

Original Research Article

Determinants of confirmatory diagnosis of chronic hepatitis C among women of reproductive age: a surveillance-based analysis, 2018-2022

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ABSTRACT

Background: Women of reproductive age are disproportionately affected by chronic hepatitis C virus (HCV) infection, yet disparities in confirmatory diagnosis remain poorly understood. This study examined determinants of confirmed chronic HCV diagnosis among women aged 15-45 years in Maryland and assessed whether rural or urban residence influenced diagnostic confirmation.

Methods: This cross-sectional study used secondary surveillance data from the Maryland National Electronic Disease Surveillance System (NEDSS) for women aged 15-45 years with chronic HCV reported between 2018 and 2022. We used logistic regression to assess the association between residence and confirmed diagnosis, controlling for demographic characteristics and period of diagnosis.

Results: Among 2,197 women, 62.7% had a confirmed diagnosis and 37.3% were classified as probable cases. Bivariate analyses showed significant associations between diagnosis status and residence, age, and race. In unadjusted analysis, rural residents were more likely than urban residents to receive a confirmed diagnosis (OR=1.30, 95% CI: 1.09-1.54). After adjustment, residence was no longer significant (OR=1.07, 95% CI: 0.89-1.29). Women aged 26-35 years had higher odds of confirmed diagnosis than those aged 15-25 years (OR=1.32, 95% CI: 1.03-1.70). Compared with White women, Black women (OR=0.45, 95% CI: 0.35-0.58) and women of other racial backgrounds (OR=0.51, 95% CI: 0.26-0.99) had lower odds of confirmation.

Conclusions: Age and race were stronger determinants than residence, highlighting persistent disparities in completion of HCV diagnostic evaluation and the need for targeted confirmatory testing efforts.

Keywords: Hepatitis C virus, Women of reproductive age, Confirmatory diagnosis, Surveillance, Health disparities, Maryland, Logistic regression

INTRODUCTION

Hepatitis C virus (HCV) infection remains a major public health challenge worldwide and is a leading cause of chronic liver disease, cirrhosis, hepatocellular carcinoma,

and liver-related mortality.^{1,2} Although highly effective direct-acting antiviral therapies are available, many infected individuals remain undiagnosed or fail to complete the diagnostic process required for confirmation of active infection.³

In the United States, the epidemiology of HCV has undergone a substantial shift during the past decade. Historically, chronic HCV infection was concentrated among individuals born between 1945 and 1965; however, surveillance data have demonstrated increasing rates of infection among younger adults, particularly those aged 20-39 years.^{4,5} This epidemiologic transition has been largely attributed to the opioid injection epidemic, which has fueled increasing transmission among persons who inject drugs.^{6,7}

Women of reproductive age represent a population of growing public health concern. National surveillance data indicate substantial increases in HCV infection among women aged 15-45 years, with corresponding increases in maternal HCV infection and the risk of perinatal transmission.^{5,8,9} It has been estimated that approximately 15% of women of childbearing age living with HCV become pregnant each year, creating important opportunities for screening, diagnosis, and treatment interventions.¹⁰

Accurate diagnosis of chronic HCV infection requires confirmatory nucleic acid testing following an initial reactive antibody test. Because acute and chronic HCV infections are frequently asymptomatic, failure to complete confirmatory testing may delay linkage to care and treatment while contributing to ongoing transmission.^{3,11} Surveillance systems classify individuals with positive antibody results as probable cases, whereas confirmed cases require evidence of active infection through HCV RNA testing.¹²

Previous research has demonstrated that social determinants of health influence HCV diagnosis, treatment uptake, and health outcomes. Factors such as geographic residence, race and ethnicity, socioeconomic status, healthcare access, and neighborhood deprivation have been associated with variations in HCV-related outcomes.¹³⁻¹⁷ Rural communities face additional challenges, including shortages of healthcare providers, limited specialist availability, geographic isolation, and barriers to accessing screening and treatment services.¹⁸⁻²¹

Racial and ethnic disparities have also been documented throughout the HCV care continuum. Although HCV affects all racial and ethnic groups, differences in healthcare access, structural inequities, and social determinants of health contribute to disparities in diagnosis, treatment, and disease outcomes.^{15,22,23}

Despite increasing reports of HCV among women of reproductive age, limited evidence exists regarding determinants of confirmatory diagnosis among this population in Maryland. Understanding factors associated with completion of confirmatory testing is important because confirmed diagnosis represents a critical step toward treatment initiation and prevention of future transmission. Therefore, this study examined the association between place of residence and confirmatory

diagnosis of chronic HCV among women aged 15-45 years reported to the Maryland NEDSS between 2018 and 2022. The study further assessed the influence of age, race, and period of diagnosis on the likelihood of receiving a confirmed diagnosis of chronic HCV.

METHODS

Study design

This study employed a cross-sectional analytical design using secondary surveillance data obtained from the Maryland National Electronic Disease Surveillance System (NEDSS). It examined determinants of confirmatory diagnosis of chronic HCV among women of reproductive age reported in Maryland between January 1, 2018, and December 31, 2022.

Data source

Data were obtained from Maryland's NEDSS, the state's electronic disease surveillance system used to collect, manage, and monitor reportable infectious diseases. The surveillance system receives laboratory reports and case information from healthcare providers, laboratories, hospitals, and other reporting entities across Maryland. NEDSS is maintained by the Maryland Department of Health and serves as the primary repository for surveillance information related to HCV infection.

Study population

The study population consisted of women aged 15-45 years with chronic HCV reported in Maryland between 2018 and 2022. Cases were identified from the surveillance database using the Centers for Disease Control and Prevention (CDC) case definitions for chronic HCV infection.

Eligible records included women of reproductive age who met the surveillance criteria for chronic HCV and had complete information on diagnosis status and demographic variables required for the analysis. Records with missing information on key study variables were excluded from the final analytical dataset.

A total of 2,197 women met the inclusion criteria and were included in the analysis.

Outcome variable

The dependent variable was HCV diagnosis status.

Diagnosis status was categorized as: Confirmed chronic HCV diagnosis and probable chronic HCV diagnosis

For analytical purposes, confirmed diagnosis was coded as the outcome of interest. The classification was based on CDC surveillance case definitions and laboratory criteria documented in the Maryland NEDSS database.

Independent variable

The primary independent variable of interest was place of residence.

Residence was categorized as: urban and rural.

Classification of residence was based on county-level geographic designation used within the Maryland surveillance system.

Covariates

Additional demographic variables included:

Age

Age was categorized into three groups: 15-25 years, 26-35 years and 36-45 years.

Race

Race was categorized as: White, Black or African American and other.

Period of diagnosis

To assess the potential influence of the COVID-19 pandemic on HCV diagnosis, year of diagnosis was grouped into: Pre-COVID-19 period (2018-2019) and during and post-COVID-19 period (2020-2022).

Statistical analysis

Descriptive statistics were used to summarize the characteristics of women included in the study. Frequencies and percentages were calculated for all categorical variables. Findings from the descriptive analysis are presented in Table 1.

Bivariate analyses were conducted to examine associations between HCV diagnosis status and the independent variables. Pearson's chi-square tests were used to evaluate statistical significance. Results of the bivariate analyses are presented in Table 2.

Logistic regression analysis was performed to estimate odds ratios (ORs) and 95% confidence intervals (CIs) for factors associated with confirmatory diagnosis of chronic HCV. Two models were developed.

Model 1 estimated unadjusted associations between each independent variable and confirmatory diagnosis status. Results are presented in Table 3.

Model 2 included place of residence, age, race, and period of diagnosis simultaneously to estimate adjusted odds ratios while controlling for potential confounding variables. Results are presented in Table 4.

Statistical significance was assessed using 2-sided alpha level of 0.05. All analyses conducted using statistical software appropriate for epidemiologic analysis.

Ethical considerations

The study utilized secondary surveillance data obtained from the Maryland Department of Health. All data were de-identified prior to analysis to protect participant confidentiality. Approval for data access and use was obtained in accordance with applicable institutional and public health requirements governing surveillance data.

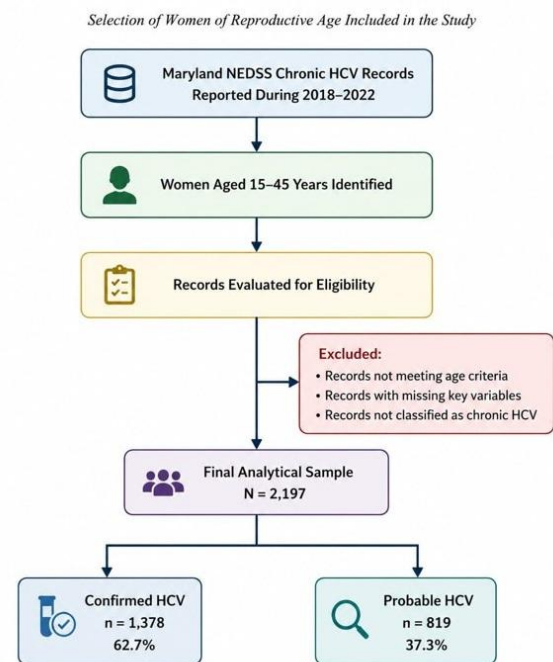


Figure 1: Study population selection flow diagram.

RESULTS

Characteristics of the study population

A total of 2,197 women aged 15-45 years diagnosed with HCV and reported to the Maryland National Electronic Disease Surveillance System (NEDSS) between 2018 and 2022 were included in the analysis. Among these women, 1,378 (62.7%) had a confirmed diagnosis of chronic HCV, while 819 (37.3%) were classified as probable cases (Table 1).

More than half of the study population resided in urban jurisdictions (55.4%), whereas 44.6% lived in rural jurisdictions. Women aged 26-35 years constituted the largest age group (51.1%), followed by women aged 36-45 years (32.0%) and those aged 15-25 years (17.0%). The majority of women were White (77.9%), while Black or African American women accounted for 20.4% of the study population and women from other racial groups represented 1.6%.

The distribution of diagnoses by year was relatively consistent across the study period, with the largest proportion reported in 2018 (25.8%) and the lowest in 2020 (15.7%). When grouped by pandemic period, 49.3% of cases were reported during the pre-COVID-19 period (2018-2019), while 50.7% were reported during and after the COVID-19 period (2020-2022) (Table 1).

Table 1: Characteristics of study population.

Variables	N	Percentages (%)
Dependent variable		
Hepatitis C status		
Confirmed	1,378	62.72
Probable	819	37.28
Independent variable of interest		
Residence		
Urban	1,216	55.35
Rural	981	44.65
Other demographic indicators:		
Age (in years)		
15-25	373	16.98
26-35	1,122	51.07
36-45	702	31.95
Race		
Whites	1,712	77.92
Blacks or African Americans	449	20.44
Others	36	1.64
Year of diagnosis		
2018	567	25.81
2019	517	23.53
2020	345	15.70
2021	413	18.80
2022	355	16.16
Year of diagnosis, category by COVID pandemic		
Pre-COVID-19 (2018-2019)	1,084	49.34
During and post COVID-19 (2020-2022)	1,113	50.66
Total sample	2,197	100.0

Bivariate analysis

Bivariate analysis demonstrated a statistically significant association between place of residence and HCV diagnosis status ($\chi^2=8.42$, $p=0.004$) (Table 2). Women residing in rural jurisdictions were more likely to receive a confirmed diagnosis of chronic HCV (66.1%) compared with women residing in urban jurisdictions (60.0%).

Age was also significantly associated with diagnosis status ($\chi^2=9.58$, $p=0.008$). Across all age categories, the proportion of women receiving a confirmed diagnosis exceeded the proportion receiving a probable diagnosis. The highest proportion of confirmed diagnoses was observed among women aged 26-35 years (65.7%).

Race was strongly associated with diagnosis status ($\chi^2=67.62$, $p<0.001$). White women had the highest proportion of confirmed diagnoses (67.2%), whereas Black or African American women had the highest proportion of probable diagnoses (53.5%).

Women classified in the “other” racial category were equally distributed between confirmed and probable diagnosis categories.

No statistically significant association was observed between diagnosis status and period of diagnosis ($\chi^2=2.55$, $p=0.110$) (Table 2).

Logistic regression analysis

Table 3 presents the unadjusted logistic regression estimates examining factors associated with confirmatory diagnosis of chronic HCV.

Women residing in rural jurisdictions were significantly more likely to receive a confirmed diagnosis than women residing in urban jurisdictions (OR=1.30; 95% CI: 1.09-1.54; $p=0.004$).

Women aged 26-35 years were also significantly more likely to receive a confirmed diagnosis than women aged 15-25 years (OR=1.41; 95% CI: 1.11-1.79; $p=0.005$). The association for women aged 36-45 years was not statistically significant.

Compared with White women, Black or African American women were significantly less likely to receive a confirmed diagnosis (OR=0.42; 95% CI: 0.34-0.52; $p<0.001$).

Similarly, women categorized as other races were less likely to receive a confirmed diagnosis (OR=0.49; 95% CI: 0.25-0.94; $p=0.033$). Period of diagnosis was not significantly associated with diagnosis status (OR=0.86; 95% CI: 0.73-1.03; $p=0.110$).

Adjusted logistic regression model

After adjustment for residence, age, race, and period of diagnosis, residence was no longer significantly associated with confirmatory diagnosis of chronic HCV (OR=1.07; 95% CI: 0.89-1.29; $p=0.449$) (Table 4).

Age remained an important determinant of diagnosis. Women aged 26-35 years were 32% more likely to receive a confirmed diagnosis compared with women aged 15-25 years (OR=1.32; 95% CI: 1.03-1.70; $p=0.023$). The association for women aged 36-45 years was not statistically significant.

Racial disparities persisted after adjustment for covariates. Compared with White women, Black or African American women were 55% less likely to receive

a confirmed diagnosis (OR=0.45; 95% CI: 0.35-0.58; $p<0.001$).

Women categorized as other races were 49% less likely to receive a confirmed diagnosis (OR=0.51; 95% CI: 0.26-0.99; $p=0.049$).

The association between diagnosis period and diagnosis status remained statistically insignificant in the adjusted model (OR=0.91; 95% CI: 0.84-1.41; $p=0.288$).

Overall, age and race emerged as the strongest determinants of confirmatory diagnosis of chronic HCV among women of reproductive age in Maryland.

Table 2: Bivariate associations between study variables and HCV diagnosis status.

Variables	Chronic HCV diagnosis; confirmed				Chi square	P value
	Yes		No			
	N	%	N	%		
Independent variable of interest						
Place of residence						
Urban	730	60.03	486	39.97	8.42	0.004
Rural	648	66.06	333	33.94		
Covariates						
Age (in years)						
15-25	215	57.64	158	42.36	9.58	0.008
26-35	737	65.69	385	34.31		
36-45	426	60.68	276	39.32		
Race						
Whites	1,151	67.23	561	32.77	67.62	<0.001
Blacks	209	46.55	240	53.45		
Others	18	50.00	18	50.00		
Period of diagnosis						
2018-2019	698	64.39	386	35.61	2.55	0.110
2020-2022	680	61.10	433	38.90		

Table 3: Unadjusted logistic regression results.

Covariates	Model 1 (unadjusted)		P value
	OR	95% CI	
Independent variable of interest			
Place of residence			
Urban	1.00	-	-
Rural	1.30	1.09- 1.54	0.004
Co-variables			
Age (in years)			
15-25	1.00	-	-
26-35	1.41	1.11- 1.79	0.005
36-45	1.13	0.88-1.46	0.333
Race			
Whites	1.00	-	-
Blacks	0.42	0.34-0.52	<0.001
Others	0.49	0.25-0.94	0.033
Period of diagnosis			
2018-2019	1.00	-	-
2020-2022	0.86	0.73-1.03	0.110

Table 4: Adjusted logistic regression results.

Covariates	Model 2 (Adjusted)		P value
	OR	95% CI	
Independent variable of interest			
Place of residence			
Urban	1.00	-	-
Rural	1.07	0.89-1.29	0.449

Continued.

Covariates	Model 2 (Adjusted)		P value
Covariates			
Age (in years)			
15-25	1.00	-	-
26-35	1.32	1.03-1.70	0.023
36-45	1.09	0.84-1.41	0.510
Race			
Whites	1.00	-	-
Blacks	0.45	0.35-0.58	<0.001
Others	0.51	0.26-0.99	0.049
Period of diagnosis			
2018-2019	1.00	-	-
2020-2022	0.91	0.84-1.41	0.288

DISCUSSION

This study examined determinants of confirmatory diagnosis of chronic HCV infection among women of reproductive age in Maryland using statewide surveillance data collected between 2018 and 2022. The findings demonstrated that age and race were the strongest predictors of receiving a confirmed diagnosis, whereas the association between rural residence and confirmatory diagnosis observed in unadjusted analyses was no longer significant after adjustment for demographic characteristics. These findings contribute to the growing body of literature examining disparities in HCV diagnosis and access to care among populations disproportionately affected by the ongoing HCV epidemic.^{6,7,13}

The unadjusted analysis suggested that women residing in rural jurisdictions were more likely to receive a confirmed diagnosis compared with women residing in urban areas. However, this association disappeared after controlling for age, race, and diagnosis period. Previous studies have documented increasing HCV incidence in rural communities, particularly in regions heavily affected by the opioid epidemic.^{18,19} Rural populations often experience barriers to HCV screening and treatment, including shortages of healthcare providers, limited specialist availability, geographic isolation, and reduced access to harm-reduction services.^{20,21} The findings of the present study suggest that observed differences between rural and urban jurisdictions in Maryland may be explained largely by demographic characteristics rather than residence alone.

Age emerged as an important determinant of confirmatory diagnosis. Women aged 26-35 years were significantly more likely to receive a confirmed diagnosis than women aged 15-25 years. This finding is consistent with national surveillance reports indicating increasing HCV burden among adults aged 20-39 years.^{4,5} Women in this age group may have greater interaction with healthcare systems through reproductive, prenatal, and primary care services, thereby increasing opportunities for HCV screening, confirmatory testing, and linkage to care.⁸⁻¹⁰ Expanded HCV screening recommendations for

adults and pregnant women may further contribute to improved case identification within this age group.^{24,25}

The most notable disparities identified in this study were associated with race. After adjustment for other variables, Black women and women belonging to other racial groups remained significantly less likely than White women to receive a confirmed diagnosis. These findings are consistent with previous studies demonstrating disparities across the HCV care continuum, including screening, diagnosis, treatment initiation, and achievement of sustained virologic response.^{17,22,23} Structural barriers, differences in healthcare access, socioeconomic inequities, and systemic racism have all been identified as contributors to disparities in HCV-related outcomes among racial and ethnic minority populations.^{15,22,23} The persistence of these disparities after adjustment suggests that interventions designed to improve diagnostic completion should specifically address barriers experienced by minority populations.

The COVID-19 pandemic did not appear to significantly influence confirmatory diagnosis in this study. Although the adjusted model demonstrated slightly lower odds of confirmatory diagnosis during the pandemic period, the association was not statistically significant. This finding may indicate that HCV reporting and diagnostic confirmation activities within Maryland's surveillance system remained relatively stable despite disruptions experienced by healthcare systems during the pandemic. Similar observations have been reported in some surveillance settings where established reporting infrastructure continued to function despite reductions in healthcare utilization.²⁶

The findings have important implications for public health practice. Confirmatory diagnosis represents a critical step in the HCV care cascade because active infection cannot be established through antibody testing alone. Current CDC surveillance definitions classify individuals with positive antibody tests as probable cases, whereas confirmed cases require laboratory evidence of active infection through HCV RNA testing.¹² Failure to complete confirmatory testing may delay treatment initiation, increase the risk of disease progression, and

contribute to continued transmission within communities. Identifying populations less likely to complete the diagnostic process may assist public health agencies in developing targeted interventions to improve linkage to care and support HCV elimination efforts.^{24,27}

Several limitations should be considered when interpreting these findings. First, the analysis relied on secondary surveillance data collected for public health purposes rather than research. Consequently, variables such as socioeconomic status, health insurance coverage, substance use history, and healthcare utilization were unavailable for analysis. Second, the cross-sectional design limits causal inference and permits only the identification of associations. Third, surveillance data may be affected by incomplete reporting, misclassification, and missing information. Despite these limitations, the study utilized a comprehensive statewide surveillance database and included all eligible women of reproductive age reported with chronic HCV during the study period, thereby enhancing the generalizability of findings within Maryland.

The study also possesses several strengths. The use of population-based surveillance data provided a large sample size and enabled examination of HCV diagnosis across diverse demographic and geographic populations. Furthermore, the application of multivariable logistic regression allowed for adjustment of important demographic factors and provided insight into independent determinants of confirmatory diagnosis among women of reproductive age.

CONCLUSION

This study demonstrates that age and race, rather than rural–urban residence, were the strongest determinants of confirmatory chronic hepatitis C diagnosis among women of reproductive age in Maryland. Women aged 26–35 years were more likely to complete confirmatory diagnosis, whereas Black women and women from other racial groups were significantly less likely than White women to do so, indicating persistent disparities within the HCV diagnostic continuum. These findings are important because failure to complete confirmatory testing can delay treatment, weaken linkage to care, and sustain opportunities for ongoing transmission. The study advances knowledge in the field by showing that demographic disparities may be more crucial than geographic residence in shaping diagnostic completion among women of reproductive age. This evidence can help public health practitioners and policymakers refine HCV elimination strategies by prioritizing equity-focused approaches, including targeted patient navigation, community-based testing, integration of HCV services into reproductive health settings, and culturally responsive outreach. Although the cross-sectional design and limitations of surveillance data restrict causal interpretation, the findings provide a clearer understanding of where gaps occur in the HCV care

cascade and identify priority populations for future intervention and research.

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