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# Prevalence of Hepatitis C Infection in New York City, 2004

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**ABSTRACT** *Hepatitis C virus (HCV) is the leading cause of chronic liver disease in the United States. Accurate hepatitis C prevalence estimates are important to guide local public health programs but are usually unavailable to local health jurisdictions. National surveys may not reflect local variation, a particular challenge for urban settings with disproportionately large numbers of residents in high-risk population groups. In 2004, the New York City Department of Health and Mental Hygiene conducted the NYC Health and Nutrition Examination Survey, a population-based household survey of non-institutionalized NYC residents ages 20 and older. Study participants were interviewed and blood specimens were tested for antibody to HCV (anti-HCV); positive participants were re-contacted to ascertain awareness of infection and to provide service referrals. Of 1,786 participants with valid anti-HCV results, 35 were positive for anti-HCV, for a weighted prevalence of 2.2% (95% confidence interval [CI] 1.5% to 3.3%). Anti-HCV prevalence was high among participants with a lifetime history of injection drug use (64.5%, 95% CI 39.2% to 83.7%) or a lifetime history of incarceration as an adult (8.4%, 95% CI 4.3% to 15.7%). There was a strong correlation with age; among participants born between 1945 and 1954, the anti-HCV prevalence was 5.8% (95% CI 3.3% to 10.0%). Of anti-HCV positive participants contacted (51%), 28% (n=5) first learned of their HCV status from this survey. Continued efforts to prevent new infections in known risk behavior groups are essential, along with expansion of HCV screening and activities to prevent disease progression in people with chronic HCV.*

**KEYWORDS** *Hepatitis C, Prevalence, NYC, New York City, Survey, Serosurvey*

## INTRODUCTION

Hepatitis C virus (HCV) is the most common chronic bloodborne infection in the United States (US)[1,2] and is a leading cause of chronic liver disease such as cirrhosis, liver cancer, or liver failure.[3–5] For many diseases, accurate estimates of the population burden can be captured through routine public health surveillance systems which monitor incident diagnoses of reportable disease. However, because HCV infection is often asymptomatic for many years, and because HCV testing is not included in routine blood tests for healthy people, it is often undiagnosed. Surveillance data therefore underestimates the true prevalence of HCV, and population-based serologic studies are needed. The National Health and Nutrition

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Examination Survey (NHANES), routinely conducted by the Centers for Disease Control and Prevention, estimates the national HCV prevalence based on a representative serosurvey.[1,6,7] However, these data may not fully describe local variability in the epidemiology of HCV, a particular challenge for urban settings with high-risk populations.

Common risk factors for acquiring HCV in the US are injection drug use (through sharing needles or other paraphernalia) and having had a blood transfusion prior to 1992. In recent years, studies have documented that the prevalence of hepatitis C among injection drug users has decreased, though it remains high.[8–10] Needle and paraphernalia use and sharing among drug users have decreased since the 1990s as a result of improved awareness and education, and because higher drug purity facilitates snorting rather than injecting.[11–13] Receiving a blood transfusion is also a common risk factor, but HCV transmission through transfusion declined as standards for donor deferral and screening improved, especially since US blood banks began using an accurate HCV screening test in 1992.[14] Most people currently living with chronic HCV infection in the US acquired their infections 20, 30 or even 40 years ago.[15,16]

Local estimates of HCV disease burden are important to facilitate public health planning to anticipate future requirements of patients with chronic liver disease and respond to current HCV prevention and treatment needs. In 2004, the New York City Department of Health and Mental Hygiene (NYC DOHMH) conducted the NYC Health and Nutrition Examination Survey (NYC HANES), a population-based household survey of non-institutionalized NYC residents ages 20 and older. One of the objectives was to estimate the prevalence of HCV among non-institutionalized adults, overall and within subgroups, to compare local estimates with national estimates, and to describe the population of study participants with HCV.

## METHODS

NYC HANES, modeled after NHANES, is a population-based, household survey of non-institutionalized adults aged 20 years or older in NYC. Detailed information on NYC HANES study design, data collection, and participation rates is published elsewhere.[17] The survey consisted of (1) a face-to-face interview, which included detailed questions about demographics, mental health, and health history; (2) an audio computer-assisted self-interview (ACASI), for questions about sensitive topics such as drug use, sexual behavior, and incarceration; (3) a physical exam; and (4) laboratory testing. The face-to-face interview was conducted in English or Spanish by trained staff. Interviews in other languages were translated by staff, a family-member, or a commercial telephone translation service. ACASI was only available for English or Spanish speakers (7.6% of participants in this analysis did not complete ACASI). All survey instruments, protocols, equipment, and measurements were based on standardized NHANES procedures.[18,19]

Serum samples were tested for anti-HCV antibodies at the NYC DOHMH Public Health Laboratory. Samples were initially tested with the Abbott HCV EIA 2.0 enzyme immunoassay test kit. Samples with signal to cut-off (s/co) ratio less than 1.0 were considered negative, and otherwise, the sample was considered initially reactive and retested in duplicate. If both retests had s/co ratio below 1, the sample was considered negative; if either duplicate retest had s/co ratio over 3.8, the sample was considered positive;[20] otherwise, a second antibody test, a recombinant

immunoblot assay (RIBA) (Chiron RIBA HCV 3.0), was performed. Samples with reactive RIBA results were considered positive; samples with non-reactive RIBA results were considered negative. Samples with indeterminate RIBA results were considered inconclusive and excluded from the analysis.

After the survey was completed, participants who tested anti-HCV positive were informed by mail about their test result and referred for medical care for hepatitis C if they did not already have a provider. Anti-HCV-positive participants were subsequently contacted by telephone and interviewed to determine if they had been aware of their anti-HCV-positive status prior to the survey. Participants were also asked whether they had a doctor or other healthcare provider and again offered a referral for care if needed.

Of the 4,026 households selected for NYC HANES, eligibility screening questionnaires were completed in 3,388 (84%). A total of 3,047 eligible survey participants were identified. Of these, 1,999 (66%) individuals completed the face-to-face interview and at least one comprehensive examination measurement. The screening response rate (84%) multiplied by the participant response rate (66%) yielded an overall survey response rate of 55%. Of the 1,999 participants, 1,790 attended the clinic and provided blood samples.[17] Four participants were excluded from the analysis because their anti-HCV results were inconclusive, and the analysis dataset therefore included 1,786 participants.

All analyses including subgroup comparisons were weighted to adjust for complex sampling design, survey and component non-response, and were post-stratified to represent the NYC population. Statistical analyses were conducted using SUDAAN Version 9.0 (Research Triangle Institute, Research Triangle Park, NC, USA). Standard error estimates were obtained by Taylor series linearization. Statistical significance for differences in prevalence estimates was determined at $\alpha = 0.05$. Relative standard errors (RSEs) and 95% confidence intervals (CI) were calculated for percentages. Estimates with RSEs of >30% or estimates based on subgroups of fewer than 50 study participants are noted as unreliable.

Since specimens were not tested for viral nucleic acid and since some antibody-positive individuals are no longer infected, the prevalence of HCV infection was estimated from the antibody prevalence. The proportion of anti-HCV positive participants who were infected was based on the findings of NHANES 1999–2002, which found that 80% of anti-HCV-positive participants had detectable HCV RNA.[1] Therefore, the prevalence of anti-HCV in New York City was multiplied by 80% to estimate the prevalence of HCV infection.

To compare NYC and national HCV prevalence estimates, the 2003–2004 NHANES public-use dataset was downloaded and limited to respondents aged 20 and older, and analyzed using similar methods as for NYC HANES. For comparison purposes, both NYC HANES data and 2003–2004 NHANES data were age adjusted to the Year 2000 US standard population. NHANES HCV testing protocol differed from NYC HANES testing in that all NHANES specimens that were repeatedly reactive based on EIA testing were confirmed using RIBA. RIBA reactive specimens were considered positive, RIBA non-reactive specimens were considered negative, and those with indeterminate RIBA results were considered inconclusive.[21]

## RESULTS

Overall, 35 participants tested anti-HCV-positive, for a weighted prevalence of 2.2% (95% CI 1.5% to 3.3%). Multiplying this by 80% to adjust for the fact that

some antibody-positive individuals are no longer infected gives a chronic HCV infection prevalence estimated at 1.8%.

Anti-HCV prevalence was strongly associated with age ($p<0.001$ for linear trend), with the highest rate among those aged 50–59 years (5.8%, 95% CI 3.3% to 10.0%), corresponding to dates of birth from 1945 to 1954. Among 476 study participants age 20 to 29 years, none were anti-HCV-positive (Table 1). Anti-HCV prevalence was higher among US-born than foreign-born participants (3.1% vs. 1.3%, $p=0.04$), and higher among those with a lifetime history of incarceration as an adult than those never incarcerated (8.4% vs. 1.5%, $p=0.02$). Prevalence was higher among those with less education ($p=0.04$) and those receiving public assistance ($p=0.03$). Differences by race and ethnicity were not statistically significant.

The largest differences in prevalence were associated with well-established risk factors for acquiring HCV. Among the 35 anti-HCV-positive participants, 13 reported a history of injection drug use and five reported a blood transfusion prior to 1992 (two of these reported both injection drug use and transfusion). Among participants with a lifetime history of injection drug use, anti-HCV prevalence was 64.5%, compared to 1.1% among those with no history of drug use ($p<0.001$). Of the 13 anti-HCV-positive participants with a history of injection drug use, ten reported no current drug use, two reported current drug use, and one did not respond. Anti-HCV prevalence was 11.9% among those with a history of blood transfusion prior to 1992, compared to 1.8% among those without ($p=0.02$).

Telephone follow-up interviews were attempted with 34 of the 35 anti-HCV-positive participants (one had requested in advance that survey staff not contact him). Sixteen were unreachable (four disconnected telephones, two apparent wrong telephone numbers, two participants with unknown telephone numbers, and the remainder did not respond to telephone messages or letters). Of 18 reached by phone, 13 reported that they had been aware of their HCV status prior to the survey, and five learned about their HCV status as a result of the survey. Of note, four of these five had no obvious risk factors for infection.

Anti-HCV prevalence in NYC HANES was compared to that in the national NHANES (Table 2). After age adjustment, the overall anti-HCV prevalence was 2.3% in NYC (95% CI 1.5–3.5%) and 1.8% in NHANES (95% CI 1.3–2.6%); the observed difference was not statistically significant. For each of the subgroups examined, by gender, age, or race/ethnicity, the prevalence in NYC was somewhat higher than nationally, again without statistical significance. The same patterns were seen in NYC as nationally, i.e., higher prevalence for men, Blacks, and people in their 50s. NYC HANES data allowed an estimation of prevalence for Asians (2.4%, 95% CI 0.6–9.2), whereas in the national data an estimate for Asians was not available because of small sample size. Hispanic populations are presented differently in NYC and nationally, so direct comparisons are not possible. In NHANES, most Hispanic participants are Mexican-American and are presented separately as such. Most Hispanics in NYC, however, have ancestors from the Caribbean, and for NYC HANES, all Hispanics are presented together, with an anti-HCV prevalence of 1.4% (95% CI 0.6–3.4).

## CONCLUSIONS

This survey estimated that 2.2% of the civilian housed adult population in NYC, or an estimated 129,000 people, have ever been infected with HCV. About 80%, or 103,000 of these people, are likely to have chronic hepatitis C infection. These data

**TABLE 1 Anti-HCV prevalence in NYC by selected demographic, health, and behavioral characteristics**

| | N[a] | % | Lower 95% CI | Upper 95% CI | p[c] |
|---|---|---|---|---|---|
| Overall | 1,786 | 2.2 | 1.5 | 3.3 | |
| Sex | | | | | |
| Female | 1,032 | 1.9 | 1.2 | 3.1 | 0.36 |
| Male | 754 | 2.6 | 1.5 | 4.3 | |
| Race/ethnicity[b] | | | | | |
| White, non-Hispanic[d] | 524 | 1.9 | 0.8 | 4.1 | Reference |
| Black, non-Hispanic[d] | 379 | 4.4 | 2.4 | 7.8 | 0.10 |
| Hispanic, any race[d] | 627 | 1.2 | 0.5 | 2.7 | 0.95 |
| Asian, non-Hispanic[d] | 226 | 1.8 | 0.5 | 6.0 | 0.44 |
| Age (in years) | | | | | |
| 20–29 | 476 | 0.0 | – | – | <0.001[e] |
| 30–39[d] | 421 | 0.6 | 0.2 | 2.3 | |
| 40–49[d] | 389 | 2.5 | 1.3 | 4.8 | |
| 50–59 | 269 | 5.8 | 3.3 | 10.0 | |
| ≥60[d] | 231 | 3.0 | 1.5 | 6.2 | |
| Education level | | | | | |
| More than high school | 926 | 1.3 | 0.7 | 2.6 | 0.04 |
| High school grad or less | 852 | 3.3 | 2.0 | 5.5 | |
| Public assistance | | | | | |
| Yes[d] | 290 | 6.6 | 3.3 | 12.6 | 0.03 |
| No | 1,475 | 1.5 | 0.9 | 2.4 | |
| Blood transfusion <1992 | | | | | |
| Yes[d] | 66 | 11.9 | 5.8 | 22.9 | 0.02 |
| No | 1,699 | 1.8 | 1.1 | 2.8 | |
| Lifetime illicit drug use | | | | | |
| None or only marijuana[d] | 1,347 | 1.1 | 0.6 | 2.1 | Reference |
| Yes, no injection[d] | 276 | 1.3 | 0.5 | 3.6 | 0.82 |
| Yes, injection[d] | 21 | 64.5 | 39.2 | 83.7 | <0.001 |
| Age at first sexual intercourse | | | | | |
| ≥18 years[d] | 732 | 1.0 | 0.5 | 2.2 | 0.01 |
| <18 years | 784 | 3.4 | 2.1 | 5.5 | |
| Ever incarcerated as an adult | | | | | |
| Yes[d] | 152 | 8.4 | 4.3 | 15.7 | 0.02 |
| No | 1,491 | 1.5 | 0.9 | 2.6 | |
| Country of birth | | | | | |
| US and Territories | 869 | 3.1 | 1.9 | 5.0 | 0.04 |
| Other[d] | 911 | 1.3 | 0.7 | 2.6 | |

% weighted prevalence estimate. *N* unweighted sample size

[a]Total estimated populations may not equal the sum of subgroup estimated populations because of missing data

[b]Other race not included in NYC HANES estimate due to small sample size

[c]*p* value for test for difference in proportions

[d]Relative standard error >30% or denominator is <50. Prevalence estimate may be unstable and should be interpreted with caution

[e]*p* value for test for linear trend

provide a more accurate local estimate for public health planning in New York City, compared to the national prevalence as estimated from NHANES, which was used previously. This is especially important for NYC's Asian and Hispanic populations for which no estimate was available from NHANES.

**TABLE 2 Comparison of age-adjusted anti-HCV prevalence between NYC HANES and national HANES**

| | NYC HANES | | | | NHANES | | | | $p$[a] |
|---|---|---|---|---|---|---|---|---|---|
| | *N* | % | Lower 95% CI | Upper 95% CI | *N* | % | Lower 95% CI | Upper 95% CI | |
| Overall | 1,786 | 2.3 | 1.5 | 3.5 | 4,485 | 1.8 | 1.3 | 2.6 | 0.59 |
| Sex | | | | | | | | | |
| Male | 754 | 2.7 | 1.6 | 4.6 | 2,172 | 2.1 | 1.4 | 3.2 | 0.66 |
| Female | 1,032 | 1.9 | 1.2 | 3.2 | 2,313 | 1.6 | 1.0 | 2.5 | 0.65 |
| Race/ethnicity[c] | | | | | | | | | |
| White, non-Hispanic | 524 | 1.8[b] | 0.8 | 4.0 | 2,423 | 1.7 | 1.1 | 2.6 | 0.96 |
| Black, non-Hispanic | 379 | 4.3 | 2.4 | 7.5 | 873 | 3.2 | 2.3 | 4.3 | 0.35 |
| Asian, non-Hispanic | 226 | 2.4[b] | 0.6 | 9.2 | x | x | x | x | |
| Hispanic | 627 | 1.4[b] | 0.6 | 3.4 | x | x | x | x | |
| Other, non-Hispanic | x | x | x | x | 150 | 0.4[b] | 0.1 | 1.9 | |
| Mexican-American | x | x | x | x | 901 | 2.1 | 1.2 | 3.6 | |
| Hispanic, other than Mexican-American | x | x | x | x | 138 | 2.2[b] | 0.9 | 5.5 | |
| Age (in years) | | | | | | | | | |
| 20–29 | 476 | 0.0 | | | 817 | 0.0 | | | |
| 30–39 | 421 | 0.6[b] | 0.2 | 2.3 | 738 | 1.0[b] | 0.5 | 2.2 | 0.54 |
| 40–49 | 389 | 2.5[b] | 1.3 | 4.8 | 725 | 3.6 | 2.2 | 5.8 | 0.35 |
| 50–59 | 269 | 5.8 | 3.3 | 10.0 | 551 | 4.3 | 2.5 | 7.1 | 0.46 |
| ≥60 | 231 | 3.0[b] | 1.5 | 6.1 | 1,654 | 0.8 | 0.5 | 1.3 | 0.05 |

% Prevalence estimates, weighted and age adjusted using the Year 2000 standard population; *N* unweighted sample size; *x* estimate unavailable

[a] $p$ value for difference between NYC HANES and NHANES

[b] Relative standard error >30% or denominator <50. Prevalence estimate may be may be unstable and should be interpreted with caution

[c] Other race not included in NYC HANES estimate due to small sample size

Nearly two thirds of participants with a history of injection drug use were anti-HCV-positive, consistent with published studies of HCV among injection drug users.[8,22,23] About one in nine participants reporting a blood transfusion prior to 1992 were anti-HCV-positive, reflecting the high risk associated with blood transfusion prior to the introduction of an accurate HCV screening test.[24] There was a strong correlation with age, with the highest rates among participants born between 1945 and 1954. Although based on responses from only half the participants contacted for follow-up interview, approximately one quarter of the anti-HCV-positive participants contacted for follow-up had been unaware of their HCV status prior to the survey. This highlights the problem of undiagnosed HCV: without knowing their HCV status, people cannot take steps to decrease the chance that they will progress to serious liver disease (e.g., avoiding alcohol and getting vaccinated against hepatitis A and B). Most anti-HCV-positive participants with a history of injection drug use said they were not currently using drugs; this emphasizes the need for clinicians to ask patients about a remote history of drug use, as well as current drug use, to identify patients who need HCV screening.

There are a few limitations of this study. Since the overall response rate was 55%, it is possible that participants were not entirely representative of the NYC population. However, all data reported were weighted using information on age,

gender, and race/ethnicity to correct for potential bias. Due to limited sample size, there was inadequate statistical power to detect differences among some subgroups. Specimens were not tested for viral nucleic acid, only antibodies, so the data do not allow direct estimation of the prevalence of chronic HCV infection. NHANES data on the prevalence of RNA among antibody-positive participants were used to estimate the infection prevalence for our study population; this was appropriate because the two populations are similar in terms of age distribution, duration of infection, and distribution of risk factors for acquisition of infection, which are the factors most likely to correlate with infection among antibody-positive individuals. Only half the anti-HCV-positive participants in this survey were reached for follow-up telephone interview to ask whether they had been aware of their HCV status, so estimates of awareness about HCV status should be interpreted with caution. ACASI was only available for English and Spanish speakers (overall, 7.6% of participants did not complete ACASI). Despite the use of ACASI to enable privacy, it is possible that some participants with a history of injection drug use may not have disclosed it, due to the associated stigma.

Homeless and institutionalized New Yorkers were not included in this household-based survey (or in the national NHANES survey to which we compare our results). Studies have consistently documented that people who are incarcerated[25,26] or homeless[27] have a higher HCV prevalence. Therefore, surveys in these typically high-prevalence settings are needed to form a complete picture of the HCV epidemic in NYC.[28]

Reducing HCV transmission among drug users by maintaining and strengthening prevention programs such as drug treatment, harm reduction, and syringe exchange programs is essential. Initiatives to prevent HCV transmission in the healthcare setting are also important. Our finding that approximately one quarter of HCV-infected adults were unaware of their HCV status prior to the survey, and that most of those unaware of their status do not report drug use histories, illustrates the need to expand screening activities. Because of under-diagnosis and underreporting, routine surveillance systems will continue to underestimate the true prevalence of HCV. Therefore, serologic studies such as NYC HANES are essential to periodically monitor HCV prevalence and provide the accurate, local HCV prevalence estimates needed for prevention planning and allocation of resources for medical care.

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