art Piercing facilities (n/km^2)	1.44	1.1, 1.9	1.28	0.9, 1.8	1.23	0.9, 1.7	1.21	0.9, 1.7
Recent body art piercing (past 6 months)	0.98	0.4, 2.8	0.92	0.3, 2.6	1.01	0.4, 2.9	0.96	0.3, 2.7
Duration of injection (5-year increment)	1.00	0.8, 1.2	0.99	0.8, 1.2	1.00	0.8, 1.2	0.99	0.8,1.2
≥30 injections past month	3.31	1.7, 6.3	3.22	1.7, 6.1	3.40	1.8, 6.5	3.29	1.7, 6.3
Imprisonment past 6 months	2.15	1.2, 3.9	2.20	1.2, 4.0	2.14	1.2, 3.9	2.18	1.2, 4.0

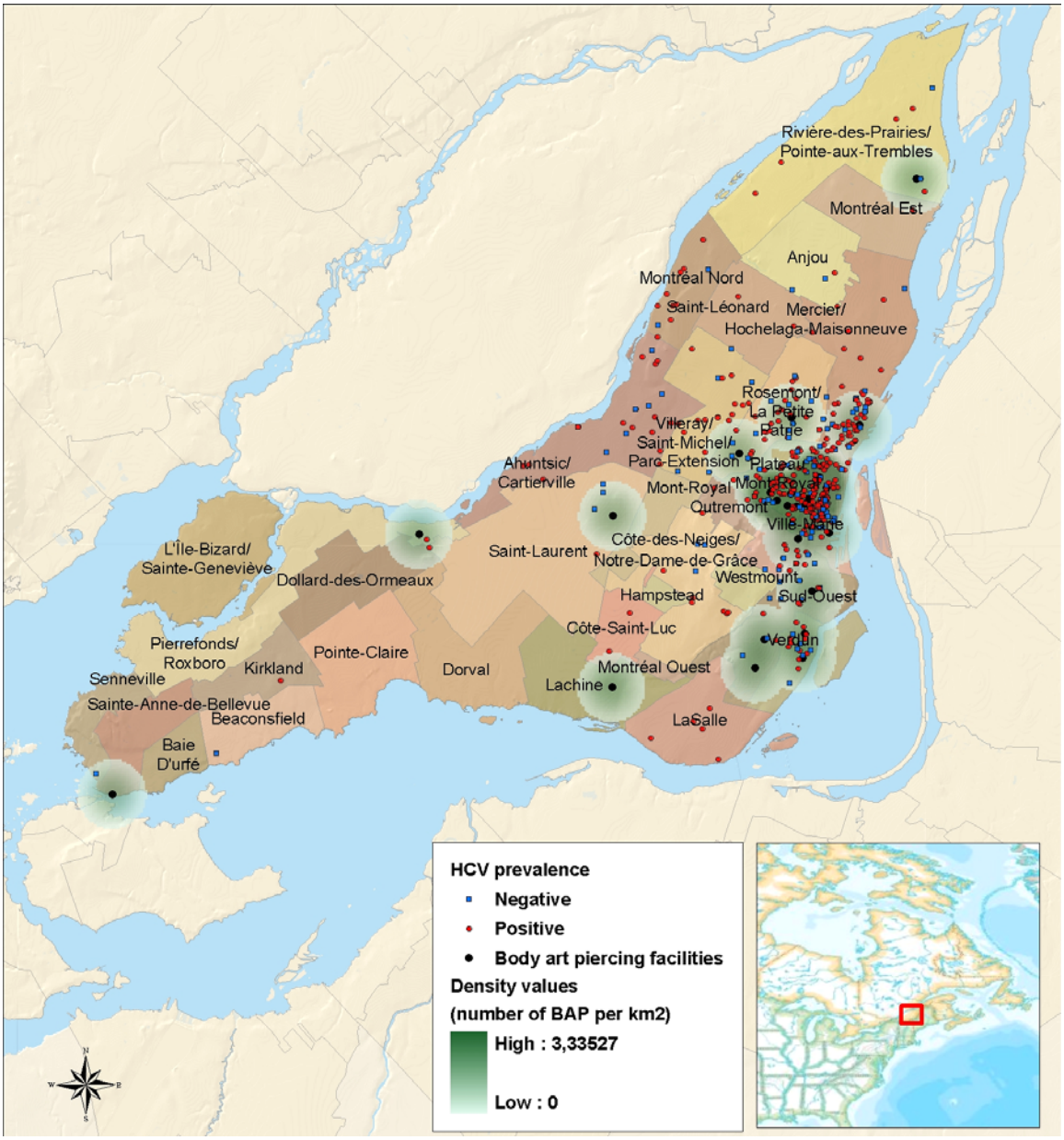
LICO [b]						
(10 % increase)	1.35	1.0, 1.8			1.22	0.9, 1.7
Crime index [c]			1.22	1.0, 1.5	1.11	0.9, 1.5

[a]CI: Confidence Interval

[b]LICO: Low-income cut-off (percentage households below the before-tax low income cut-off for the Census tract in which one resides)

[c] Crime index: number of total crimes against the person by 100 inhabitants for the Police district in which one resides

Figure 1. Density of body art piercing facilities and distribution of participants according to their Hepatitis C status among 784 injection drug users on the island of Montréal, Québec, Canada.



Legend: Availability of body art piercing locations (number of BAP facilities per square kilometre estimated by kernel density calculation) was estimated by kernel density calculations.