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POPULATIONS AT RISK

Risk Factors for Hepatitis C Virus Infection Among Homeless Adults

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OBJECTIVE: **To describe the prevalence of hepatitis C virus (HCV) infection in a sample of homeless and impoverished adults and examine risk factors for HCV infection in the overall sample and as a function of injection drug use.**

DESIGN: **Assays were conducted on stored sera. Socio-demographic characteristics and risky sexual activity were measured by content-specific items. Substance use was measured by a structured questionnaire. HCV antibodies were tested by enzyme-linked immunosorbent assay; a confirmatory level was defined by recombinant immunoblot assay.**

SETTINGS: **Shelters (*N* = 36) and outdoor locations in Los Angeles.**

PARTICIPANTS: **Eight hundred eighty-four homeless women and/or partners or friends.**

RESULTS: **Among this sample of 884 homeless and impoverished adults, 22% were found to be HCV infected. Lifetime injection drug users (IDUs) (cocaine, crack, and methamphetamine) and recent daily users of crack were more likely than nonusers or less-frequent users of these drugs to be HCV-infected. Similar results were found for those who had been hospitalized for a mental health problem. Among non–injection drug users and persons in the total sample, those who reported lifetime alcohol abuse were more likely than those who did not to be HCV infected. Controlling for socio-demographic characteristics, multiple logistic regression analyses revealed IDUs have over 25 times greater odds of having HCV infection than non-IDUs. HCV infection was also predicted by older age, having started living on one's own before the age of 18, and recent chronic alcohol use. Males and recent crack users had about one and a half times greater odds of HCV infection when compared to females and non–chronic crack users.**

CONCLUSIONS: **Targeted outreach for homeless women and their partners, including HCV testing coupled with referrals to HCV and substance abuse treatments, may be helpful.**

KEY WORDS: **hepatitis C; homeless and impoverished adults; injection drug users; Los Angeles.**
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Nationwide, hepatitis C virus (HCV) is a serious and rapidly emerging infectious disease that is on an equal par with HIV in terms of morbidity and prevalence.[1] To date, approximately 4 million Americans have been infected with HCV.[2] Recently, members of the California Senate reported HCV to be at epidemic proportions in California, with an estimated 500,000 residents already infected. Approximately 80% of individuals infected with HCV become chronic carriers of the virus,[3] and about 85% of infected individuals develop chronic liver disease.[1] Given the magnitude of affected individuals, scientists are now warning about a future epidemic of end-stage liver disease resulting from HCV infection.[3,4]

Homeless persons are at high risk for HIV as a result of injection drug use, unprotected sexual activity, prostitution, and victimization.[5,6] Although the extent of HCV infection among homeless populations remains largely unknown, there is increasing suspicion that it is silently escalating among the homeless as risk factors for HCV, particularly injection drug use, overlap with those for HIV.[7] Studies conducted with homeless men and women have found that 73% to 80% report a lifetime history of drug use, with 13% to 20% involved in injection drug use.[8–10] Beyond drug use behaviors, over 70% of homeless adults report unprotected sex with multiple partners,[11] which may increase their risk for HCV infection.[12] Finally, many homeless individuals have histories of mental illness and incarceration, which have been demonstrated to be important considerations in evaluating risk for HCV infection.[13,14]

In terms of risk behaviors, epidemiological studies show that injection drug use accounts for about 60% of all chronic and new HCV infections annually.[15] However, controversy exists about the number of HCV

cases attributable to noninjection drug use and sexual transmission. Data from several studies indicate that the percentage of reported cases of HCV acquired through sexual exposure has tripled since 1990 to a high of 16%.[15] The highest sexual risks for HCV infection appear to be having sex with multiple partners and traumatic sex that results in blood exchange.[16] Research regarding HCV transmission in relation to other documented risk behaviors; such as noninjection drug use (e.g., inhaled cocaine, and methamphetamine)[17] is advancing. Alcohol abusers have also been found to be at increased risk in some studies in which no other risk factors existed.[18] However, other studies found alcohol users to be at greater risk only in the presence of injection drug use.[19]

Aside from the identification of HCV risk factors, it is important to consider how these risk factors vary among different vulnerable populations. Diaz et al.[13] demonstrated that, even among injection drug users (IDUs), important variations in patterns of HCV infection exist. In this context, therefore, analysis of the population-specific risk factors present in a homeless group becomes critical. To date, research regarding HCV in homeless populations in the United States is very limited, and there are no published accounts specifically addressing HCV infection among injecting and noninjecting homeless women and their intimate partners.

In this study, we describe the prevalence of HCV in a sample of homeless and impoverished adults and examine risk factors for HCV infection. Analysis of risk factors is presented for the overall sample, as well as for IDUs and non-IDUs as separate subsamples.

METHODS

Subjects and Setting

The sample for this study was derived from a larger study, conducted between 1995 and 1999, in which 1,020 homeless women and their supportive persons, the majority of whom were their intimate partners, were enrolled in a quasi-experimental study involving a convenience sample. The parent study assessed the impact of 2 longitudinal health promotion and HIV risk reduction programs.[20] Women were recruited from 36 homeless shelters or sober-living shelters or from street outreach if they met the following inclusion criteria: a) 18 to 65 years of age; b) homelessness; and c) having an intimate partner or friend, termed an impoverished adult, who was willing to participate. A homeless person was defined as one who spent the previous night in a shelter, hotel, motel, or home of a relative or friend and was uncertain as to his/her residence in the next 60 days, or stated that he/she did not have a home or house of his/her own in which to reside.[21] Intimate partners and friends were eligible if they were aged 18 years or older and willing to participate. For the most part, they were

individuals with whom a homeless woman had had an intimate sexual relationship for at least the past 3 months. Over 90% of the women who were approached agreed to participate. The major reasons for not enrolling women in the study were that they either did not have a partner or friend (6%) or their designated person refused to participate (4%). Ninety-eight percent of the participants agreed to be tested for HIV using venous blood drawn from a finger stick. All participants were administered a questionnaire that measured mental health and well-being, physical health, alcohol and drug use, and sexual behaviors.

The current HCV analysis was conducted on 884 (90%) of the homeless women and their intimate partners or friends who were recruited into the original study. Subject loss was due primarily to storage of a portion of the finger stick bloods in an inaccessible location at the State Laboratories at Berkeley. The Human Subject Protection Committee of the University of California, Los Angeles, approved the supplemental HCV testing on stored blood.

Measures

Sociodemographic characteristics, including age, years of education, race, age at which one started living on one's own, homeless history, and history of being in jail were assessed with a structured questionnaire.

Substance use was assessed by the slightly revised Drug History Form.[22] The modification was a single item on use of injection drugs in the last 6 months. Items included: alcohol, inhalants, marijuana, hallucinogens, crack/freebase, other cocaine, heroin, street methadone, other opiates, amphetamines and methamphetamine, barbiturates, and librium or other sedatives. Items covered lifetime use, lifetime use by injection (where appropriate), and frequency of use in the past 30 days, and in the past 6 months. Concurrent and predictive validity on the modified form have been found acceptable for variables derived from the Drug History Form.[22] Using the same data collection format, Anglin et al.[23] found excellent test-retest reliability and predictive validity for most drug use measures. The 4-item CAGE screening instrument measured lifetime history of alcohol abuse/dependence.

Two items that inquired about types of risky behaviors that these homeless and impoverished adults were engaged in during the past 6 months were used to measure sexual activity. These items were number of sexual partners and having sex without a condom; both are critical predictors of sexually transmitted diseases among homeless women.[24,25]

One item assessed a history of hospitalization for mental illness by means of a "yes" or "no" response. A similarly worded item has been used in the Course of Homelessness Study[26] with satisfactory validity demonstrated.

Laboratory Methods

A peripheral venous blood sample was collected onto filter paper and stored at the Berkley laboratories of the State of California, Department of Health Services. Specimens were screened for HIV antibodies using enzyme-linked immunosorbent assay (ELISA) and confirmed with western blot. Residual specimens were frozen and stored for HCV analysis. Subsequently, blood specimens were screened for HCV infection using the Ortho HCV ELISA Test Kit System, Version 3.0 (Ortho Clinical Diagnostics, Raritan, NJ) and were confirmed using the Chiron recombinant immunoblot assay (RIBA), HCV 3.0 (Chiron Corp., Emeryville, Calif) strip immunoblot assay (SIA). To accommodate the use of frozen, filter-paper-preserved specimens for these analyses, both diagnostic assays were modified slightly.* Specimens that repeatedly tested positive by ELISA and were confirmed using RIBA SIA were considered positive for HCV infection. Relative classification criteria for positive specimens were in accordance with manufacturer specifications.[27,28] Specimens that were not confirmed using the Chiron RIBA SIA or that tested negative using the Ortho screening test were classified as HCV negative for these analyses.

Statistical Analyses

The prevalence of HCV infection was documented in the sample as a whole and in specific subgroups of individuals with and without a lifetime history of injection drug use.

X^2 tests were used to contrast individuals with positive and negative HCV antibody test results on categorical variables of interest. Age was divided into tertiles for analytic purposes. Multiple logistic regression analysis was performed to identify factors that were independently associated with positive HCV antibody status (anti-HCV). Candidate predictors for the final model were identified using stepwise backward techniques with the SAS statistical software package (SAS, version 6.12, SAS Institute, Cary, NC). All the variables shown in Table 1, as well as gender, education, risky sexual behavior, lifetime sexually transmitted disease (STD) and having an intimate partner were included and variables significant at the .10 level were allowed to remain. Findings were confirmed with stepwise forward techniques. The Stata statistical package (version 7, STATA Corp., College Station, Tex) was used for final regression analysis to address possible clustering effects from dyads. This series of analyses was then repeated for individuals with and without a history of injection drug use.

RESULTS

Sociodemographic Characteristics

Of the 884 samples tested for HCV antibodies, 197 (22%) were determined to be HCV positive. A total of 687 specimens were classified as HCV negative for these analyses. However, 42 (6%) of negative specimens tested positive using ELISA and negative by RIBA SIA.

In unadjusted analyses, respondents categorized either as IDUs or non-IDUs, as well as those in the total sample, were all more likely to be HCV antibody infected if they were older (See Table 1). No significant differences on HCV antibody positivity rates were found with respect to high school completion, gender, or having spent time in jail (data not tabled). However, persons in the non-IDU subsample and those in the total sample who were living on their own before the age of 18 were more likely to be HCV-infected. This same result was also found for adults who reported being homeless more than 1 year. Among homeless and impoverished non-IDUs, African Americans and whites were more likely to be HCV infected than were members of other ethnic groups.

In terms of HIV status (not tabled), findings revealed that 4 of 12 HIV-infected participants were also HCV infected; these 4 individuals were equally divided between women and men. Of these dually infected individuals, 3 reported a history of injection drug use. Among the 12 HIV-infected persons, 5 reported a history of injection drug use. Further, correlations (not tabled) of having more than 3 sexual partners in the past 6 months was associated with more frequent use of condoms ($r = .27$, $P < .001$).

Substance Use, Sexual Activity and Health History

Among the total sample, homeless adults who were lifetime users of injection drugs, cocaine, crack, and methamphetamine, and recent daily users of crack were more likely to be HCV infected than nonusers or less frequent recent users of these drugs (Table 1). Similar results were found for those who had been hospitalized for

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*Ortho HCV ELISA Test Kit System, Version 3.0 (hepatitis C virus–encoded antigen, recombinant c22-3, c200 and NS5). Blood was eluted overnight at 4°C (from a 0.25-inch circle punched from the original dried blood specimen) into a flat well micro titer plate using 200 μL specimen dilution buffer (Ortho HCV ELISA Test Kit, Version 3.0). In each well, 100 μL of eluate and 100 μL specimen dilution buffer were mixed together and processed according to the test kit instructions. The confirmatory test used was Chiron RIBA, HCV 3.0, SIA, (hepatitis C virus–encoded antigen and 2 individual recombinant antigens, c33c and NS5; and synthetic peptides 5-1-5, c100, and c22) with the following modifications: a 0.25-inch circle was punched from the dried blood sample into a sterile tube and eluted with 1.0 mL of specimen diluents (Chiron RIBA, HCV 3.0, SIA) overnight at 4°C. For testing, 1.0 mL of eluate was then incubated on nitrocellulose strips and the procedure was continued according to test kit package insert directions. The (Chiron) RIBA confirmatory test was considered positive if 2 or more of the tests for 4 viral proteins were positive.

Table 1. HCV Antibody Positivity in Relation to Selected Characteristics and Behaviors of Homeless and Impoverished Injection and Non–injection Drug Users*

Characteristics	Injection Drug Users (*n* = 141), % (*n*)	Non–injection Drug Users (*n* = 743), % (*n*)	Total Sample (*N* = 884), % (*n*)
Age, y			
18–32	47.6 (10)[†]	5.2 (14)[†]	8.2 (24)[†]
33–40	68.3 (28)	12.5 (31)	20.3 (59)
$\geq$41	89.9 (71)	19.3 (43)	37.8 (114)
Race			
African American	79.5 (66)	14.6 (75)[‡]	23.6 (141)
Latino	76.9 (20)	3.5 (5)	14.9 (25)
White	70.0 (30)	10.3 (8)	22.2 (79)
Other	100.0 (2)	0 (0)	0 (2)
Living on own before age 18			
Yes	78.2 (61)	14.9 (42)[§]	28.6 (103)[†]
No	75.4 (46)	9.8 (43)	17.8 (89)
Any time in jail			
Yes	80.3 (98)	13.1 (54)	28.4 (152)[†]
No	61.1 (11)	10.4 (34)	13.0 (45)
Homeless for >1 y			
Yes	76.4 (68)	14.9 (50)[§]	27.8 (118)[†]
No	80.0 (40)	9.4 (35)	17.7 (75)
Substance use			
Lifetime injection drug use			
Yes	—	—	77.3 (109)[†]
No	—	—	11.8 (88)
Injection drug use past 6 mo			
Yes	—	—	84.6 (44)[†]
No	—	—	18.3 (150)
Lifetime cocaine use			
Yes	75.2 (82)	13.0 (34)	31.4 (116)[†]
No	84.4 (27)	11.3 (54)	15.8 (81)
Lifetime crack use			
Yes	76.1 (89)	14.6 (67)[‡]	27.1 (156)[†]
No	83.3 (20)	7.4 (21)	13.4 (41)
Daily crack use past 6 mo			
Yes	86.1 (37)	15.9 (29)	29.2 (66)[‡]
No	73.5 (72)	10.6 (59)	20.0 (131)
Lifetime methamphetamine use			
Yes	65.3 (32)[§]	11.3 (9)	31.8 (41)[‡]
No	83.7 (77)	12.0 (79)	20.7 (156)
Lifetime alcohol abuse			
Yes	78.2 (10)	15.2 (52)[§]	29.5 (131)[†]
No	71.4 (25)	9.3 (35)	14.6 (60)
Daily alcohol past 6 mo			
Yes	78.6 (33)	19.9 (35)[†]	31.2 (68)[†]
No	76.8 (76)	9.4 (53)	19.4 (129)
Health history			
Hospitalized for drug problem			
Yes	79.1 (53)	14.0 (14)	40.1 (67)[†]
No	74.3 (52)	12.7 (62)	20.4 (114)
Hospitalized for mental illness			
Yes	78.4 (29)	15.0 (12)	35.0 (41)[†]
No	76.9 (80)	11.6 (76)	20.6 (156)
Sexual activity: multiple sexual partners past 6 mo[‖]			
Yes	41.7 (5)[‡]	2.70 (1)	12.2 (6)
No	80.6 (104)	12.3 (87)	22.9 (191)

* Injection drug use based on lifetime history; comparison group includes all individuals not reporting any lifetime IDU.

[†] P < .001, χ^2 test for differences between predictor categories and HCV antibody positivity.

[‡] P < .01, χ^2 test for differences between predictor categories and HCV antibody positivity.

[§] P < .05, χ^2 test for differences between predictor categories and HCV antibody positivity.

[‖] More than 3 sex partners in the past 6 months.

a mental health problem. Respondents who had been hospitalized for drug problems were also more likely to be HCV infected compared to those without this history. Except for the IDU subgroup, in which individuals were less likely to be HCV positive if they reported lifetime methamphetamine use, no other drug use was significantly associated with HCV infection among persons in the IDU or non-IDU subgroups alone.

Among persons with no reported history of injection drug use and individuals in the total sample, those who reported lifetime alcohol abuse were more likely than those who did not to be HCV infected. Moreover, persons in the non-IDU subgroup who reported daily alcohol use in the past 6 months were also more likely to be HCV positive than less-chronic alcohol users.

When subanalyses were conducted on a subset of homeless women and their intimate partners (*n* = 386 couples), we found the risk of HCV infection to be markedly higher when the intimate partner was HCV infected than when she/he was not (43% vs 17%, respectively). HCV infection rates differed in a similar fashion when the intimate partner was an IDU as opposed to a non-IDU (48% vs 18%, respectively).

In terms of sexual behaviors (not tabled), IDUs who reported more than 3 sexual partners in the past 6 months were less likely to test positive for HCV infection than those with fewer partners. Moreover, other sexual risk factors, such as sex without condoms in the past 6 months, lifetime STD history, and having an intimate partner were not related to HCV infection in the overall sample or in either subgroup.

Table 2 shows unadjusted odds ratios corresponding to the associations in Table 1. Among the total sample, individuals with a history of injection drug use had 25 times greater odds of HCV infection than did those not reporting such a history. Findings for persons reporting recent injection drug use were almost identical. Persons with histories of hospitalization for drugs, hospitalization for mental illness, and incarceration had over twice the odds of testing positive for HCV infection as their counterparts who did not have these histories. In the overall sample, the magnitudes of odds ratios for lifetime cocaine, crack, and alcohol use were similar; among non-users of injection drugs, those who used alcohol on a daily basis also had over twice the odds of HCV infection as less frequent users of alcohol. Compared to whites, Latinos had low odds of infection in the subgroups of non-users of injection drugs, as well as in the total sample, while individuals over 40 years of age had at least 4 times greater odds of infection than those 33 and under in all groups.

Multivariable Analyses

Findings of logistic regression analyses revealed 2 factors that were consistently associated with HCV infection among homeless IDUs, non-IDUs and the total sample (Table 3). Participants who were over the age of 40 were more likely to be HCV infected than the younger cohort between 18 and 32 years, and homeless persons with more than 3 recent sexual partners had extremely low odds of HCV infection compared to those with fewer sexual partners in the past 6 months.

In the overall sample, injection drug users had over 25 times greater odds of having HCV infection than non-users of injection drugs. Other significant predictors of HCV infection were being between 33 and 40 years of age, or over 40 years of age, as opposed to 32 or younger, having started living on their own before the age of 18, and recent chronic alcohol use. Males and recent chronic crack users had about one and a half time greater odds of HCV infection when compared to females and persons not using crack on a chronic basis, respectively. Similar sociodemographic associations with HCV infection were found among the subsample of non-users of injection drugs, although in this group non-Hispanics had almost 3 times greater odds of HCV infection than Hispanics. Recent chronic alcohol use was also an important predictor of HCV infection among non-users of injection drugs. Among IDUs, recent chronic use of crack independently predicted HCV infection, and these crack users had 4 times greater odds of infection than their counterparts who used crack less frequently or not at all.

DISCUSSION

Within our sample of 884 homeless and impoverished adults in Los Angeles, our findings revealed that 22% were HCV infected. Lifetime injection drug use and age were clearly associated with HCV antibody positivity among the total sample. Recent daily use of alcohol and possibly crack also significantly increased the chances of being HCV antibody positive, but to a much lesser degree.

Important similarities and differences were shown between respondents with and without histories of injection drug use, thus corroborating results of past research and highlighting the extreme importance of this risk factor. Injection drug use has been repeatedly identified as the predominant current risk factor for HCV infection in the United States, and it has been postulated that HCV may be endemic in IDU populations.[29] The 77% HCV seroprevalance rate in the IDU subsample (as opposed to 12% in the non-IDU group) corresponds with the 60% to 90% range reported in other injection drug use prevalence studies.[13] Moreover, several studies have documented that needle exchange programs can be an effective part of a comprehensive strategy to reduce the incidence of blood-borne virus transmission.[15] This study reaffirms the importance of assessing injection drug use behaviors when working with homeless populations.

Apart from injection drug use, in unadjusted analyses, lifetime cocaine, crack, and methamphetamine use and recent chronic crack use also proved to be significant

Table 2. Unadjusted Odds Ratios (ORs) for Effects of Selected Characteristics and Behaviors on Testing Positive for HCV Infection Among Homeless and Impoverished Injection and Non–injection Drug Users*

Predictors	Injection Drug Users (*n* = 141)		Non–injection Drug Users (*n* = 743)		Total Sample (*N* = 884)	
	OR (95% CI)	*P* Value	OR (95% CI)	*P* Value	OR (95% CI)	*P* Value
Age, y						
18–32	1.00 —		1.00 —		1.00 —	
33–40	2.37 (0.81 to 6.98)	.12	2.61 (1.35 to 5.03)[†]	.004	2.85 (1.72 to 4.73)[‡]	.001
≥41	9.76 (3.17 to 30.10)[‡]	.001	4.39 (2.33 to 8.25)[‡]	.001	6.77 (4.20 to 10.42)[‡]	.001
Race						
White	1.00 —		1.00 —		1.00 —	
African American	1.66 (0.64 to 4.28)	.29	1.49 (0.69 to 3.23)	.31	0.84 (0.53 to 1.34)	.46
Latino	1.43 (0.43 to 4.73)	.56	0.32 (0.10 to 1.01)	.053	0.48 (0.26 to 0.87)[§]	.02
Other[‖]	—					
Living on own before 18						
No	1.00 —		1.00 —		1.00 —	
Yes	1.17 (0.53 to 2.59)	.70	1.61 (1.02 to 2.54)[§]	.04	1.85 (1.34 to 2.56)[‡]	.001
Any time in jail						
No	1.00 —		1.00 —		1.00 —	
Yes	2.60 (0.91 to 7.41)	.07	1.30 (0.82 to 2.05)	.26	2.66 (1.84 to 3.83)[‡]	.001
Homeless for >1 y						
No	1.00 —		1.00 —		1.00 —	
Yes	0.81 (0.35 to 1.89)	.63	1.69 (1.07 to 2.69)[§]	.02	1.79 (1.29 to 2.48)[‡]	.001
Substance use						
Lifetime injection drug use						
No	—		—		1.00 —	
Yes	—		—		25.35 (16.13 to 39.86)[‡]	.001
Injection drug use past 6 mo						
No	—		—		1.00 —	
Yes	—		—		24.64 (11.37 to 53.42)[‡]	.001
Lifetime cocaine use						
No	1.00 —		1.00 —		1.00 —	
Yes	0.56 (0.20 to 1.6)	.28	1.18 (0.75 to 1.87)	.48	2.43 (1.76 to 3.36)[‡]	.001
Lifetime crack use						
No	1.00 —		1.00 —		1.00 —	
Yes	0.64 (0.20 to 2.02)	.44	2.14 (1.28 to 3.58)[†]	.004	2.42 (1.66 to 3.52)[‡]	.001
Daily crack use past 6 mo						
No	1.00 —		1.00 —		1.00 —	
Yes	2.23 (0.84 to 5.89)	.11	1.59 (0.99 to 2.57)	.057	1.65 (1.17 to 2.33)[†]	.01
Lifetime methamphetamine use						
No	1.00 —		1.00 —		1.00 —	
Yes	0.37 (0.16 to 0.82)[§]	.015	0.93 (0.45 to 1.94)	.85	1.78 (1.18 to 2.69)[†]	.01
Lifetime alcohol use						
No	1.00 —		1.00 —		1.00 —	
Yes	1.44 (0.60 to 3.44)	.42	1.74 (1.10 to 2.75)[§]	.02	2.45 (1.74 to 3.45)[‡]	.001
Daily alcohol use past 6 mo						
No	1.00 —		1.00 —		1.00 —	
Yes	1.11 (0.46 to 2.66)	.82	2.40 (1.51 to 3.82)[‡]	.001	1.88 (1.33 to 2.66)[‡]	.001
Health history						
Hospitalized for drug problem						
No	1.00 —		1.00 —		1.00 —	
Yes	1.31 (0.59 to 2.91)	.51	1.12 (0.60 to 2.10)	.71	2.62 (1.81 to 3.80)[‡]	.001
Hospitalized for mental illness						
No	1.00 —		1.00 —		1.00 —	
Yes	1.09 (0.44 to 2.70)	.86	1.34 (0.70 to 2.59)	.38	2.08 (1.37 to 3.16)[‡]	.001
Sexual activity: multiple sexual partners past 6 mo[¶]						
Yes	1.00 —		1.00 —		1.00 —	
No	0.17 (0.05 to 0.59)[§]	.005	0.20 (0.03 to 1.46)	.112	0.47 (0.20 to 1.12)	.090

* *Injection drug use based on lifetime history; comparison group includes all individuals not reporting any lifetime injection drug use.*

[†] P < .01, χ² *test for differences between predictor categories and the HCV antibody positivity.*

[‡] P < .001, χ² *test for differences between predictor categories and the HCV antibody positivity.*

[§] P < .05, χ² *test for differences between predictor categories and the HCV antibody positivity.*

[‖] *There were too few people of "other" racial backgrounds to compute odds ratios.*

[¶] *More than 3 sexual partners in the past 6 months.*

CI, confidence interval.

drug-related HCV risk factors in the total sample. In reporting non-IDU drug behaviors as HCV risk factors, it is important to consider their potentially associated mechanisms of transmission such as cocaine use via intranasal delivery[29] or crack use, which may facilitate HCV transmission because of oral lesions developed from smoking.[30] However, these findings may reflect the difficulty of assessing past and present injection drug use among any population and the fact that even brief exposure to blood, such as through even a few episodes of injection drug use activity, may be sufficient to transmit HCV. Thus, it is possible that the relationships found with non-IDUs are confounded by unreported injection drug use.

Since all of the specific lifetime drug use factors became nonsignificant when injection drug use was controlled, it appears that their effects in this sample resulted from use by injection. This study did not evaluate whether the people shared drug preparation equipment, including cookers and/or filtration cotton; however, it is likely that

sharing of equipment may have occurred, given the lack of resources and frequently communal nature of many homeless groups. Interestingly, recent chronic crack use was a significant predictor of HCV infection in the regression model for IDUs alone, and appeared to play some role in HCV infection for the sample as a whole. Thus, continued investigation is warranted.

The relationship found between alcohol use and HCV antibody positivity is quite interesting, and perhaps somewhat ominous. Why lifetime alcohol abuse, and especially recent daily alcohol use, were significantly related to HCV antibody positivity in the non-IDU group and not in the IDU group is unclear; however, it may demonstrate the drug preferences of each group or just the overwhelming effect of injecting drugs.

Regarding HCV transmission through unprotected sex, past research results have been inconsistent, precluding convincing evidence of trends. In this study, as in some others,[31,32] no pattern of risk associated with sexual behaviors was demonstrated. The finding that homeless

Table 3. Adjusted Odds Ratios (ORs) for Effects of Predictor Variables on Testing Positive for HCV Infection Among Homeless and Impoverished Adults and Among Those With and Without a History of Injection Drug Use*

Predictors	Injection Drug Users (n = 141)		Non–injection Drug Users (n = 716)		Total Sample (N = 856)	
	OR (95% CI)	P Value	OR (95% CI)	P Value	OR (95% CI)	P Value
Gender						
Female	NA[†]		1.00 —	—	1.00 —	—
Male			1.59 (0.98 to 2.57)	.059	1.47 (0.98 to 2.21)	.064
Age, y						
18–32	1.00 —	—	1.00 —	—	1.00 —	—
33–40	2.02 (0.61 to 6.69)	.248	2.05 (1.07 to 3.93)	.031	2.38 (1.28 to 4.43)	.006
≥41	7.97 (2.44 to 26.06)	.001	3.96 (2.09 to 7.47)	.001	5.44 (3.05 to 9.70)	.001
Ethnicity						
Hispanic	NA		1.00 —	—	NA	
Non-Hispanic			2.87 (0.97 to 8.48)	.056		
Age started living on their own						
>18	NA		1.00 —	—	1.00 —	—
<18			1.84 (1.13 to 2.98)	.014	1.65 (1.07 to 2.54)	.023
Lifetime injection drug use						
No	NA		NA		1.00 —	—
Yes					25.78 (15.41 to 43.10)	.001
Recent daily alcohol use						
No	NA		1.00		1.00	
Yes			2.46 (1.50 to 4.05)	.001	2.02 (1.21 to 3.36)	.007
Recent daily crack use[†]						
No	1.00 —	—	NA		1.00 —	—
Yes	4.31 (1.03 to 17.95)	.045			1.59 (.096 to 2.62)	.070
Recent sexual partners, n[‡]						
0–3	1.00 —	—	1.00		1.00	
>3	0.10 (0.02 to 0.47)	.003	0.14 (0.02 to 1.06)	.057	0.15 (0.05 to 0.41)	.001

* *Includes Huber adjustment for clustering of some individuals within intimate couples.*
[†] *Not applicable since variable was not included in the final regression model.*
[‡] *Recent refers to past six months.*
CI, confidence interval; NA, not applicable.

individuals with more than 3 recent sexual partners had extremely low odds of HCV infection compared to those with fewer sexual partners in the past 6 months was unexpected, but supported our findings that having multiple partners was positively associated with frequency of condom use among homeless persons. It is also possible that HCV could have been transmitted during lifetime sexual activity. Thus, the extent to which HCV is sexually transmissible remains an important concern given that the epidemic could spread outside currently identified risk groups by this route.[32] Hence, sexual transmission[33] as well as other potential modes of transmission, such as sharing of toothbrushes, razors, etc., should be investigated.[32,34]

Similar to other reports in the literature,[32,35] our findings revealed greatly increased risk for HCV infection when a partner or friend was either HCV infected or reported injection drug use. While sexual transmission was not supported in our findings, or in those of other researchers,[32,35] other studies have found evidence that higher rates of HCV transmission occur between spouses than in the general population.[33,36]

Only 12 of the 884 participants (1.4%) were found to be HIV infected, and of these, 4 were both HIV and HCV infected. This seemingly low prevalence of HIV among at risk homeless women has been corroborated in previous studies of homeless men and women both in the Los Angeles area[37] and nationwide,[38] and provides evidence that education and prevention continue to be important strategies to employ. While the presence of HIV infection has been found to correlate with HCV infection in heterosexual couples,[36] the low prevalence of HIV among the homeless and impoverished adults in Los Angeles may explain the fact that a relatively small number of HCV-infected participants were also HIV infected.

Because we do not have data on the subjects' liver enzyme measurements, HCV polymerase chain reaction quantification, or liver biopsy results, we cannot describe the extent of active disease. However, data show that almost all HCV-infected persons develop chronic infection.[15,39] Experts suggest that the majority of chronically ill infected persons develop HCV-related hepatic abnormalities and that as many as 20% of the chronically infected develop cirrhosis.

This study demonstrates that a history of mental health problems serious enough to warrant hospitalization is important to consider in evaluating HCV risk. This finding corroborates research by Rosenberg et al.[14] and others[40] who investigated HCV prevalence rates among patients under treatment for serious mental illness. Much remains to be learned about the relationship between mental health and HCV, because it has not been thoroughly addressed in past research on the epidemiology of HCV.

Although involvement with injection drug use or injection drug–using partners probably contributes significantly to transmission of HCV infection among the mentally ill, it is clear that the risks for HCV infection in this population are compounded. Given the high rates of HCV infection among persons with serious mental illness, the development of HCV prevention and screening programs targeted toward the mentally ill appears to be both timely and justified.

While this study provides strong evidence that HCV infection is widespread in this urban homeless population, replication in other homeless populations is necessary. The limitations of this study include the self-report nature of the behavioral risk factors and the utilization of a convenience sample for HCV testing. Underreporting of injection drug use is of particular concern. Reluctance to divulge illegal behavior has been reported in the literature,[41] and has been attributed to factors such as self-image issues, concerns about legal risk, and fear of losing shelter residence.[41,42] However, we have found that when interviewers from the community develop rapport with respondents early in the interview process, and trust and confidentiality are emphasized, underreporting becomes less of a problem. For example, we found a relatively high level of concordance (76%) between objective hair analysis and self-report of cocaine use among homeless women in a previous study.[42] Finally, because the sample was drawn from an urban center in California, the findings of this study may not be generalizable to other populations of homeless individuals and/or homeless couples who reside in different parts of the country and whose behaviors may be more characteristically region specific.

Several policy implications can be drawn from this study. First, resource allocation for HCV education and prevention should include money targeted toward homeless populations. In 1998, the Centers for Disease Control and Prevention called for HCV testing of persons in settings with potentially high proportions of IDUs, including correctional institutions, HIV counseling and testing sites, or drug and STD treatment programs. Locations where homeless people congregate should be included in this list. Homeless drop-in centers, soup kitchens, food pantries, shelters, and street outreach using mobile units could be effective settings for HCV testing and education. Additionally, mental health centers whose clients include homeless people should be more aggressive in testing for possible HCV infection. Ideally, HCV testing programs in these settings should include counseling and referral or arrangements for medical management. Targeted outreach for homeless women and their partners, including HCV testing coupled with referrals to HCV and substance abuse treatments, may be useful. In particular, clinicians should recommend HCV testing if clients disclose any known risk factors, such as previous injection drug use, sharing of needles and/or drug preparation equipment, or blood transfusion prior to 1992. Further, information about the dangers of continued alcohol use, as well as treatment with interferon and other approved drugs for HCV infection, may impede and/or delay the development of liver disease. Hepatitis A virus and hepatitis B virus

immunization for HCV-infected persons is important for clinicians to consider and should be offered.

In making recommendations for future research, continued investigation and comparison of HCV risk factors between and across populations in differing environments would be warranted. Understanding population-specific predictors of HCV infection will facilitate the provision of appropriate and relevant health services and risk reduction activities.

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