



Prevalence and sociodemographic disparities of Hepatitis C in Baby Boomers and the US adult population

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ABSTRACT

Background: The US Baby Boomer (BB) generation is associated with high rates of Hepatitis C virus (HCV) infection. There is limited literature detailing age-specific risk factors for HCV infection. Using a nationally representative sample, this study examines US adult HCV prevalence and age-specific risk factors for chronic HCV infection.

Methods: We analyzed data from National Health and Nutrition Examination Survey (NHANES) for years 1999–2012. Age was divided into three categories: BB, younger than BB (YG) and older than BB (OG). HCV status was determined by the presence of a positive HCV antibody and a positive HCV RNA. Sociodemographic variables were analyzed by HCV status. Multivariable logistic regression models adjusting for sociodemographic variables were fitted to identify age-specific risk factors for HCV positivity.

Results: The overall prevalence of chronic HCV was 1.19% with a US population estimate of 2,347,852 US adults. BB had the highest prevalence at 2.23%, accounting for over 74% of all chronic HCV cases. HCV prevalence was highest among all ages (1.83%) and BB (2.71%) in 2001–2002 survey cycle. Among BB, males, non-Hispanic blacks, positive blood transfusion history, current and former smoker, and living below the poverty line were significant predictors of chronic HCV positivity.

Conclusion: This study highlights the elevated prevalence of chronic HCV among BB and identifies age-specific risk factors for chronic HCV infection. As the BB population ages, it is important to use these generation-specific risk factors that can guide health professionals in targeted screening and public health prevention efforts.

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Introduction

Born in the Post-World War II era, the Baby Boomer (BB) generation is associated with high rates of Hepatitis C virus (HCV) infection. HCV is the most common chronic blood borne infection in the United States (US), and the virus is most commonly contracted parenterally via intravenous drug use, blood transfusions from untested donors, and healthcare-related procedures [1,2]. Chronic HCV has the potential for complications such as liver cirrhosis, decompensated liver failure, and hepatocellular carcinoma [3]. Hepatocellular carcinoma incidence is on the rise in the US [4]. Most hepatocellular carcinoma is associated with Hepatitis B or Hepatitis C infection [5]. With novel HCV treatments

available, early detection and treatment may provide a means to avoid long-term HCV complications [6].

As the BB population ages, it is important to identify and to address chronic health conditions early to avoid long-term complications. In addition to a higher prevalence of HCV, studies have shown that BB have higher rates of chronic disease and disability compared to other generations [7]. While the elevated prevalence of HCV in the BB generation is well-documented, there is limited literature identifying age-specific HCV risk factors with specific attention to the BB generation. Age-specific risk factors can identify high-risk sociodemographic groups to target for screening. Using a nationally representative database, this study examines HCV prevalence and risk factors among BB and age groups both older and younger to discern age-specific HCV infection risk factors.

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Table 1
Sociodemographic characteristics of HCV positivity^c by age category: NHANES 1999–2012.

	All		Age groups		
	Positive % ^a	US population estimate n	Younger generation % ^a	Baby Boomers % ^a	Older generation % ^a
Total	1.19	2,347,852	0.52	2.23	0.46
Gender					
Male	1.64	1,562,453	0.68	3.13	0.51
Female	0.77	785,399	0.37	1.36	0.41
Race					
Non-Hispanic white	1.07	1,495,546	0.56	1.97	0.29
Non-Hispanic black	2.61	549,671	0.79	5.01	1.84
Hispanic/Latino	0.88	228,164	0.37	1.75	0.94
Other race	0.65	74,470	0.15	1.37	0.41
Educational attainment					
Less than HS	1.79	672,019	1.38	3.19	0.72
HS graduate	1.54	737,796	0.72	2.99	0.40
Greater than HS	0.83	933,577	0.20	1.67	0.32
Blood transfusion history					
Yes	2.45	538,507	1.77	4.54	0.97
No	1.01	1,745,446	0.45	1.93	0.28
Smoking status					
Current	3.27	1,476,734	1.47	5.85	1.26
Former	1.02	498,095	0.34	1.85	0.44
Never	0.36	369,877	0.12	0.68	0.28
Income poverty ratio ^b					
Above poverty	0.97	1,670,446	0.30	1.90	0.37
Below poverty	2.63	677,406	1.54	5.24	1.27

Differences across age groups were statistically significant for all variables ($p < 0.01$).

Younger generation – Born after 1965; Baby Boomers – Born between 1945–1965; Older generation – Born before 1965.

^a Row percentages.

^b Income Poverty Ratio determined by ratio of family income to national poverty threshold; ≥ 1 – Above, < 1 – Below.

^c HCV positivity determined by Hepatitis C serum antibody presence and HCV-RNA; HS: High School.

Materials & methods

Data source

We used data from the National Health and Nutrition Examination Survey (NHANES) years 1999–2012 (7 cycles) for adults (≥ 20 years). NHANES is a nationally representative sample of the non-institutionalized adult US population. The NHANES sampling design and methods have been detailed elsewhere [8]. NHANES is unique, series of population-based surveys that combine interviews and physical examinations to assess the health and nutritional status of adults and children in the US. NHANES is a program of the National Center for Health Statistics (NCHS), which is part of the Centers for Disease Control and Prevention (CDC) in the US. To be able to capture the representative of the US population, NHANES uses a non-random complex, multistage sampling. There are four stages included in the sampling process: US counties, segments (i.e. city blocks), households, and individuals. Sample weights are applied to each sampled individual to represent non-institutionalized US population. Sampled individuals are subject to interviews, self-reported questionnaires, biological sampling, and physical examinations.

Outcome and predictor variables

BB were defined as the individuals born between 1945 and 1965. The younger generation (YG) and older generation (OG) were defined as individuals born after (post-1965) and before the BB era (pre-1945), respectively. Smoking status, history of blood transfusion, educational attainment, race/ethnicity were self-reported. Income to poverty ratio (IPR) was calculated by taking into account household income to their appropriate poverty threshold by the

poverty guidelines, specific to family size, state, and year (U.S. Census Bureau, 2004). In our study, IPR was divided into below or at/above 1 – ratios below 1 indicate that the income for the respective household is below the official definition of poverty, while a ratio of 1 or greater indicates income above the poverty level.

HCV status, our dichotomous outcome variable, was determined by both HCV surface antibody and HCV-RNA from serum samples [9]. Individuals were considered as HCV positive if HCV-RNA result is positive for those with positive or indeterminate HCV surface antibody. Positive for HCV-RNA result with missing HCV surface antibody was also considered as HCV positive. HIV status was determined by presence of HIV antibody. HIV status was excluded from the regression model given that there was no testing available for OG.

Theory & statistical analysis

Sociodemographic variables were tabulated by HCV status and age groups. For all individuals, a multivariable logistic regression model adjusted for sociodemographic variables was fitted to predict HCV status. Three independent multivariable logistic regression models were also fitted by age group to predict HCV status and to identify age-specific risk factors for HCV positivity. Adjusted odds ratios (aOR) and corresponding 95% confidence intervals (95%CI) were calculated to identify variables as risk factors for HCV positivity. NHANES uses a complex sampling design to produce nationally representative results. Therefore, NHANES sample weights were incorporated in all statistical analysis using SAS v9.4 (SAS Institute, Cary, NC). This study is a secondary data analysis from publicly available NHANES datasets and is exempt from Institutional Review Board approval.

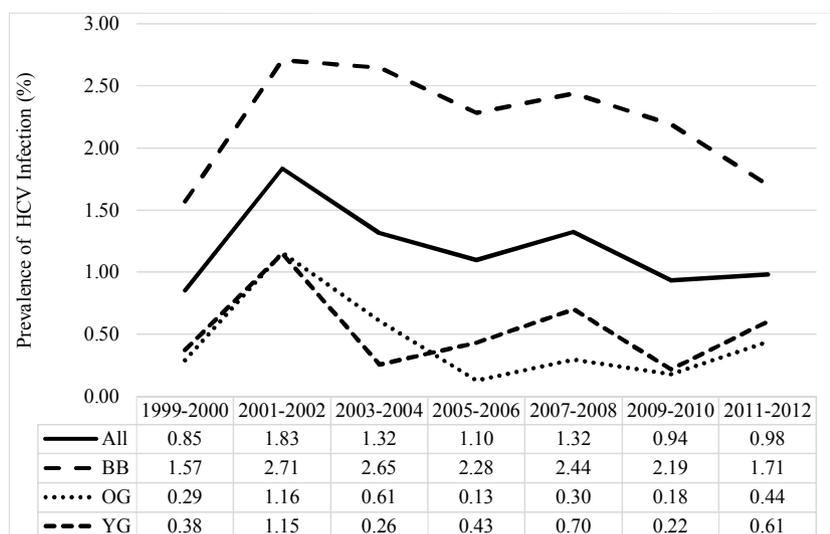


Fig. 1. Prevalence (%) of HCV infection by age group: NHANES 1999–2012.

Table 2

Multivariable logistic regression analyses predicting HCV positivity^b by age category: NHANES 1999–2012.

	All aOR (95% CI)	Age groups		
		Younger generation aOR (95% CI)	Baby Boomers aOR (95% CI)	Older generation aOR (95% CI)
Gender (ref= Female)				
Male	2.04 (1.56–2.66)	1.65 (0.88–3.11)	2.25 (1.65–3.07)	1.31 (0.64–2.64)
Race (ref= Other race)				
Non-Hispanic White	1.53 (0.80–2.94)	2.79 (0.36–21.78)	1.57 (0.75–3.31)	0.73 (0.19–2.88)
Non-Hispanic Black	3.43 (1.88–6.24)	3.40 (0.42–27.51)	3.48 (1.75–6.89)	3.87 (1.05–14.23)
Hispanic/Latino	1.21 (0.59–2.52)	1.36 (0.16–11.30)	1.43 (0.62–3.28)	1.96 (0.39–9.99)
Education (ref= Greater than HS)				
Less than HS	1.17 (0.83–1.63)	3.28 (1.13–9.50)	0.99 (0.69–1.42)	1.21 (0.51–2.87)
HS graduate	1.22 (0.88–1.70)	1.76 (0.77–4.05)	1.26 (0.86–1.85)	1.12 (0.40–3.12)
Transfusion history (ref= No)				
Yes	2.74 (1.95–3.83)	3.63 (1.47–8.94)	2.34 (1.48–3.68)	3.77 (2.14–6.65)
Smoking status (ref= Never)				
Current	8.02 (5.64–11.42)	7.18 (3.11–16.57)	7.85 (5.01–12.29)	3.71 (1.52–9.05)
Former	2.71 (1.72–4.28)	2.79 (0.99–7.88)	2.73 (1.58–4.71)	1.59 (0.64–3.96)
Poverty status ^a (ref= Above poverty)				
Below poverty	2.09 (1.55–2.81)	3.64 (1.51–8.76)	1.99 (1.40–2.82)	2.13 (0.93–4.85)

aOR (95% CI): Adjusted odds ratio and 95% confidence interval by taking into account the NHANES survey weights. Younger generation – Born after 1965; Baby Boomers – Born between 1945–1965; Older Generation – Born before 1965.

^a Poverty status determined by ratio of family income to national poverty threshold; ≥ 1 – Above, <1 – Below.

^b HCV positivity determined by Hepatitis C serum antibody presence and HCV-RNA; HS: High school.

Results

Overall & sociodemographic characteristics

From 1999 to 2012, the overall estimated US prevalence of HCV was 1.19% (US population estimate = 2,347,852) (Table 1). For all years, BB had the highest estimated HCV prevalence at 2.23% (US population = 1,750,839), accounting for over 74% of all HCV cases. The YG and OG had lower prevalence of HCV for all ages (0.52% and 0.46%, respectively).

For all ages, males had higher rates of HCV compared to females – the highest prevalence for males and females were among the BB generation. In terms of race, non-Hispanic blacks had the highest prevalence (2.61%) while Other race had the lowest prevalence of HCV (0.65%). Among BB, non-Hispanic blacks had a prevalence over two times higher than other races (5.01%). Current smokers had the highest HCV prevalence across all sociodemographic characteristics across all generations (3.27%) and within the BB gen-

eration (5.85%). Never smokers had the lowest prevalence among all sociodemographic characteristics (0.36%). HIV prevalence was higher among BB (0.60%) than YG (0.34%), and the rate of co-infection with HCV and HIV was 9.18% among BB and YG.

Individuals with a positive blood transfusion history had a higher prevalence of HCV compared to those without a history of blood transfusion (2.45% and 1.01%, respectively). Those with a higher income poverty ratio had a lower prevalence of HCV than those with a lower income poverty ratio (0.97% and 2.63%, respectively).

Trends in HCV prevalence

Fig. 1 shows the HCV prevalence by age-group from 1999 to 2012 by NHANES cycle. HCV prevalence was highest among all ages (1.83%) and BB (2.71%) in 2001–2002 cycle. HCV prevalence was lowest in the 1999–2000 cycle with a prevalence of 1.57% for BB

and 0.85% for all US adults. HCV prevalence peaked for OG (1.16%) and YG (1.15%) in 2001–2002.

Multivariable logistic regression models for predicting HCV positivity

Among all individuals, males, non-Hispanic blacks, positive transfusion history, current and former smokers, and those below poverty line were significantly more likely to be HCV positive (Table 2). Current smokers and a positive transfusion history were significant predictors of HCV positivity across all independent age groups. Among BB, males, non-Hispanic blacks, positive blood transfusion history, current and former smoker, and living below the poverty line were significant predictors for positive HCV status. The most significant predictor of HCV positivity among BB was being a current smoker (aOR 7.85; 95% CI 5.01–12.29).

Conclusions

This study highlights the public health issue of increased HCV prevalence among the BB population. Our results also demonstrate that there are distinct age-specific HCV infection risk factors in US adults. BB showed a HCV prevalence over four times higher than YG or OG. BB also had more significant predictors of positive HCV status than YG or OG. The most significant risk factor for HCV positivity differed across age groups – current smokers in YG and BB, and non-Hispanic blacks in OG.

The HCV prevalence in this study (1.0%) was lower compared to the previous NHANES studies examining HCV prevalence from 1988 to 1994 (1.8%) and 1999 to 2002 (1.6%) [10–12]. The lower prevalence may be attributable to improved treatment options and greater access to care for HCV positive individuals [13]. While it is promising that the overall prevalence of HCV infection has decreased, our results show that HCV poses a significant public health challenge with an estimated 2,347,852 individuals infected with HCV.

A major barrier to HCV screening and early detection is the lack of symptoms with chronic HCV infection. Past screening studies have shown that the majority of infected Hepatitis C patients are unaware of their status [14]. The low rates of awareness among HCV-infected individuals can be attributed to the lack of symptoms for the majority of chronic HCV infections. Consequently, infected individuals do not seek treatment until complications arise, limiting the opportunity to treat the disease early and effectively.

Similar to past studies, BB had significantly higher prevalence of chronic HCV compared to other age groups. Novel HCV treatments are highly-effective, yet a significant proportion of individuals are unaware of their HCV status [15]. Given the low rates of HCV status awareness, the CDC recommends a one-time HCV screening test for BB [16]. While all BB should be screened for HCV, this study highlights specific BB risk factors for chronic HCV infection. Health professionals and public health professionals can organize targeted screening programs and public health prevention strategies directed at high-risk groups such as current smokers.

The high prevalence of HCV infection among BB is not well-understood, yet exposure to infected blood via unscreened blood transfusions or non-sterile medical equipment is commonly considered a strong risk factor. Assays to screen blood transfusions for HCV were approved in the early 1990s, which suggests that BB and OG were potentially exposed to unscreened blood products if given a transfusion [17]. However, studies have shown that the majority of HCV incident cases are not related to unscreened blood transfusions [18]. Our study showed that while history of transfusion was a significant predictor of HCV positivity for all age groups, the lowest risk was seen among BB compared to YG or OG.

This study showed higher rates of chronic HCV among males compared to females for all age groups. Higher HCV prevalence among males has been shown in other HCV-screening studies [19]. The higher rates among males may be attributed to more high-risk behaviors such as intravenous drug-use among males compared to females. Studies examining HCV screening habits have shown that males from the BB generation are more likely to undergo HCV screening compared to females [20]. In the context of our results, this is a positive finding since males show a higher prevalence of HCV, warranting more aggressive screening and prevention strategies.

Our results show that current smoking is a significant risk factor of HCV positivity. Studies have linked tobacco smoking and histological activity in chronic HCV patients [21]. Consequently, current smokers may face a double risk of higher rates of potential HCV infection in addition to more aggressive complications. Further research is necessary to better understand the increased risk for HCV positivity among current smokers in addition to the potential impact of tobacco smoking on HCV complications.

A strength of this study is the large sample size and laboratory screening used to identify HCV status via population-based approach. The use of a positive or indeterminate HCV antibody and a positive HCV-RNA have been used to identify HCV infection in other studies [12]. Despite its strength, this study is not without limitations. A limitation is the NHANES sampling restriction to the non-institutionalized US population. This restriction excludes prisoners, homeless, and those living in institutions. Studies have shown higher rates of HCV in homeless and prisoner populations [22–24]. Future studies should seek to determine the prevalence of HCV among these high-risk populations. Another limitation to this study is the cross-sectional nature, which limits the temporal association between HCV positivity and risk factors such as blood transfusion history.

This study expands on the previous studies using NHANES to estimate the HCV prevalence of US adults [12]. Given the asymptomatic nature of the majority HCV infections, nationally-representative screenings such as NHANES are important to determine the prevalence and burden of HCV infection. These results show that HCV infection continues to be a significant public health issue and warrants further attention given the aging BB population. Future studies should seek to further identify age-specific risk factors for HCV infection to optimize HCV screening and prevention programs through public health interventions.

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Competing interests

None declared.

Ethical approval

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