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# The prevalence and correlates of hepatitis C virus (HCV) infection and HCV–HIV co-infection in a community sample of gay and bisexual men

Ted Myers<sup>a,b,\*</sup>, Dan Allman<sup>a,b</sup>, Kunyong Xu<sup>a,b</sup>, Robert S. Remis<sup>a,b</sup>, Jeffrey Aguinaldo<sup>a,c</sup>, Ann Burchell<sup>a</sup>, Liviana Calzavara<sup>a,b</sup>, Carol Swantee<sup>d</sup>

<sup>a</sup>HIV Social, Behavioral and Epidemiological Studies Unit, University of Toronto, Room 516, 155 College Street, Toronto, M5T 3M7 Canada

<sup>b</sup>Dalla Lana School of Public Health, University of Toronto, Toronto, Ontario, Canada

<sup>c</sup>Department of Sociology, Wilfrid Laurier University, Waterloo, Ontario, Canada

<sup>d</sup>HIV Laboratory, Central Public Health Laboratory, Ontario Ministry of Health and Long-Term Care, Toronto, Ontario, Canada

Received 6 September 2008; received in revised form 17 November 2008; accepted 28 November 2008

Corresponding Editor: William Cameron, Ottawa, Canada

## KEYWORDS

HCV;  
HIV;  
MSM;  
Gay and bisexual;  
Prevalence;  
Correlates

## Summary

**Objective:** To describe hepatitis C virus (HCV) and HIV prevalence and co-infection, and to examine variables associated with infection in a community sample of men who have sex with men (MSM).

**Methods:** Data were from an anonymous, cross-sectional study ( $N = 5080$ ) in Canada. Men self-completed a questionnaire and provided an optional saliva specimen for HCV and HIV testing. Polytomous logistic regressions identified variables associated with HCV, HIV, and HCV–HIV co-infection.

**Results:** The prevalences of HCV, HIV, and HCV–HIV co-infection were 1.9%, 9.0%, and 0.7%, respectively. The greatest contribution to HCV (odds ratio (OR) 23.66, 95% confidence interval (CI) 9.69–57.73) and HCV–HIV co-infection (OR 26.76, 95% CI 7.97–89.80) was injection drug use. Sexual behaviors and proxies were associated with HIV but not HCV infection.

**Conclusions:** Results suggest there are subgroups of MSM at risk for HCV. While sexual transmission of HCV was not ruled out, the predominant risk was needle sharing. The greater prevalence of HCV among HIV-positive men suggests the need for greater vigilance in the detection of HCV in this group.

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\* Corresponding author. Tel.: +1 416 978 8979; fax: +1 416 971 2704.

E-mail address: [ted.myers@utoronto.ca](mailto:ted.myers@utoronto.ca) (T. Myers).

## Introduction

Worldwide, few studies have been undertaken to determine the prevalence of hepatitis C virus (HCV) or to examine social and other behavioral risk factors associated with this infection in a community sample. Most HCV prevalence estimates have been derived from modeling of data from clinic and laboratory populations and through cohort studies.<sup>1</sup> Clinical and population-based studies have predominantly captured heterosexual populations and many have excluded known homosexual populations. Methods have not been designed to include marginalized and difficult to sample groups such as gay and bisexual men.

HCV prevalence varies greatly from country to country and from region to region.<sup>1</sup> It is estimated that one third of HIV-positive persons worldwide are co-infected with HCV.<sup>2</sup> While estimates of co-infection rates vary among 'at-risk' populations, co-infections occur most frequently among injection drug users (IDUs).<sup>3–5</sup> Concern about co-infection among HIV-infected populations exists for a number of reasons. HIV-infected people are more likely to be susceptible to HCV morbidity,<sup>3</sup> and co-infection is thought to accelerate HIV disease progression. Further, persons co-infected with HCV and HIV exhibit more rapid progression to liver cirrhosis and liver failure.<sup>6–10</sup> Available treatments for co-infection are challenging and complex.<sup>2</sup>

Given what is known about transmission, research identifying HCV and HCV–HIV co-infection has mainly focused on IDUs. A large number of studies have shown that HCV prevalence among HIV-infected IDUs is higher than HIV-negative IDUs. Several studies have found increased prevalence of HCV among men who have sex with men (MSM) compared with the general population.<sup>11–17</sup> The contribution of sexual activities between gay and bisexual men to HCV transmission has been somewhat equivocal.<sup>11–13,18</sup> There are a number of reasons why gay and bisexual male populations may be at risk for HCV. First, considerable drug use and potential mixing with injection drug using populations may place those in the gay community at risk for HCV. For example, in a study of gay and bisexual men who use drugs other than alcohol or marijuana, 52% reported needle use at least once in their lifetime.<sup>19</sup> Millson et al. (1995) reported that rates of HIV infection among male IDUs who have sex with men (29%) are higher than other male IDUs in a community sample (4.9%).<sup>20</sup> Second, with the repertoire of sexual activities practiced by gay and bisexual men, rectal trauma may result in an increased potential for direct exposure to blood.<sup>21,22</sup> While Craib (2004) found the predominant factor associated with HCV infection among MSM to be injection drug use, he also identified the sexual practice of insertive fisting to be marginally associated with HCV seropositivity.<sup>23</sup> Rauch and colleagues have found unprotected anal intercourse to be associated with increased incidence of HCV infection among MSM.<sup>26</sup>

The purpose of this study was to assess the prevalence of HCV and HCV–HIV co-infection in a community sample of gay and bisexual men. The specific objectives were to ascertain HCV prevalence, to examine the extent of co-infection with HIV, and to undertake investigations of variables and factors associated with HCV infection and HCV–HIV co-infection.

## Methods

### Study population

The data used for this analysis were from an anonymous, cross-sectional study of socio-behavioral issues and sexual health in a community sample of gay and bisexual men in Ontario, Canada. The survey was based in venues, including bars and bathhouses, and community groups in 13 cities/regions. A purposive sampling strategy was utilized to recruit a diverse sample of gay and bisexual men.

Only men over the age of 15 years were included. Informed consent was obtained verbally from all participants prior to data collection. The study received approval from the University of Toronto Research Ethics Board.

### Data collection

Data collection was conducted by trained coordinators and volunteer recruiters. A self-report questionnaire was available in seven languages (English, French, Chinese, Portuguese, Spanish, Tamil, and Vietnamese). The sampling strategy was developed prior to entry in the field through an assessment of the patterns of socialization (i.e., number of venues, groups, days of week for special events, etc.). Over 418 recruitment sessions, varied by day-of-week and time-of-day were conducted. The number of respondents recruited in each venue was determined by the venue size. A systematic sampling approach was utilized to ensure that individuals frequenting venues at different points in time were selected.

The questionnaire sought information on sociodemographic and personal characteristics, socialization, sexual health, patterns of partner seeking, sexual relationships, condom use, sexual behavior (lifetime, past 12 months, and past 3 months), substance use, and HIV testing. Upon completion of the questionnaire, respondents were given the option to provide a saliva specimen. The saliva specimen was collected with an Omni-Sal™ device. Completed anonymous questionnaires and saliva specimens were coded with unique identifiers prior to analysis.

### Laboratory methods

HIV and HCV antibody testing were conducted at the Central Public Health Laboratory, Ontario Ministry of Health and Long-Term Care. The hepatitis C screen test was performed using the Ortho Diagnostic HCV 3.0 SAvE ELISA test kit and the confirmatory testing was performed using the Bio-Rad Mono-lisa anti-HCV Plus version 2. The sensitivity of the assay ranged from 72% to 88% and the specificity ranged from 89% to 100%.<sup>25</sup> Fluid specimens were tested for the HIV antibody using the Biochem Detect HIV v1 test kit, an enzyme linked immunoassay (ELISA). Reactive specimens were confirmed with the Vironostika HIV-1 Micro-ELISA system (bio-Merieux, Organon Teknika). The Vironostika assay was sensitive (98.7%) and highly specific (100%). If the second test was not reactive (indeterminate or negative), the discrepancy was resolved using a Genetic Systems HIV-1 Western Blot (Bio-Rad).

**Table 1** The characteristics of participants providing sufficient saliva for HCV and HIV testing and those not providing saliva

Variables	No saliva provided (N = 1445)		Sufficient saliva provided (N = 3304)	
	n (%)	Mean (SD)	n (%)	Mean (SD)
<b>Sociodemographic</b>				
Age		34.9 (11.1)		35.5 (11.8)
First language <sup>a</sup>				
English	1101 (76.7)		2624 (80.0)	
Other	334 (23.3)		656 (20.0)	
Education <sup>a</sup>				
High school or less	364 (25.3)		743 (22.6)	
College or university	907 (63.2)		2084 (63.4)	
Graduate education	165 (11.5)		458 (13.9)	
Employment status <sup>a</sup>				
In labor force	1128 (78.8)		2431 (74.4)	
Not in labor force	304 (21.2)		836 (25.6)	
Student status (yes)	284 (20.3)		658 (20.4)	
Personal income				
Less than \$29 999	565 (40.9)		1384 (43.1)	
\$30 000–\$59 999	557 (40.4)		1195 (37.2)	
\$60 000 or more	258 (18.7)		635 (19.8)	
Ethnicity <sup>a</sup>				
Caucasian	1117 (77.3)		2703 (81.8)	
Other	328 (22.7)		601 (18.2)	
Aboriginal (yes)	50 (3.7)		89 (2.8)	
Country of birth <sup>a</sup>				
Canada	993 (76.7)		2436 (80.0)	
Other	302 (23.3)		610 (20.0)	
Years lived in Canada <sup>a</sup>		30.1 (14.0)		31.5 (14.3)
<b>Social life</b>				
Gay bar attendance				
Never or <2/year	643 (45.9)		1480 (45.7)	
1–3/month	577 (41.2)		1376 (42.5)	
>3/month	182 (13.0)		384 (11.9)	
Straight bar attendance <sup>a</sup>				
Never or <2/year	244 (17.6)		482 (14.9)	
1–3/month	554 (39.9)		1282 (39.6)	
>3/month	591 (42.5)		1474 (45.5)	
Bathhouse attendance				
Never or <2/year	82 (5.9)		151 (4.7)	
1–3/month	286 (20.7)		682 (21.1)	
>3/month	1016 (73.4)		2401 (74.2)	
Gay dance, events or parties attendance <sup>a</sup>				
Never or <2/year	159 (11.4)		360 (11.1)	
1–3/month	541 (38.9)		1461 (45.2)	
>3/month	691 (49.7)		1412 (43.7)	
Members of an organized gay or bisexual group or organization not AIDS-related (yes) <sup>a</sup>	294 (21.0)		866 (27.7)	
<b>Sexual identity</b>				
Gay	1136 (81.4)		2716 (84.0)	
Bisexual	190 (13.6)		386 (11.9)	
Other	70 (5.0)		133 (4.1)	

**Table 1** (Continued)

Variables	No saliva provided (N = 1445)		Sufficient saliva provided (N = 3304)	
	n (%)	Mean (SD)	n (%)	Mean (SD)
<b>Sexual health</b>				
Oral gonorrhoea (ever)	48 (3.3)		130 (3.9)	
Rectal gonorrhoea (ever)	40 (2.8)		84 (2.5)	
Urethral gonorrhoea (ever) <sup>a</sup>	105 (7.3)		319 (9.7)	
Chlamydia (ever) <sup>a</sup>	59 (4.1)		184 (5.6)	
Genital or anal warts (ever) <sup>a</sup>	102 (7.1)		300 (9.1)	
Syphilis (ever) <sup>a</sup>	27 (1.9)		114 (3.5)	
Genital herpes (ever)	30 (2.1)		100 (3.0)	
Hepatitis A (ever) <sup>a</sup>	46 (3.2)		149 (4.5)	
Hepatitis B (ever)	65 (4.5)		170 (5.1)	
<b>Sex life</b>				
Total number of male sex partners in the past 12 months <sup>a</sup>				
1	324 (25.3)		705 (23.7)	
2–4	418 (32.7)		899 (30.2)	
≥5	538 (42.0)		1376 (46.2)	
Paid money to a male for sex in the past 12 months (yes)	86 (6.6)		186 (6.2)	
Received money for sex from a male in the past 12 months (yes)	96 (7.4)		207 (6.9)	
Gave drugs, goods, clothing, protection, or shelter to a male for sex in the past 12 months (yes)	46 (3.6)		123 (4.1)	
Received drugs, goods, clothing, protection, or shelter from a male for sex in the past 12 months (yes)	63 (4.9)		149 (4.9)	
UIAI (ever) <sup>a</sup>	706 (55.0)		1915 (64.1)	
URAI (ever) <sup>a</sup>	660 (51.5)		1722 (57.7)	
<b>Genital modification</b>				
Circumcised (cut) (yes)	900 (63.8)		2118 (64.7)	
Genital piercing (yes)	29 (2.1)		90 (2.8)	

SD, standard deviation; UIAI, unprotected insertive anal intercourse with a man; URAI, unprotected receptive anal intercourse with a man.

<sup>a</sup>  $p < 0.05$ .

## Data analysis

We carried out descriptive analyses of the sample including the distribution of key sociodemographic and personal characteristics, socialization, sexual health, sex life, and recreational drug use variables. Only participants providing sufficient saliva for testing were included in the univariate and multivariate analyses. Categorical variables were dummy coded. Univariate and multivariate polytomous logistic regressions were used to identify the variables associated with the presence of HCV infection only, HIV infection only, and HCV–HIV co-infection relative to individuals who had no infection. Crude odds ratios (COR), adjusted odds ratios (AOR), and 95% confidence intervals (CI) were calculated. A backward selection process was used to identify factors associated with the outcome. If the  $p$ -value of the variable was less than or equal to 0.20 in the univariate polytomous analysis, it was entered into the multivariate polytomous analysis. The significance level

required for inclusion was set at 0.05. All analyses were performed using SAS, version 9.1 (SAS Institute Inc., Cary, NC, USA).

## Results

### Study sample characteristics

In total, 5080 men participated in the survey. Of these, 3635 (71.6%) participants provided saliva and 3304 (65.0%) of specimens collected contained sufficient fluid to conduct laboratory tests to detect the presence of both HCV and HIV antibodies.

Table 1 compares the characteristics of the participants who provided sufficient saliva for HIV and HCV biological testing with the characteristics of those who did not provide saliva. The 331 (6.5%) men who provided saliva but whose saliva was not sufficient for HCV and HIV biological testing and who were excluded from univariate and multivariate analysis did not differ from men who had sufficient saliva.

## Drug use

For those who provided sufficient saliva, more than half (60.2%) reported the use of recreational drugs in the previous 12 months. The most commonly used drugs were marijuana/hash (46.9%), poppers (21.3%), ecstasy (19.7%), cocaine (17.5%), and special K (12.9%). Further, 185 (5.7%) reported using a needle to inject a recreational drug in their lifetime.

## HCV, HIV, and HCV–HIV prevalence

In this sample, the overall HCV prevalence was 1.9% and the overall HIV prevalence was 9.0%. The prevalence rates of HCV infection only, HIV infection only, and HCV–HIV co-infection among men providing sufficient saliva (i.e., the sample examined in the regression analysis), were 1.2% (0.86–1.6%), 8.3% (7.4–9.3%), and 0.7% (0.41–0.98%), respectively.

Table 2 presents the HCV, HIV, and HCV–HIV prevalence and prevalence ratios for various subgroups of individuals.

## Univariate analyses

Univariate polytomous logistic regressions were undertaken to examine the relationship of sociodemographic and personal characteristics, socialization, sexual health, sex life, and drug use variables with HCV infection, HIV infection, and HCV–HIV co-infection (see Table 3).

## Multivariate analyses

Multivariate polytomous logistic regressions were used to examine the associations among selected variables and HCV infection, HCV–HIV co-infection, and HIV infection individually in relation to no infection (see Table 4).

**Table 2** HCV, HIV, and HCV–HIV prevalence and prevalence ratios ( $N = 3304$ )

Categories	HCV prevalence ( $n$ ) <sup>a</sup>	PR	HIV prevalence ( $n$ ) <sup>a</sup>	PR	HCV–HIV prevalence ( $n$ ) <sup>a</sup>	PR
Overall	1.9% (64)		9.0% (298)		0.7% (23)	
HCV status						
Positive			35.9% (23) <sup>b</sup>	4.2		
Negative			8.5% (275)	1.0		
HIV status						
Positive	7.7% (23) <sup>b</sup>	5.5				
Negative	1.4% (41)	1.0				
Recreational drug user (past 12 months)						
Yes	2.7% (54) <sup>b</sup>	3.6	11.2% (222) <sup>b</sup>	1.9	1.0% (20) <sup>b</sup>	4.3
No	0.76% (10)	1.0	5.8% (76)	1.0	0.23% (3)	1.0
Injection drug use						
Ever	19.5% (36) <sup>b</sup>	25.7	28.1% (52) <sup>b</sup>	3.6	7.6% (14) <sup>b</sup>	33
Never	0.76% (23)	1.0	7.8% (236)	1.0	0.23% (7)	1.0
Sexual identity						
GBI	1.6% (10) <sup>b</sup>	0.21	9.3% (6)	2.1	0.64% (20) <sup>b</sup>	0.28
Other	7.5% (50)	1.0	4.5% (288)	1.0	2.3% (3)	1.0
HIV-positive						
GBI					6.9% (3) <sup>b</sup>	0.14
Other					50.0% (20)	1.0
Recreational drug users						
GBI	2.4% (44)	1.0	11.6% (216)	2.5	0.97% (18)	0.42
Other	2.3% (1)	1.0	4.7% (2)	1.0	2.3% (1)	1.0
Injection drug users						
GBI	17.8% (29) <sup>b</sup>	6.8	30.1% (49) <sup>b</sup>	16.7	7.4% (12) <sup>b</sup>	
Other	2.6% (3)	1.0	1.8% (2)		0.0% (0)	

PR, prevalence ratio; GBI, gay or bisexual identified.

<sup>a</sup> Number may vary based on questionnaire item response.

<sup>b</sup>  $p$ -Value of Chi-square test is less than 0.05.

**Table 3** Univariate polytomous logistic regression (N = 3304)

Variables	HCV infection only		HCV–HIV co-infection		HIV infection only	
	COR (95% CI)	p-Value	COR (95% CI)	p-Value	COR (95% CI)	p-Value
<b>Sociodemographic</b>						
Age	<b>1.04 (1.02, 1.07)</b>	<b>0.0006</b>	<b>1.05 (1.02, 1.09)</b>	<b>0.0007</b>	<b>1.04 (1.03, 1.05)</b>	<b>&lt;0.0001</b>
First language (other) <sup>a</sup>	0.94 (0.43, 2.05)	NS	0.58 (0.17, 1.97)	NS	0.74 (0.53, 1.04)	0.0800
Education <sup>b</sup>						
College or university	<b>0.31 (0.16, 0.60)</b>	<b>0.0005</b>	<b>0.34 (0.14, 0.83)</b>	<b>0.0175</b>	0.90 (0.67, 1.20)	0.4624
Graduate	0.40 (0.15, 1.08)	0.0707	0.46 (0.13, 1.67)	NS	<b>0.57 (0.36, 0.92)</b>	<b>0.0196</b>
Employment status <sup>c</sup>						
Not in labor force	1.72 (0.88, 3.39)	0.1146	<b>11.94 (4.42, 32.26)</b>	<b>&lt;0.0001</b>	<b>12.80 (2.17, 3.60)</b>	<b>&lt;0.0001</b>
Student status (yes) <sup>d</sup>	<b>10.71 (1.47, 78.12)</b>	<b>0.0194</b>	6.20 (0.83, 46.07)	0.0747	<b>3.72 (2.32, 5.98)</b>	<b>&lt;0.0001</b>
Personal income <sup>e</sup>						
Less than \$29 999	1.24 (0.54, 2.81)	NS	2.82 (0.83, 9.64)	0.0965	1.22 (0.86, 1.74)	NS
\$30 000–\$59 999	0.60 (0.23, 1.57)	NS	0.18 (0.019, 1.72)	0.1363	1.24 (0.87, 1.79)	NS
Ethnicity (other) <sup>f</sup>	0.49 (0.17, 1.37)	0.1716	1.25 (0.46, 3.38)	NS	1.05 (0.76, 1.44)	NS
Country of birth (other) <sup>g</sup>	0.75 (0.31, 1.80)	NS	0.71 (0.21, 2.42)	NS	1.08 (0.78, 1.48)	NS
<b>Social life</b>						
Gay bar attendance <sup>h</sup>						
1–3 times a month	1.05 (0.39, 2.84)	NS	0.55 (0.19, 1.63)	NS	0.99 (0.66, 1.49)	NS
>3 times a month	0.77 (0.28, 2.13)	NS	0.36 (0.11, 1.14)	0.0820	1.01 (0.67, 1.52)	NS
Straight bar attendance <sup>h</sup>						
1–3 times a month	1.12 (0.54, 2.30)	NS	0.92 (0.38, 2.22)	NS	<b>0.73 (0.56, 0.95)</b>	<b>0.0183</b>
>3 times a month	1.73 (0.75, 3.98)	0.1976	0.52 (0.12, 2.37)	NS	<b>0.40 (0.25, 0.64)</b>	<b>0.0001</b>
Bathhouse attendance <sup>h</sup>						
1–3 times a month	1.35 (0.63, 2.89)	NS	2.10 (0.83, 5.28)	0.1160	<b>2.54 (1.94, 3.33)</b>	<b>&lt;0.0001</b>
>3 times a month	2.09 (0.63, 7.01)	NS	<b>4.19 (1.18, 14.88)</b>	<b>0.0270</b>	<b>2.78 (1.73, 4.47)</b>	<b>&lt;0.0001</b>
Member of an organized gay or bisexual group or organization that is not AIDS-related (no) <sup>i</sup>	1.42 (0.65, 3.11)	NS	1.80 (0.61, 5.30)	NS	<b>1.43 (1.06, 1.94)</b>	<b>0.0195</b>
Identity <sup>j</sup>						
Gay	<b>0.16 (0.068, 0.39)</b>	<b>&lt;0.0001</b>	<b>0.23 (0.065, 0.81)</b>	<b>0.0225</b>	<b>4.10 (1.29, 12.98)</b>	<b>0.0165</b>
Bisexual	0.34 (0.12, 0.99)	0.0471	0.68 (0.17, 2.75)	NS	2.15 (0.62, 7.38)	NS
<b>Sexual health</b>						
Oral gonorrhoea (ever) <sup>k</sup>	0.74 (0.10, 5.43)	NS	2.82 (0.65, 12.18)	0.1659	<b>3.62 (2.36, 5.56)</b>	<b>&lt;0.0001</b>
Rectal gonorrhoea (ever) <sup>k</sup>	2.82 (0.66, 11.97)	0.1605	<b>5.24 (1.20, 22.89)</b>	<b>0.0279</b>	<b>5.98 (3.70, 9.68)</b>	<b>&lt;0.0001</b>
Urethral gonorrhoea (ever) <sup>k</sup>	0.88 (0.27, 2.87)	NS	1.67 (0.49, 5.67)	NS	<b>3.74 (2.76, 5.05)</b>	<b>&lt;0.0001</b>
Chlamydia (ever) <sup>k</sup>	0.46 (0.063, 3.37)	NS	0.84 (0.11, 6.24)	NS	<b>2.17 (1.43, 3.29)</b>	<b>0.0003</b>
Genital or anal warts (ever) <sup>k</sup>	1.71 (0.66, 4.40)	NS	2.59 (0.87, 7.68)	0.0863	<b>4.04 (2.97, 5.49)</b>	<b>&lt;0.0001</b>
Genital herpes (ever) <sup>k</sup>	1.05 (0.14, 7.74)	NS	<b>6.30 (1.83, 21.69)</b>	<b>0.0035</b>	<b>4.57 (2.88, 7.26)</b>	<b>&lt;0.0001</b>
Hepatitis A (ever) <sup>k</sup>	1.43 (0.34, 5.98)	NS	<b>12.16 (4.90, 30.20)</b>	<b>&lt;0.0001</b>	<b>14.32 (2.90, 6.43)</b>	<b>&lt;0.0001</b>
Hepatitis B (ever) <sup>k</sup>	1.92 (0.59, 6.32)	NS	<b>3.65 (1.07, 12.46)</b>	<b>0.0386</b>	<b>5.02 (3.49, 7.22)</b>	<b>&lt;0.0001</b>
<b>Sex life</b>						
Total number of male sex partners in the past 12 months <sup>l</sup>						
2–4	0.96 (0.41, 2.23)	NS	5.59 (0.69, 45.55)	0.1078	1.21 (0.81, 1.80)	NS
≥5	0.59 (0.25, 1.41)	NS	5.40 (0.69, 42.25)	0.1083	<b>1.87 (1.32, 2.66)</b>	<b>0.0005</b>
Paid money to a male for sex in the past 12 months (yes) <sup>d</sup>	0.96 (0.23, 4.03)	NS	0.85 (0.11, 6.40)	NS	1.07 (0.64, 1.79)	NS
Received money for sex from a male in the past 12 months (yes) <sup>d</sup>	<b>2.63 (1.01, 6.90)</b>	<b>0.0491</b>	2.76 (0.80, 9.58)	0.1089	<b>1.70 (1.11, 2.61)</b>	<b>0.0149</b>
Gave drugs, goods, clothing, protection, or shelter to a male for sex in the past 12 months (yes) <sup>d</sup>	2.78 (0.84, 9.27)	0.0955	<b>11.06 (3.86, 31.68)</b>	<b>&lt;0.0001</b>	<b>12.91 (1.82, 4.66)</b>	<b>&lt;0.0001</b>

**Table 3** (Continued)

Variables	HCV infection only		HCV–HIV co-infection		HIV infection only	
	COR (95% CI)	p-Value	COR (95% CI)	p-Value	COR (95% CI)	p-Value
Received drugs, goods, clothing, protection, or shelter from a male for sex in the past 12 months (yes) <sup>d</sup>	1.49 (0.35, 6.30)	NS	<b>11.93 (4.39, 32.37)</b>	<0.0001	<b>13.33 (2.20, 5.06)</b>	<0.0001
UIAI (ever) <sup>k</sup>	0.53 (0.27, 1.04)	0.0641	2.22 (0.74, 6.72)	0.1567	<b>2.21 (1.62, 3.01)</b>	<0.0001
URAI (ever) <sup>k</sup>	0.58 (0.29, 1.17)	0.1296	2.22 (0.80, 6.18)	0.1267	<b>2.88 (2.12, 3.92)</b>	<0.0001
Genital modification						
Circumcised (yes) <sup>d</sup>	0.76 (0.38, 1.54)	NS	0.87 (0.35, 2.14)	NS	1.04 (0.80, 1.34)	NS
Genital piercing (yes) <sup>d</sup>	1.03 (0.14, 7.61)	NS	1.86 (0.25, 14.05)	NS	<b>2.28 (1.29, 4.03)</b>	<b>0.0047</b>
Drug use						
Recreational drug use in the past 12 months (yes) <sup>d</sup>	<b>3.46 (1.53, 7.83)</b>	<b>0.0029</b>	<b>4.75 (1.41, 16.01)</b>	<b>0.0120</b>	<b>1.97 (1.49, 2.60)</b>	<0.0001
Used a needle to inject a recreational drug (ever) <sup>k</sup>	<b>34.61 (17.69, 67.73)</b>	<0.0001	<b>150.34 (19.92, 127.20)</b>	<0.0001	<b>14.18 (2.82, 6.18)</b>	<0.0001

COR, crude odds ratio; CI, confidence interval; NS, not significant at 0.20 level; UIAI, unprotected insertive anal intercourse with a man; URAI, unprotected receptive anal intercourse with a man.

Reference level: <sup>a</sup>English; <sup>b</sup>elementary/high school; <sup>c</sup>in labor force; <sup>d</sup>no; <sup>e</sup>\$ 60 000 or more; <sup>f</sup>Caucasian; <sup>g</sup>Canada; <sup>h</sup>never/less than twice a year; <sup>i</sup>yes; <sup>j</sup>other; <sup>k</sup>never; <sup>l</sup>one.

In view of the cumulative nature of prevalence, infection was associated with increasing age in all three groupings (HCV infection, HCV–HIV co-infection, and HIV infection). HCV and HCV–HIV co-infection were not associated with education. However, HIV infection was less likely to be associated with those with graduate education compared to those with high school education or less. HCV–HIV co-infection as well as HIV infection were more likely to be found among those who were not in the labor force compared to those who were.

HCV, HIV, and HCV–HIV co-infection were not associated with gay bar or straight bar attendance. Men who attended bathhouses one to three times a month were more likely to be HIV-infected compared to those who never attended or attended bathhouses less than twice a year (AOR 2.03, 95% CI 1.49–2.76).

Similar to socializing variables, a number of sexually transmitted diseases (STDs) dropped out in the multivariate analysis. Nevertheless, urethral gonorrhea and genital or anal warts were associated with HIV infection. Men who had ever had hepatitis A virus (HAV) were more likely to be HCV–HIV co-infected compared to those who never had (AOR 16.64, 95% CI 4.17–66.36;  $p < 0.0001$ ). This association is somewhat difficult to explain based simply on route of transmission. The main source of HAV transmission is fecal and the main source of transmission for HCV and HIV is through blood or semen, respectively. It is possible that individuals who are HCV–HIV co-infected may engage in a wider range of sexual activities, which may include oral–anal contact and oral sex, where HAV transmission is more likely to occur. Our data on unprotected oral, and oral–anal sex did not adequately permit us to examine this. Also, it is possible that HCV–HIV co-infection may accelerate the likelihood of becoming HAV-infected. Further, men who were ever infected with hepatitis B were more likely to be HIV-infected compared to others (AOR 1.98, 95% CI 1.24–3.14;  $p = 0.0040$ ).

Unprotected receptive anal intercourse was associated with HIV infection (AOR 2.14, 95% CI 1.52–2.99;  $p < 0.0001$ ) but not with HCV or HCV–HIV co-infection. Receipt of drugs, goods, clothing, protection, or shelter from a male in exchange for sex was not associated with HCV infection but was associated with HCV–HIV co-infection and HIV infection; and there was a stronger association with HCV–HIV co-infection (AOR 7.18, 95% CI 1.81–28.45;  $p = 0.0050$ ) than HIV infection (AOR 2.38, 95% CI 1.41–4.00;  $p = 0.0011$ ). Further, no associations were found for the receipt of money in exchange for sex.

Variables most strongly associated with HCV and HCV–HIV co-infection were recreational drug use and injection drug use. For injecting drugs, the respective AORs were 23.66 (95% CI 9.69–57.73;  $p < 0.0001$ ) and 26.76 (95% CI 7.97–89.80;  $p < 0.0001$ ). For recreational drug use, the respective AORs were 18.81 (95% CI 2.44–144.89;  $p = 0.0048$ ) and 11.76 (95% CI 1.21–114.57;  $p = 0.0340$ ).

## Discussion

While HCV prevalence is thought to be higher in the general population than HIV prevalence, in this gay and bisexual community sample HCV prevalence was found to be lower than HIV prevalence. Although, in some regards, HCV infection may not be a major concern in the gay and bisexual community at large, the finding that HCV prevalence in the gay and bisexual community is slightly higher than in the general population in Canada suggests there may be concern for some subgroups of men, specifically MSM who are also recreational drug users and/or IDUs. In this analysis, the greatest contribution to HCV infection and HCV–HIV co-infection were injection and recreational drug use. Personal income, ethnicity, sexual identity, gay bar attendance, and professional sex work (i.e., sex for money) were not associated with HCV infection in this analysis. Sex for drugs or

**Table 4** Multivariate polytomous logistic regression (*N* = 3304)

Variables	HCV infection only		HCV–HIV co-infection		HIV infection only	
	AOR (95% CI)	<i>p</i> -Value	AOR (95% CI)	<i>p</i> -Value	AOR (95% CI)	<i>p</i> -Value
<b>Sociodemographic</b>						
Age <sup>a</sup>	<b>1.07 (1.03, 1.11)</b>	<b>0.0001</b>	<b>1.10 (1.04, 1.15)</b>	<b>0.0005</b>	<b>1.03 (1.01, 1.04)</b>	<b>&lt;0.0001</b>
Education <sup>b</sup>						
College/university	0.42 (0.17, 1.04)	0.0612	0.48 (0.15, 1.55)	0.2196	0.95 (0.67, 1.35)	0.7668
Graduate	0.65 (0.18, 2.35)	0.5118	0.39 (0.062, 2.42)	0.3102	<b>0.42 (0.24, 0.73)</b>	<b>0.0020</b>
Employment status <sup>c</sup>						
Not in labor force	0.98 (0.40, 2.41)	0.9644	<b>7.21 (1.96, 26.69)</b>	<b>0.0031</b>	<b>2.51 (1.86, 3.40)</b>	<b>&lt;0.0001</b>
<b>Social life</b>						
Bathhouse attendance <sup>d</sup>						
1–3 times a month	1.05 (0.42, 2.59)	0.9248	1.48 (0.44, 4.99)	0.5288	<b>2.03 (1.49, 2.76)</b>	<b>&lt;0.0001</b>
>3 times a month	0.86 (0.17, 4.36)	0.8531	2.76 (0.57, 13.44)	0.2076	1.59 (0.89, 2.84)	0.1193
<b>Sexual health</b>						
Urethral gonorrhoea (ever) <sup>e</sup>	0.37 (0.079, 1.77)	0.2143	<b>0.13 (0.020, 0.83)</b>	<b>0.0312</b>	<b>1.74 (1.20, 2.53)</b>	<b>0.0038</b>
Genital or anal warts (ever) <sup>e</sup>	2.12 (0.69, 6.54)	0.1904	2.40 (0.58, 9.90)	0.2244	<b>2.60 (1.80, 3.77)</b>	<b>&lt;0.0001</b>
Hepatitis A (ever) <sup>e</sup>	1.10 (0.19, 6.24)	0.9154	<b>16.64 (4.17, 66.36)</b>	<b>&lt;0.0001</b>	1.51 (0.89, 2.54)	0.1264
Hepatitis B (ever) <sup>e</sup>	1.69 (0.40, 7.12)	0.4766	0.33 (0.05, 1.96)	0.2212	<b>1.98 (1.24, 3.14)</b>	<b>0.0040</b>
<b>Sex life</b>						
Received drugs, goods, clothing, protection, or shelter from a male for sex in the past 12 months (yes) <sup>f</sup>	0.54 (0.07, 4.42)	0.5650	<b>7.18 (1.81, 28.45)</b>	<b>0.0050</b>	<b>2.38 (1.41, 4.00)</b>	<b>0.0011</b>
URAI (ever) <sup>e</sup>	<b>0.28 (0.12, 0.68)</b>	<b>0.0046</b>	1.13 (0.31, 4.10)	0.8564	<b>2.14 (1.52, 2.99)</b>	<b>&lt;0.0001</b>
<b>Drug use</b>						
Recreational drug use in the past 12 months (yes) <sup>a,f</sup>	<b>18.81 (2.44, 144.89)</b>	<b>0.0048</b>	<b>11.76 (1.21, 114.57)</b>	<b>0.03399</b>	<b>1.46 (1.05, 2.10)</b>	<b>0.0267</b>
Used a needle to inject a recreational drug (ever) <sup>a,e</sup>	<b>23.66 (9.69, 57.73)</b>	<b>&lt;0.0001</b>	<b>26.76 (7.97, 89.80)</b>	<b>&lt;0.0001</b>	<b>1.18 (1.10, 2.99)</b>	<b>&lt;0.0202</b>

AOR, adjusted odds ratio; CI, confidence interval; URAI, unprotected receptive anal intercourse with a man.

<sup>a</sup>*p* < 0.05 for HCV infection, HIV infection and HCV–HIV co-infection.

Reference level: <sup>b</sup>elementary/high school; <sup>c</sup>in labor force; <sup>d</sup>never/less than twice a year; <sup>e</sup>never; <sup>f</sup>no.

R-square = 0.20, max-rescaled R-square = 0.29.

goods may be a corollary for drug use.<sup>24,25</sup> Sexual behaviors and proxies for sexual risk behavior, such as STDs, were associated with HIV infection but not HCV infection.

In Canada, the HCV prevalence in the population at large was estimated to be 0.8% in 2002.<sup>27</sup> The HCV prevalence for the USA population at large has been estimated to be 1.8%.<sup>28</sup> The overall HCV prevalence for men in this sample was 1.9%. Based on the male population in Ontario, we calculated the age standardized prevalence rate for our sample to be 1.7%, which is higher than the estimated rate of 1.14% for the total male population of the province.<sup>29</sup> No estimates of the HCV prevalence in a community sample of gay and bisexual men in Canada have been previously available. Internationally, information on the prevalence of HCV among gay and bisexual men suggests it may range from 3% to 14%, which demonstrates considerable variation in HCV infection by country and sampling frame.<sup>1,11,18,30,31</sup> In this community sample, we found that HCV prevalence was higher among HIV-positive men compared to HIV-negative men, but was lower among

self-identified gay and bisexual men compared with those with other identities. Univariate analysis suggests associations between sexual identity (gay/bisexual versus other) and HCV infection; however, these associations disappeared in the multivariate analysis. Despite the lifetime prevalence, this suggests self-identified gay and bisexual men may not be at increased risk for HCV infection.

The overall HCV–HIV co-infection prevalence among men in our analysis was 0.7%. In our sample among HIV-positive individuals, 7.7% were HCV-positive, and among HCV-positive individuals 35.9% were HIV-positive. In Canada, a study conducted in an HIV laboratory in Alberta found a prevalence of 9.3% among 54 HIV-positive men;<sup>32</sup> another study in general practice clinics in Vancouver reported an HCV rate of infection of 8.8% among 352 HIV-infected men;<sup>33</sup> and a cohort study of HIV-negative MSM conducted in Montreal reported an HCV prevalence of 2.9%.<sup>34</sup> In a review of 15 international studies of HCV–HIV co-infection among MSM, the rates of co-infection ranged from 0% to 14%.<sup>1</sup>

In the current study, 5.7% reported ever using needles to inject recreational drugs. This study confirms that injection drug use is the predominant mode of HCV infection and HCV–HIV co-infection among the men in the sample, which agrees with the results found in Europe, Australia, and the USA.<sup>14,35–39</sup>

Our data on related risk factors show an association between STDs, a proxy for lifetime sexual behavior, specifically urethral gonorrhea and genital or anal warts, and HIV infection but not HCV infection. There are equivocal data regarding the association between the number of sex partners and HCV infection.<sup>32,40,41</sup> In this analysis, an association was found with the number of sexual partners in the univariate analysis but not in the multivariate analysis. Further, HCV–HIV co-infection differed between some subpopulations. Additional study of the differences between subpopulations is important.<sup>25,26</sup>

In our analysis, HIV-positive men were 5.5 times more likely to be HCV-infected compared to those who were HIV-negative. This may suggest that HCV is associated with specific sexual behaviors among people who are HIV-infected and perhaps the increased vulnerability to HCV infection among those who are HIV-positive. The finding of this analysis is consistent with the results that have been found in European studies, which have shown outbreaks of HCV among MSM who have high-risk sexual behaviors.<sup>42–45</sup>

In this sample of gay and bisexual men, more than half took recreational drugs. Longitudinal studies are needed to investigate and confirm the sexual risk of HCV transmission among HIV-infected people, especially those who are not IDUs.

There are limitations to our findings. Because the study was cross-sectional, we could not determine when the men acquired HIV and HCV, which presents challenges to the understanding of causal relationships. Additional studies using a prospective design are necessary to clarify the predictors of infection. The survey results relied on self-report data. Therefore, as participants retrospectively report their behavior, there may be inaccuracies in reporting lifetime behavior. The study recruitment was primarily venue-based. Methods were varied to ensure a broad and diverse sample, but there may have been some community sectors who were not represented or who were underrepresented. Also, our study did not examine several identified sexual risk behaviors for HCV infection among MSM, such as fisting.<sup>46</sup>

Our study provides important initial insights to be considered for targeting and enhancing existing prevention, surveillance, and care initiatives. Due to the lack of an effective vaccine for either HCV or HIV infection, increased awareness, education, screening, and health services are needed to help reduce disease transmission and infection.<sup>47</sup> Identifying individuals who could benefit from behavioral and medical intervention is vital in the effort to reduce HCV, HIV, and HCV–HIV co-infection.

Our results suggest that within the gay and bisexual community there are subgroups of men for whom HCV infection is a concern. This study confirms findings of other studies, which indicate needle sharing to be the major mode of transmission of HCV. The sexual transmission of HCV, if any, would seem to account for a very small proportion of HCV infections. Testing and counseling programs should clearly distinguish between the risks for transmission of HCV and HIV infection. Care for HIV-infected people needs to emphasize

the prevention of HCV infection and motivate MSM who are HIV-positive to practice safer sex because of the additional risk that may exist in transmitting and acquiring HCV infection. Clearly, for some men, such as men who may have few options but to exchange sex for their survival, more structural and program supports are needed. Programs for MSM need to consider some of the essential components of harm reduction and provide options for addiction treatment for those who require it.

## Acknowledgements

Funding for this analysis was provided by the Canadian Institutes for Health Research (CIHR), grant No. 64707. The survey was funded by the Research Unit, Ontario Ministry of Health and Long-Term Care, and GlaxoSmithKline Positive Action Program, AIDS Program Committee. The HIV Social, Behavioral and Epidemiological Studies Unit is funded by the AIDS Bureau, Ontario Ministry of Health and Long-Term Care, and the Faculty of Medicine, University of Toronto. Dr Myers holds an Ontario HIV Treatment Network (OHTN) Career Scientist Award. Mr Allman is a CIHR doctoral fellow.

*Conflict of interest:* The researchers in this study have no affiliation with financial interests of any nature in a business corporation, or receive remuneration, royalties or a research grant from a business corporation.

*Ethical approval:* The study received approval from the University of Toronto Research Ethics Board.

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