Social determinants of health associated with hepatitis C co-infection among people living with HIV: results from the Positive Spaces, Healthy Places study

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ABSTRACT

Background: Social determinants of health (SDOH) may influence the probability of people living with HIV also being infected with hepatitis C virus (HCV). We compared the SDOH of adults co-infected with HCV/HIV with that of HIV mono-infected adults to identify factors independently associated with HCV infection.

Methods: In this cross-sectional study, face-to-face interviews were conducted with 509 HIV-infected adults affiliated with or receiving services from community-based AIDS service organizations (CBAOs). The primary outcome measure was self-reported HCV infection status. Chi-square, Student's *t* tests, and Wilcoxon rank-sum tests were performed to compare SDOH of HCV/HIV co-infected participants with that of HIV mono-infected participants. Multivariable hierarchical logistic regression was used to identify factors independently associated with HCV co-infection.

Results: Data on 482 (95 HCV/HIV co-infected and 387 HIV mono-infected) adults were analyzed. Compared with participants infected with HIV only, those who were co-infected with HIV and HCV were more likely to be heterosexual, Aboriginal, less educated and unemployed. They were more likely to have a low income, to not be receiving antiretroviral treatment, to live outside the Greater Toronto Area (GTA), to use/abuse substances, experience significant depression, and utilize addiction counselling and needle-exchange services. They also were more likely to report a history of homelessness and perceived housing-related discrimination and to have moved twice or more in the previous 12 months. Factors independently associated with HCV/HIV co-infection were history of incarceration (odds ratio [OR] 8.81, 95% CI 4.43–17.54), history of homelessness (OR 3.15, 95% CI 1.59–6.26), living outside of the GTA (OR 3.13, 95% CI 1.59–6.15), and using/abusing substances in the past 12 months (OR 2.05, 95% CI 1.07–3.91).

Conclusion: Differences in SDOH exist between HIV/HCV co-infected and HIV mono-infected adults. History of incarceration, history of homelessness, substance use, and living outside the GTA were independently associated with HCV/HIV co-infection. Interventions that reduce homelessness and incarceration may help prevent HCV infection in people living with HIV.

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Hepatitis C virus (HCV) has become increasingly common among people living with HIV. Approximately 30% of people with HIV infection worldwide and 20% of Canadians living with HIV are also infected with HCV.[1–4] In Canada, HCV is transmitted mainly through the sharing of injection drug use equipment and the receipt of blood and blood products.[5–6] Other mechanisms of transmission include travelling or living in HCV-endemic countries, sharing equipment for inhalation drug use (such as crack pipes), sexual contact, perinatal or mother-to-child transmission, tattooing or body piercing with contaminated equipment, and the sharing of personal hygiene items such as razors and toothbrushes; these modes of transmission account for a small proportion of HCV cases.[1,2,7,8–12]

In more than 75% of people living with HIV infection, acute HCV infections develop into chronic infections.[13] Among those with chronic HCV infection, HIV infection significantly impairs the cell-mediated responses to HCV antigens,[14] leading to more rapid liver fibrosis.[15,16] People with chronic HCV infection are at higher risk of severe liver disease,[17] liver decompensation,[18] progression to an AIDS-defining event,[19] lower health-related quality of life,[20] and death.[18,19] Because of their increased burden of disease, co-infected individuals use more health care services than HIV mono-infected individuals.[21] Prevention or early treatment of HCV co-infection would, therefore, benefit individual patients and the health care system as a whole.

Social determinants of health (SDOH) may have a bearing on an individual's risk of becoming infected with HCV. Raphael[22] defines SDOH as the economic and social conditions that determine the extent to which a person possesses the physical, social, and personal resources to identify and achieve health. These determinants include Aboriginal status, education, employment and working conditions, food security, health care services, housing, income and its distribution, the existence of a social safety net, social exclusion, unemployment and employment security.[22] Among Canadians living with HIV, for example, injection drug use is a strong predictor of HCV infection,[23,24] while injection drug use, in turn, is prevalent among Aboriginal people, street youth, current and former prisoners, and homeless people.[25,26] Incarceration and homelessness are increasingly being recognized as determinants of health among injection drug users and those infected with HCV.[27–29] There is also evidence linking HCV infection with other determinants of health, including age, gender, ethnicity, education, income, and unstable housing.[2,7,30–34]

To prevent co-infections and provide effective care for people who are already HCV/HIV co-infected, it is important to understand the complex interplay between demographic and socioeconomic factors, such as incarceration, substance use, HIV, and housing, that may affect the probability of becoming infected with HCV. Housing may play a particularly important role as an intermediate structural factor that links broader societal processes with an individual's immediate social and physical environment and in turn influences health and well-being.[35] Within the context of HIV, housing is powerfully linked with risk factors for exposure and transmission, and with the care and health of persons living with HIV.[36–38] However, the potential influence of housing instability on HCV infection among those living with HIV in Ontario and Canada has not been explored. As such, our current study was designed to determine the unique contribution of housing characteristics, particularly housing instability factors, in the context of other social determinants of health for people with HCV/HIV co-infection.

Methods

Participants. Data for this study came from the 1-year follow-up of the Positive Spaces, Healthy Places (PSHP) study, an observational study involving a cohort of 602 people living with HIV infection and affiliated with or receiving services from community-based AIDS service organizations (CBAOs) in Ontario. The purpose of the PSHP study was to examine the impact of housing on health and health-related quality of life among people living with HIV.

To ensure the representativeness of the study sample, participants in the PSHP study were recruited using a wide range of access points, including shelters for homeless people; agencies serving women, families, and youth; Aboriginal organizations; transitional housing providers; and supportive housing agencies. Efforts were made to include harder-to-reach populations such as injection drug users and street-involved people (individuals who live in and out of hostels and homeless shelters).

Recruitment. Posters and flyers with information about the PSHP study were distributed to individuals receiving services from CBAOs across Ontario. Calls for study participants were also posted in CBAO newsletters and in a gay and lesbian news magazine. Interested participants were asked to call a toll-free telephone number.

Of the 676 individuals who expressed interest in participating, 602 met the eligibility criteria and were enrolled in the PSHP study (see Fig. 1); thus the study's targeted recruitment goal of 600 people was met. Participants were eligible if they lived in Ontario and were

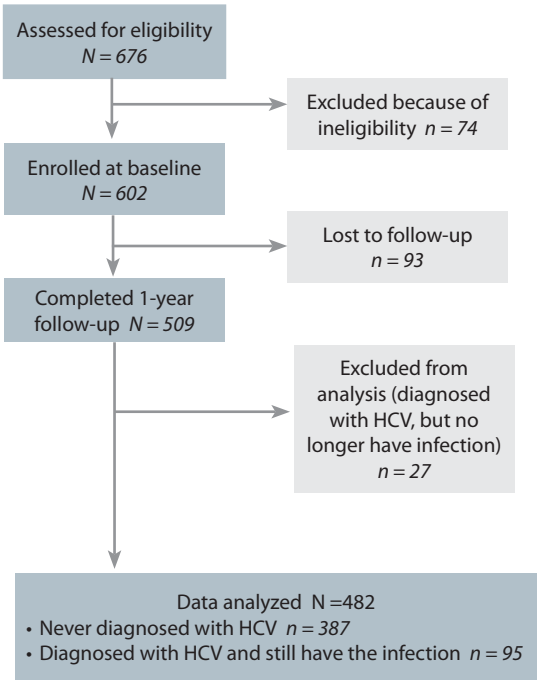

Figure 1: Profile of the Positive Spaces, Healthy Places study

HIV-positive, were aged 18 years or older, and were able to provide informed consent. To minimize bias, recruitment was guided by predefined targets that reflected the regional, gender, sexual orientation, and ethnic distribution of HIV prevalence in the province. The 602 individuals enrolled were from various communities across Ontario, including Eastern Ontario (Ottawa, Kingston, and Peterborough), Northern Ontario (North Bay, Sudbury, and Thunder Bay), South and South Western Ontario (Niagara Falls, St. Catharines, Hamilton, London, Guelph, and Windsor) and the Greater Toronto Area (Toronto, Mississauga, Brampton, Oakville, Markham, Oshawa, Ajax, and Pickering).

To reflect the study's strong commitment to community-based research (CBR)[39] and the Greater Involvement of People living with HIV and AIDS (GIPA) principle,[40] all consent forms and questionnaires were administered by 7 peer research assistants (PRAs), that is, people living with HIV who received training from the study team on interviewing techniques, principles of CBR, ethical issues in CBR, and CBR in Aboriginal communities. Ethics approval for the PSHP study was obtained from the Research Ethics Board of McMaster University, Hamilton, Ontario.

Data collection. Face-to-face interviews were conducted at baseline (April 2006 to September 2006) and at 1-year follow-up (April 2007 to December 2007) using a quantitative questionnaire that was piloted with 33 participants. It took approximately 75 minutes to complete the questionnaire/survey. Interviews were conducted at a local CBAO or in a public place (e.g., coffee shop), according to the participant's preference. Study participants were allowed to self-complete questions that were considered confidential (e.g., the Drug Abuse Screening Test). Participants were paid an honorarium of $60 for the baseline interview and $40 for the 1-year follow-up interview. This study, however, uses data from the 1-year follow-up interviews only, as data on HCV infection were not collected at baseline.

Outcome measures. The following outcome measures were used.

HCV infection. The primary outcome in this study is self-reported HCV co-infection status. At the 1-year follow-up interview, participants were asked whether they had ever been tested for HCV and, if they had a history of HCV, whether they still had the infection. Those who reported a history of HCV diagnosis and still had the infection were considered to be HCV/HIV co-infected. Participants with a history of HCV infection who reported being clear of the infection at the time of the interview were excluded to minimize potential misclassification bias.

Sociodemographic characteristics. Data collected on sociodemographic characteristics included age, gender, sexual orientation, Aboriginal status, education, employment status, and personal income. We categorized gender as male, female or transgender; sexual orientation as heterosexual and gay, lesbian, or bisexual; Aboriginal status as Aboriginal and non-Aboriginal; education as less than high school or high school diploma or above; employment status as unemployed or employed; and income as ≤ CAD$1200/month or > CAD$1200 CAD/month. Participants were also asked whether they had ever been incarcerated; these responses were dichotomized into "have been incarcerated" or "have never been incarcerated."

Health status and health care utilization. The study gathered information on selected HIV disease markers (i.e., highest CD4 count in the past 6 months, year of HIV diagnosis, history of diagnosis of AIDS, and receipt of antiretroviral therapy) and utilization of health care services, including addiction counselling and needle exchange program, in the past 12 months.

We categorized recent CD4 counts as ≥ 500 cells/mm^3 or < 500 cells/mm^3; history of diagnosis of AIDS into

"yes, have been diagnosed with at least 1 AIDS-defining condition" or "have never been diagnosed with an AIDS defining condition"; receipt of antiretroviral therapy as "not receiving antiretroviral treatment currently" or "receiving antiretroviral treatment." Time since HIV diagnosis was computed by subtracting the year of HIV diagnosis from the year the interview was conducted. Utilization of health service was defined as visiting a service provider at least once in the previous 12 months.

Health-related quality of life. Health-related quality of life was assessed using the MOS-HIV survey.[41] This survey has 35 items that are used to compute 2 summary scores—Physical Health Summary (PHS) and Mental Health Summary (MHS)—and 10 subscales scores. This instrument has high internal consistency and test-retest reliability.[42] All scores were used as continuous variables.

Depression. Depressive symptoms were assessed using the Center for Epidemiological Studies Depression Scale (CES-D).[43] The CES-D is a self-report scale consisting of 20 items that assess the presence of depressive symptoms in the general population. The CES-D total score ranges from 0 to 60, such that higher scores indicate more severe depressive symptoms. This instrument has high test-retest reliability.[44] A 16-point cut-off was used to categorize participants into 2 groups: significantly depressed (i.e., CES-D ≥ 16), or not significantly depressed or not depressed (CES-D < 16).

Alcohol consumption. Alcohol consumption was assessed using the Alcohol Use Disorders Identification Test (AUDIT-10).[45] The AUDIT-10 has 10 items and is designed to assess and identify hazardous alcohol consumption, alcohol dependence and alcohol-related harm. This instrument has high internal consistency and test-retest reliability.[46,47] In this paper, however, we used responses to items 1 to 3 of the AUDIT survey to dichotomize participants into heavy drinkers (i.e., consumed 6 or more drinks on 1 occasion at least once a month in the previous 12 months) and light drinkers (i.e., consumed 5 or fewer drinks on 1 occasion in the previous 12 months) or non-drinkers (i.e., did not consume any alcohol in the previous 12 months).

Substance use. The presence and degree of substance use/abuse was assessed using the Drug Abuse Screening Test (DAST-20) instrument.[48] The DAST-20 is designed to assess and identify the abuse of psychoactive drugs; its validity is reported elsewhere.[49–50] In this analysis, the first item of this instrument was used to assess the presence or absence of substance use in the past 12 months.

Housing characteristics. Housing-related data collected included city/town of current residence; type of housing (i.e., house, condominium, apartment, a room in a hotel/motel/boarding house, HIV housing facility with shared kitchen and bathroom, outdoors [including parks and streets], couch surfing, and shelter); length of residence in current housing; amount of rent; receipt of rent assistance; difficulty paying housing cost; and number of times moved in the past year. Participants were also asked whether they were currently homeless, had ever been homeless, and had ever experienced housing-related discrimination. Responses for city or town of residence were coded as living in the Greater Toronto Area (GTA) (i.e., Toronto, Mississauga, Brampton, Oakville, Markham, Oshawa, Ajax, and Pickering) and outside of the GTA (i.e., Ottawa, Kingston, Peterborough, North Bay, Sudbury, Thunder Bay, Niagara Falls, St. Catharines, Hamilton, London, Guelph, and Windsor). We dichotomized type of housing into "homeless or inadequately housed" (living outdoors, including parks and streets; living in a room in a hotel, motel, or boarding house; living in a shelter; and couch surfing) or "not homeless or adequately housed" (i.e., living in own residence or renting an apartment, condominium, or house); history of homelessness into "I have been homeless at least once" or "I have never been homeless"; housing-related discrimination into "experienced housing-related discrimination at least once in my lifetime" or "never experienced housing-related discrimination"; and number of times moved in the past 12 months into "moved twice or more" or "moved once or less."

Several items from another study[51] were adapted for our survey to assess participants' level of satisfaction about various aspects of their dwelling (e.g., layout of rooms), meaningful dimensions of their housing (e.g., "proud of my home"), and their neighbourhood (e.g., satisfied with neighbourhood as a whole). Participants were asked to indicate on a Likert scale their level of satisfaction (ranging from 1 [very satisfied] to 5 [very dissatisfied]), or their agreement with statements describing meaningful dimensions of their housing (ranging from 1 [strongly agree] to 5 [strongly disagree]). For data analysis, items measuring satisfaction with dwelling and neighbourhood features were dichotomized into satisfied (i.e., very satisfied/satisfied) or neutral or dissatisfied (i.e., neutral/dissatisfied/very dissatisfied). Participants' agreements with statements describing meaningful dimensions of their housing were dichotomized into

"strongly agree/agree" or "neutral/disagree/strongly disagree."

Statistical analysis. Data analyses were conducted in 2 stages. First, means and standard deviations were calculated for continuous variables, and frequencies were calculated for categorical variables. Characteristics of HIV/HCV co-infected and HIV mono-infected groups were compared using Student's *t* test and Wilcoxon rank-sum tests for continuous variables and a chi-square test for categorical variables.

A hierarchical multivariable logistic regression model was fitted to examine factors independently associated with HCV co-infection. Hierarchical regression is not constrained by the assumption of independence observations, allows the use of multiple levels of information (thus providing additional statistical benefits), and is suited to public health research involving determinants of health.[52,53] Variables that were associated ($p < 0.05$) with HCV co-infection in bivariable analyses and supported by existing literature were considered candidates for the regression model. We further examined Pearson product-moment correlation coefficients among the candidate variables and allowed only sexual orientation (between gender and sexual orientation) and history of homelessness (among history of homelessness and current homelessness or living in inadequate housing) to enter the final model.

As we were particularly interested in exploring the association between housing and HCV co-infection, selected variables were entered into the regression model in a set of four blocks, with housing variables entered last. First, sociodemographic variables were entered into the model. Health status variables were entered in the second step, followed by incarceration and substance use variables. Finally, housing variables were entered into the model.

Cases with missing data on covariates were omitted from the final regression model. To examine the potential bias that may arise because of the exclusion or inclusion of participants with a history of HCV diagnosis but who were clear of the infection at the time of data collection, sensitivity analysis was conducted by running the hierarchical regression model treating the excluded cases first as HCV/HIV co-infected and then as HIV mono-infected. All analyses were performed using SPSS 16.0 (SPSS Inc., Chicago, IL) and all reported *p* values are two-tailed.

Results

In total, 602 people living with HIV were enrolled in the PSHP study and completed the baseline interview in 2006. Of these, 509 (85%) completed the 1-year follow-up interview in 2007. Table 1 compares the baseline characteristics of the 509 participants who completed the 1-year follow-up with the characteristics of the 93 participants who were lost to follow-up between baseline and 1-year follow-up. Those who were lost to follow-up were more likely to be homeless or to live in adequate housing, to have moved twice or more in the previous 12 months, to have a history of homelessness, to have a history of incarceration, to live in the GTA and to be heavy drinkers than those who completed the 1-year follow-up interview. They were diagnosed with HIV more recently and were less likely to be on antiretroviral treatment. They also had significantly poor functioning and well-being as measured by the mental health summary and the general health perceptions, cognitive functioning, mental health, health distress, and quality of life dimension scores of the MOS-HIV health survey.

Of the 509 participants who completed the 1-year follow-up and were considered for this analysis, 122 (24%) reported a history of diagnosis of HCV infection. Of the 122 with a history of HCV infection, 27 individuals indicated that they were free of the infection and were excluded. The 27 participants excluded from this analysis had sociodemographic, housing, drug use, and health characteristics that were similar to those of the 482 who were included, except for past history of incarceration (43% vs 24%, $p < 0.05$).

Four hundred and eighty-two (482) individuals were eligible for this analysis, including 95 HCV/HIV co-infected and 387 HIV mono-infected participants. CD4 count was unknown for 81 individuals, and 29 participants did not provide age information. Ten (10) participants refused to provide income information. Table 2 summarizes the sociodemographic, housing, incarceration, and substance use characteristics of HCV/HIV co-infected versus HIV mono-infected participants.

There were 120 (25%) women or men-to-women transgendered participants, and 362 men (75%); the mean age was 43 years. Co-infected individuals were more likely to be heterosexual (57% vs 31%, $p < 0.01$), to be Aboriginal (20% vs 10%, $p < 0.01$), to have less than a high school education (41% vs 16%, $p < 0.01$), to be unemployed (87% vs 72%, $p < 0.01$), and to report a monthly income of $1200 or less (63% vs 49%, $p < 0.05$).

Participants with HCV/HIV co-infection were more likely than participants with HIV mono-infection to live outside of the Greater Toronto Area (76% vs 35%, $p < 0.01$), to have a history of homelessness (78% vs 31%, $p < 0.01$), to have experienced housing-related discrimination (51% vs 32%, $p < 0.01$),to have moved twice or more in the previous 12 months (14% versus 5%, $p < 0.01$), and

Table 1: Baseline characteristics of Positive Spaces, Healthy Places study participants

Characteristics	Completed 1-year follow-up *n = 509*		Lost to follow-up *n = 93*	
	Mean or %	(SD) or N	Mean or %	(SD) or N
Sociodemographic characteristics				
Age (years)*	43.4	(8.5)	41.8	(9.0)
Female or transgender †	25%	125	25%	23
Heterosexual	36%	182	39%	36
Aboriginal	12%	61	19%	18
Low education (< high school diploma)	21%	108	27%	25
Unemployed	80%	405	83%	76
Low income (≤ $1200/month) ‡ §	60%	290	62%	52
Housing characteristics				
Live outside of the GTA [a]	41%	209	20%	19
Homeless or live in inadequate housing [a] ¶	4%	19	16%	15
History of homelessness (lifetime) [a]	40%	202	56%	52
History of housing-related discrimination (lifetime)	34%	171	43%	40
Moved twice or more (past 12 months) [b]	11%	56	18%	17
Incarceration and substance use				
History of incarceration (lifetime) [a]	29%	148	44%	41
Heavy drinking (past 12 months) [a] **	15%	74	26%	24
Substance use (past 12 months)	47%	237	54%	50
Health status				
Time since HIV diagnosis [a] ††	12.5	(6.4)	9.5	(6.7)
Have been diagnosed with AIDS	50%	254	47%	44
Receiving antiretroviral treatment [a]	77%	391	59%	55
Significantly depressed (CES-D ≥16)	47%	237	56%	52
Health-related quality of life (MOS-HIV)				
Physical health summary (PHS)	43.0	10.7	42.7	9.4
Mental health summary (MHS) [a]	45.6	11.4	39.4	12.1
General health perceptions [b]	46.1	10.0	43.6	10.6
Physical functioning	46.0	10.3	46.6	9.8
Role functioning	41.4	10.4	40.5	9.9
Cognitive functioning [a]	43.8	11.8	37.7	13.2
Pain	48.0	9.3	48.0	9.7
Energy	44.1	10.4	42.1	10.6
Mental health [a]	47.6	11.6	43.3	11.5
Health distress [a]	47.5	11.8	42.3	12.5
Social functioning	43.7	13.0	41.4	13.7
Quality of life [a]	45.7	12.5	41.1	12.6

[a] $p < 0.01$

[b] $p < 0.05$

* Data missing for 33 participants.

† Includes 4 male-to-female transgender participants.

‡ Baseline data missing for 35 participants.

§ Data missing for 10 participants at 1-year follow-up.

¶ Includes the homeless (i.e., living on the street, parks, cars) couch-surfers, or those living in shelters or a self-contained room in a motel, hotel or boarding house.

** Consumed ≥ 6 drinks on 1 occasion, at least once a month.

†† Data missing for 3 participants.

SD = standard deviation. GTA = Greater Toronto Area. CES-D = Center for Epidemiologic Studies Depression Scale. MOS-HIV = Medical Outcome Study HIV Health Survey.

to be less satisfied with the location of their home (58% vs 70%, $p < 0.05$). They were more likely to report a history of incarceration (82% versus 18%, $p < 0.01$) and substance use (71% versus 31%, $p < 0.01$) in the previous 12 months.

As summarized in Table 3, co-infected individuals were less likely to be on antiretroviral treatment (74% vs 86%, $p < 0.01$), but were more likely to report a significant level of depressive symptoms (64% vs 43%, $p < 0.01$). They also reported significantly ($p < 0.05$) poorer health-related quality of life in both physical and mental health summary measures of the MOS-HIV. HCV/HIV co-infected participants also reported significantly ($p < 0.05$) lower scores in general health perception, physical functioning, role functioning, cognitive functioning, pain, and energy dimensions of the MOS-HIV health survey. The utilization of services of a family doctor, HIV specialist and mental health providers in the past 12 months did not differ statistically between HCV/HIV co-infected and HIV mono-infected participants. However, co-infected participants reported higher utilization of addictions counselling (28% vs 4%, $p < 0.01$) and needle exchange (24% vs 3%, $p < 0.01$) services.

Results of the final hierarchical logistic regression model are presented in Table 4. None of the sociodemographic variables entered in the first block were significant in the final model. Similarly, receipt of antiretroviral treatment and depression were not associated independently with

Table 2: Sociodemographic, housing, incarceration and substance use characteristics of HCV/HIV co-infected and HIV mono-infected participants at 1-year follow-up

	HCV/HIV co-infected *n = 95*		HIV mono-infected *n = 387*	
Characteristics	**Mean or %**	**(SD) or N**	**Mean or %**	**(SD) or N**
Sociodemographic characteristics				
Age (years) *	44.4	(7.6)	44.3	(8.8)
Female or transgender †	27%	26	24%	94
Heterosexual [a]	57%	54	31%	119
Aboriginal [a]	20%	19	10%	39
Have not completed high school [a]	41%	39	16%	61
Unemployed [a]	87%	83	72%	278
Monthly income (≤ $1200/month) [b] ‡	63%	59	49%	187
Housing characteristics				
Live outside of GTA [a]	76%	72	35%	135
Homeless or live in inadequate housing [a] §	6%	6	1%	5
History of homelessness (lifetime) [a]	78%	74	31%	120
History of housing-related discrimination (lifetime) [a]	51%	48	32%	125
Moved twice or more (past 12 months) [a]	14%	13	5%	18
Home is at a good location to live my life [b]	58%	55	70%	269
Satisfied with residence as a whole	63%	60	61%	236
I am proud of my home	62%	59	70%	271
Satisfied with access to health/social service agencies	57%	54	62%	238
Satisfied with neighbourhood as a whole	61%	58	57%	222
I am proud of my neighbourhood	55%	53	64%	247
I feel like I belong in my neighbourhood	55%	52	53%	203
Incarceration and substance use				
History of incarceration (lifetime) [a]	82%	78	18%	69
Heavy drinking (past 12 months) ¶	20%	19	13%	52
Substance use (past 12 months) [a] **	71%	67	31%	120

[a] $p < 0.01$
[b] $p < 0.05$
* Data missing for 29 participants.
† Includes 4 male-to-female transgender individuals.
‡ Data missing for 10 individuals.
§ Includes the homeless (i.e., living on the street, parks, cars) couch-surfers, or those living in shelters or self-contained room in a motel, hotel or boarding house.
¶ Consumed ≥ 6 drinks on one occasion at least once a month.
** Used substances at least once.
SD = standard deviation. GTA = Greater Toronto Area.

HCV co-infection. Both variables entered in the third block—history of incarceration (OR = 8.81, 95% CI 4.43–17.54, $p < 0.001$) and substance use (OR = 2.05, 95 % CI 1.07–3.91; $p < 0.05$)—were independently associated with being infected with HCV. Among the 5 housing-related variables entered in the last block, history of homelessness (OR = 3.15, 95% CI 1.59–6.26, $p < 0.01$) and living outside of the GTA (OR = 3.13, 95% CI 1.59–6.15, $p < 0.01$) were significant in the final regression model.

To examine the potential bias of excluding 27 participants from the analysis, we repeated the regression model first by treating them as HCV/HIV co-infected and then as HIV mono-infected. Results of the regression models (not presented here) showed that history of incarceration, history of homelessness, substance use, and living outside of GTA remained significant in both models. However, the effects of magnitudes were slightly lower than the final model presented in Table 4.

Discussion

Although the prevalence of HCV infection among people living with HIV in Ontario is estimated to be 12%,[4] our study found a 20% prevalence in a community sample. Of all variables associated with HCV infection in bivariable analyses, only history of incarceration, history of homelessness, substance use, and living outside of the GTA were independently associated with self-reported HCV infection status in multivariable analysis.

Our finding of a strong association between history of incarceration and HCV co-infection is consistent with

Table 3: Health status, health care utilization, and health-related quality of life of HCV/HIV co-infected and HIV mono-infected participants at 1-year follow-up

	HCV/HIV co-infected *n = 95*		HIV mono-infected *n = 387*	
Characteristics	**Mean or %**	**(SD) or N**	**Mean or %**	**(SD) or N**
Health status				
Time since HIV diagnosis (years)	12.4	(6.3)	12.4	(6.4)
Have been diagnosed with AIDS	63%	60	54%	209
Receiving antiretroviral treatment [a]	74%	70	86%	331
Significantly depressed (CES-D ≥ 16) [a]	64%	61	43%	167
Health care utilization (previous 12 months)*				
Family doctor	81%	77	88%	338
HIV specialist	88%	84	83%	322
Psychiatrist	20%	19	16%	60
Psychologist or mental health counsellor	15%	14	16%	61
Addiction counsellor [a]	28%	27	4%	17
Needle exchange program [a]	24%	23	3%	10
Health-related quality of life (MOS-HIV dimensions)				
Physical health summary (PHS) [a]	39.8	(10.8)	43.8	(10.6)
Mental health summary (MHS) [b]	43.0	(9.8)	46.1	(11.7)
General health perceptions [a]	43.0	(8.6)	46.7	(10.1)
Physical functioning [b]	43.8	(10.6)	46.7	(10.1)
Role functioning [b]	39.0	(9.9)	41.9	(10.4)
Cognitive functioning [a]	40.6	(11.1)	44.8	(11.7)
Pain [a]	45.5	(9.8)	48.7	(9.2)
Energy [a]	41.0	(9.6)	44.8	(10.6)
Mental health	45.6	(10.4)	47.9	(12.0)
Health distress	46.9	(10.9)	49.2	(11.6)
Social functioning	42.3	(13.3)	43.9	(13.1)
Quality of life	45.0	(12.4)	45.8	(12.4)

[a] $p < 0.01$
[b] $p < 0.05$
* Visited provider at least once.
SD = standard deviation. CES-D = Center for Epidemiologic Studies Depression Scale. MOS-HIV = Medical Outcome Study HIV Health Survey

evidence showing high infection rates among the prison population.[4,54] Prisons may influence the transmission of HCV infection among inmates in several ways. First, a high proportion of those incarcerated use illicit drugs, including injection drugs.[55] Second, because a high proportion of incarcerated individuals are infected with HCV,[55] the prison setting may facilitate HCV transmission among inmates who engage in injection drug use. In addition to injection drug use, other risk factors for hepatitis C transmission, such as unsafe body piercings and unprotected anal sex with male injection drug users are also common in prisons.[56,57] The limited access to or lack of harm-reduction interventions in prisons, such as needle exchange programs or condoms,[55] increases the probability that inmates will contract HCV infection.

In our sample, history of homelessness was strongly associated with HCV co-infection. Previous studies have shown a link between homelessness and increased risk factors for HIV and HCV infection among injection drug users, such as needle sharing, going to a shooting gallery, having multiple sexual partners, and having unprotected sex.[58,59] Although we did not collect data on current injection drug use, needle sharing, and sexual practices of participants, it is possible that those who were homeless at some point in their lives were exposed to these HCV risk factors. In our sample, 55% of the participants (92% of HCV/HIV co-infected and 32% of HIV mono-infected) who reported a history of homelessness had also been incarcerated in the past.

The higher prevalence of HIV/HCV co-infection among those living outside of the GTA may be attributable in part to the high HCV infection rates among injection drug users in South West, Central West, East, and Northern Ontario, as compared with Central Eastern Ontario, which includes the GTA.[60] In our sample, higher proportions of participants from areas outside of the GTA reported a history of incarceration, a history of homelessness, and substance use. Therefore, the higher prevalence of HCV infection outside of the GTA may be a reflection of the higher prevalence of HCV risk factors in those areas of the province. We also hypothesize that the lack or shortage of health care, housing, employment, and social support services outside of the GTA compared with in the GTA may be a factor for the high prevalence of HIV/HIV co-infection. For example, in our sample, participants living outside of the GTA were more likely to report the need for more needle exchange services and addictions counselling than those who lived in the GTA.

There are limitations to our study. First, our study participants are primarily individuals affiliated with or receiving services from CBAOs. Although it is not possible to establish how representative these participants were of people living with HIV in Ontario, comparison of our participants with epidemiological data on people living with HIV in Ontario in 2006 [61] shows some similarity. For example, 76% of our participants were male (vs 82%), 60% were gay or bisexual men (vs 68%), 91% were between the ages of 15 and 60 years (vs 97%). However, we cannot rule out the possibility of other biases, since individuals recruited from organizations serving stigmatized populations may be different from those who do not receive these services,[62] and a study[63] has found that

Table 4: HCV co-infection status as a function of sociodemographic, health status, incarceration and substance use/abuse, and housing characteristics: odds ratio (95% CI) from hierarchical logistic regression model (*N* = *482*)

Variable	Step 1	Step 2	Step 3	Step 4
Heterosexual	2.70 (1.67–4.34)[a]	2.62 (1.61–4.27)[a]	2.52 (1.40–4.54)[a]	1.73 (0.91–3.30)
Aboriginal	1.50 (0.77–2.91)	1.53 (0.78–3.00)	1.06 (0.48–2.35)	0.92 (0.41–2.06)
Education (< High school)	2.86 (1.69–4.83)[a]	2.89 (1.69–4.94)[a]	1.57 (0.82–3.03)	1.58 (0.80–3.12)
Unemployed	2.15 (1.09–4.21)[a]	1.78 (0.88–3.60)	1.22 (0.56–2.68)	1.28 (0.56–2.94)
Not on antiretroviral treatment		2.26 (1.25–4.09)[a]	1.73 (0.86–3.51)	1.78 (0.84–3.76)
Significant depression (CSE-D ≥ 16)		2.11 (1.27–3.52)[a]	1.91 (1.04–3.51)[b]	1.61 (0.83–3.13)
History of incarceration			12.80 (6.75–24.28)[a]	8.81 (4.43–17.54)[a]
Substance use			2.46 (1.33–4.53)[a]	2.05 (1.07–3.91)[b]
Live outside of GTA				3.13 (1.59–6.15)[a]
History of homelessness				3.15 (1.59–6.26)[a]
History of housing-related discrimination				0.76 (0.39–1.46)
Moved twice or more (past 12 months)				0.45 (0.16–1.32)
Home is not at a good location				0.97 (0.51–1.85)

[a] $p < 0.01$ (two-tailed)
[b] $p < 0.05$ (two-tailed)
CI = confidence interval. GTA = Greater Toronto Area. CES-D = Center for Epidemiologic Studies Depression Scale

those who receive services from CBAOs are more likely to have poor health and physical disability. Second, it is possible that, because of their HIV-positive status, the participants may have had increased contact with the health care system and hence may be more likely to be aware of their HCV status and to report a diagnosis of HCV infection than the general population. The use of self-reported HCV status as an outcome measure may also underestimate the true prevalence of HCV infection: studies have reported its low sensitivity in comparison with laboratory diagnosis.[34,64] Third, all data are self-reported and were collected through face-to-face interviews and may be subject to recall and social desirability response biases. Finally, given the cross-sectional nature of the study, we are unable to draw conclusions about the cause and effect or direction of association between social determinants of health and HCV co-infection.

Despite these limitations, our findings contribute to existing evidence that certain determinants of health are associated with HCV infection among people living with HIV. Our study suggests that incarceration, homelessness, substance use, and living outside of the GTA are independently associated with HCV infection among people living with HIV in Ontario. Three of these four factors—homelessness, incarceration, and substance use—are highly interconnected and are influenced by socioeconomic and social factors.[27,29] Interventions that reduce homelessness may reduce the risk of HCV infection, and housing may represent one potential amenable factor in the prevention of HCV co-infection among those living with HIV. Interventions that reduce the risk of unsafe drug use and tattooing in closed housing environments, such as prisons—including access to clean equipment as well as substitution therapy and other addiction treatment services—would also likely reduce the risk of HCV co-infection in people with HIV.

Dedication: This article is dedicated to the memory of LaVerne Monette, co-investigator with the CIHR-funded Positive Spaces, Healthy Places (PSHP) research project, who passed away December 1, 2010. Responsible for the Aboriginal arm of the study, she played a key role in developing the questionnaire, analyzing the data and presenting the findings. She brought to our team her life experiences as an Aboriginal woman and her passion to help Aboriginal people living with and at risk of HIV. She understood the critical role of housing in health and quality of life, and was a strong advocate for research to identify the housing needs of Aboriginal people in Ontario and for policy change that will lead to safe, stable housing for all.

Contributors: **Sean Rourke** conceived the project, contributed to the design of the study, oversaw data collection, guided the data analysis, and was the principal writer of the manuscript. He is responsible for the integrity of the work as a whole. **Michael Sobota** conceived the study, oversaw data collection, contributed to interpretation of the data, and revised the manuscript drafts. **Ruthann Tucker** conceived the study, contributed to the design of the study and interpretation of data, and revised the manuscript. **Saara Greene, LaVerne Monette, Jay Koornstra,** and **Steve Byers** conceived the study, contributed to the design of the study, oversaw data collection, and reviewed the manuscript. **Tsegaye Bekele** conducted the data analysis and participated in all phases of the writing. **Katherine Gibson** participated in the design of the study, participated in drafting the manuscript, and reviewed the manuscript. **Colleen Price** participated in the conception of the study, contributed to interpretation of the data, and reviewed the manuscript. **James Watson** participated in the design of the study and collection of data, contributed to the interpretation of data, and reviewed the manuscript. **Stephen Hwang, Dale Guenter**, and **James Dunn** conceived the project, participated in the design of the study, contributed to the data interpretation, and revised the article. **Michael Wilson** contributed to the interpretation of the data, drafted the article, and reviewed the manuscript. **Amrita Ahluwalia** oversaw data collection and revised manuscript drafts. **Jean Bacon** contributed to the design of the study, drafted the manuscript, and reviewed the article. All of the authors approved the final version of the manuscript.

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