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Hepatitis C virus screening trends: A 2016 update of the National Health Interview Survey

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ABSTRACT

Background: 50% of liver cancer is caused by hepatitis C virus (HCV). Baby boomers are at increased risk and are recommended for one-time HCV screening. However, < 13% of baby boomers were screened in 2015.
Materials and methods: We are updating a previous study using 2013–2015 NHIS data to examine HCV screening prevalence by birth cohort, with 2016 data. We used logistic regression to evaluate whether HCV screening prevalence changed over time, stratified by birth cohort.
Results and discussion: The sample consisted of 132,742 participants from 2013–2016. Screening increased in baby boomers from 11.9 to 14.1%. Odds of HCV screening for baby boomers was significantly associated with age, gender, race/ethnicity, and other variables and increased significantly with each subsequent year (aOR = 1.21, aOR = 1.33, aOR = 1.42, consecutively). While HCV screening is increasing over time, there is still room for improvement and future interventions should focus on increasing HCV screening among groups demonstrating significantly lower screening prevalence.

1. Introduction

The Centers for Disease Control and Prevention (CDC) reports almost 23,000 people died of hepatocellular carcinoma (HCC) in the U.S. in 2012 and approximately 50% of all HCC incidence in the U.S. is caused by chronic Hepatitis C virus (HCV) infection [1]. Identification and treatment of chronic HCV infection can reduce cancer risk by 75% [1]; yet, 50–75% of those with HCV are unaware they are infected [2]. Recent data show individuals born between 1945 and 1965 (baby boomers) have nearly five times the HCV infection prevalence compared to other birth cohorts [3], and make up the majority of HCV-related morbidity and mortality [4]. Therefore, in 2012, the CDC aug-

Abbreviations: CDC, Centers for Disease Control and Prevention; HCC, hepatocellular carcinoma; HCV, hepatitis C virus; NHIS, National Health Interview Survey; USPSTF, United States Preventive Services Task Force

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mented their risk-based recommendations to also include a one-time HCV screening for all baby boomers [5]. Despite these recommendations, nationally representative analyses by our team of the National Health Interview Survey (NHIS) demonstrated HCV screening among baby boomers was less than 13% in 2015 and had increased by less than 1% per year between 2013 and 2015 [6]. These small increases were not likely to make a substantial impact in identification and treatment of HCV infection at the population-level. As a follow-up to the 2013–2015 analysis, our team used the newly released 2016 data to examine whether there were any changes in screening since the original analysis [7]. Specifically we: 1) report serial, cross-sectional HCV screening prevalence for four birth cohorts of the NHIS sample from 2016; and 2) evaluate factors associated with ever having been screened for HCV by birth cohort. Similar to other studies using national datasets to examine health trends over time [8,9], this study adds an additional year of data to examine if current HCV screening is increasing over time. If screening is not increasing, this study provides important data to support future interventions, which groups are most in need of such interventions, and a current benchmark by which to judge future success.

2. Materials and methods

Materials and methods for this analysis, including sample stratification, measures, and an NHIS description are described in detail in the previously published study [7] with the exception that the 2016 data were added to supplement the results from the 2013–2015 data.

3. Results

3.1. Sample description

After excluding 30,777 participants for whom birth year was unknown, the final analyses included 22,027 who were born before 1945 (older), 47,035 baby boomers, 42,871 born 1966–1985 (second youngest), and 20,809 born after 1985 (youngest). Demographic characteristics can be seen in Table 1.

3.2. HCV screening prevalence

Weighted analyses indicated screening prevalence varied for the four both cohorts (Fig. 1). Among the response options to indicate the reason for HCV screening, 18.8% of the 2016 baby boomers indicated the reason was their age, compared to 14.4% in 2015.

3.3. Regression models: factors independently associated with HCV screening

Complete results of bivariate and multivariable models for baby boomers are presented in Table 2. Results for the other three birth cohorts can be found in Appendix A.

3.3.1. Youngest group (born after 1985)

Odds of screening did not increase over time in the youngest group. However, age and gender were associated with screening and increasing age was associated with an increase in the odds of screening (aOR = 1.05; 95% CI = 1.02–1.08 for every 5 year increase in age) and women were less likely to have been screened than men (aOR = 0.81; 95% CI = 0.70–0.94).

3.3.2. Second youngest group (born 1966–1985)

Unlike the youngest group, odds of screening increased significantly for the second youngest group from 2013 to 2015 (aOR = 1.21; 95% CI = 1.07–1.37) but that increase was no longer significant by 2016 (aOR = 1.11; 95% CI = 0.99–1.25). Similar to the youngest group, women had lower odds of screening (aOR = 0.67; 95% CI = 0.61–0.73). The association with age was significant in this age group however, in the opposite direction of the youngest group (aOR = 0.98; 95% CI = 0.98–0.99). Additionally, unlike the youngest group, geographic location was significant and participants in the Midwest had significantly lower odds of screening than the Northeast (aOR = 0.76; 95% CI = 0.65–0.89).

3.3.3. Baby boomers (born 1945–1965)

In adjusted models, odds of screening were increasing for baby boomers for each subsequent year (2014: aOR = 1.21; 95% CI = 1.06–1.38; 2015: aOR = 1.33; 95% CI = 1.15–1.54; 2016: aOR = 1.42; 95% CI = 1.26–1.61). As with the second youngest group, the Midwest had the lowest odds of screening of any of the geographic regions (aOR = 0.78; 95% CI = 0.67–0.92), and women had lower odds of screening (aOR = 0.73; 95% CI = 0.67–0.80).

3.3.4. Older group (born before 1945)

Fewer variables were significantly associated with screening in the oldest group as compared to the younger groups. As with baby boomers, age was inversely associated with the odds of screening (aOR = 0.98; 95% CI = 0.96–1.00). As with every other age group, women had lower odds of screening (aOR = 0.77; 95% CI = 0.53–0.94).

4. Discussion

While we found screening prevalence was statistically increasing over time, the increases will likely have minimal impact from a public health perspective. As with our previous study [7], screening prevalence for baby boomers are continuing to increase by approximately 1% per year. And while the odds of screening increased by over 40% from 2013 to 2016, the actual screening prevalence only increased by 2.2%. When examining geographic region, baby boomers in the Midwest had a 22% lower odds of screening than those in the Northeast and the lowest odds of screening overall. This is particularly concerning considering recent research that has found three Midwest states have higher than average incidence of HCV infection and one of those states is more than double the national average [10]. Furthermore, non-Hispanic Black individuals and Hispanic individuals continued to have lower odds of screening in every adjusted model except for the oldest age group. This is consistent with our previous findings and is concerning given a recent study found the prevalence of HCV RNA was highest among non-Hispanic Black individuals [11], and non-Hispanic Black patients with hepatocellular carcinoma have been shown to have higher cause-specific mortality [12].

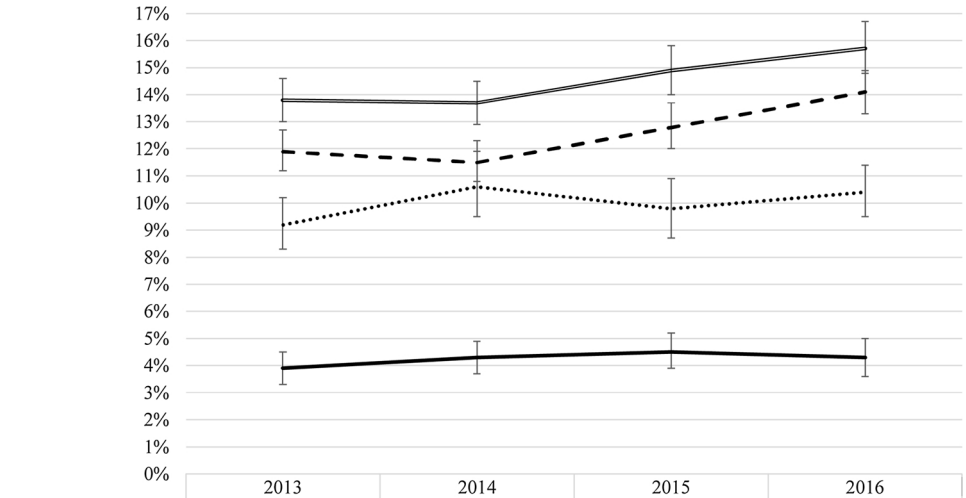
Some variables had the opposite association for the different birth cohorts. Increasing age was associated with increasing odds of screening for the youngest group, but the oldest three groups experienced a decrease in the odds of screening as age increased. This inverse relationship could be due to behavioral risk factors including risky

Table 1
Descriptive Statistics of the 2013–2016 National Health Interview Surveys[‡].

	Born pre- 1945[†] (n = 22,027)	Born 1945– 1965[†] (n = 47,035)	Born 1965–1985[†] (n = 42,871)	Born post- 1985[†] (n = 20,809)
Population characteristics	% (95%CI)	% (95%CI)	% (95%CI)	% (95%CI)
Demographic characteristics				
Region				
Northeast	19.2 (18.1, 20.4)	18.2 (17.5, 18.9)	16.2 (15.5, 17.0)	14.8 (13.7, 16.1)
Midwest	24.1 (23.0, 25.2)	23.5 (22.8, 24.2)	23.3 (22.4, 24.3)	25.3 (23.5, 27.2)
South	36.8 (35.5, 38.1)	37.7 (36.9, 38.7)	37.2 (36.2, 38.3)	37.2 (35.3, 39.1)
West	19.9 (18.9, 20.9)	20.6 (19.8, 21.3)	23.2 (22.4, 24.1)	22.7 (21.2, 24.2)
Age (Mean; 95%CI)	77.8 (77.7, 77.9)	59.3 (59.2, 59.3)	38.7 (38.6, 38.8)	24.0 (23.9, 24.1)
Race/Ethnicity				
Non-Hispanic White	80.1 (79.3, 81.0)	73.6 (72.9, 74.4)	61.7 (60.9, 62.6)	61.0 (59.8, 62.2)
Non-Hispanic Black	8.9 (8.3, 9.6)	12.2 (11.7, 12.7)	13.5 (13.0, 14.1)	14.6 (13.7, 15.4)
Non-Hispanic Asian	2.0 (1.8, 2.3)	2.2 (2.1, 2.4)	4.1 (3.8, 4.4)	4.0 (3.6, 4.4)
Non-Hispanic Other	2.0 (1.8, 2.2)	2.4 (2.3, 2.6)	3.1 (2.9, 3.4)	3.4 (3.1, 3.7)
Hispanic	7.0 (6.5, 7.5)	9.5 (9.1, 10.0)	17.5 (16.8, 18.1)	17.1 (16.3, 18.0)
Gender				
Male	39.2 (38.4, 40.0)	46.3 (45.8, 46.9)	47.4 (46.8, 48.0)	48.3 (47.4, 49.2)
Female	60.8 (60.0, 61.6)	53.7 (53.1, 54.2)	52.6 (52.0, 53.2)	51.7 (50.8, 52.6)
Education				
Less than high school graduate	20.6 (19.9, 21.4)	11.8 (11.4, 12.2)	11.1 (10.7, 11.6)	9.7 (9.2, 10.3)
High school graduate or GED	31.0 (30.1, 31.8)	26.0 (25.4, 26.5)	20.7 (20.2, 21.3)	24.0 (23.0, 25.0)
Some college/Associates degree	24.1 (23.4, 24.9)	30.5 (30.0, 31.0)	29.9 (29.3, 20.5)	41.9 (40.6, 43.3)
Bachelor's degree or higher	23.6 (22.7,24.4)	31.4 (30.8,32.1)	38.0 (37.2,38.8)	24.2 (23.1,25.3)
Marital Status				
Married/Living with partner	39.5 (38.7, 40.4)	54.2 (53.6, 54.9)	60.3 (59.6, 60.9)	29.9 (28.8, 31.1)
Not currently married (includes divorced, separated, and widowed)	55.5 (54.6, 56.4)	33.6 (33.0,3 4.1)	15.9 (15.5, 16.4)	2.5 (2.2, 2.7)
Never married	5.0 (4.6, 5.4)	12.2 (11.8, 12.6)	23.8 (23.2, 24.4)	67.6 (66.4, 68.7)
Income				
< $35,000	52.4 (51.3, 53.5)	33.9 (33.2, 34.7)	29.4 (28.7, 30.0)	51.1 (49.5, 52.6)
$35,000–$74,999	30.8 (29.9, 31.7)	30.3 (29.7, 30.9)	31.0 (30.4, 31.6)	29.0 (27.9, 30.0)
$75,000–$99,999	7.4 (6.9, 7.9)	11.8 (11.4, 12.2)	13.4 (13.0, 13.8)	8.5 (8.0, 9.1)
$100,000 +	9.4 (8.9, 10.0)	24.0 (23.3, 24.7)	26.2 (25.5, 26.9)	11.5 (10.8, 12.2)
Risk Factors				
Alcohol Use				
Lifetime abstainer	27.1 (26.2, 28.1)	16.1 (15.5, 16.6)	15.6 (15.1, 16.1)	24.7 (23.6, 25.9)
Former	26.2 (25.3, 27.0)	19.0 (18.4, 19.5)	9.8 (9.4, 10.2)	4.8 (4.5, 5.2)
Current infrequent/light/unknown frequency	31.1 (30.2, 32.1)	42.3 (41.6, 43.0)	50.2 (49.4, 50.9)	44.7 (43.7, 45.8)
Current moderate/heavy	14.2 (13.5, 15.0)	21.3 (20.7, 21.9)	23.0 (22.4, 23.7)	24.5 (23.2, 25.8)
Drinking status unknown	1.3 (1.1, 1.6)	1.4 (1.2, 1.6)	1.4 (1.2, 1.6)	1.34 (1.1, 1.5)
Health care factors				
Saw/talked to HCP in last 12 months				
Yes	86.6 (86.0, 87.3)	76.0 (75.5, 76.6)	61.8 (61.2, 62.5)	55.0 (54.2, 55.9)
No	12.3 (11.7, 12.9)	22.7 (22.2, 23.3)	36.8 (36.2, 37.5)	43.6 (42.7,4 4.5)
Don't know/Refused/Not ascertained	1.1 (0.9, 1.2)	1.3 (1.1, 1.4)	1.3 (1.2, 1.5)	1.4 (1.2, 1.6)
Have health insurance coverage				
Yes	99.5 (99.4, 99.6)	90.8 (90.4, 91.1)	83.0 (82.5, 83.5)	81.9 (81.1, 82.6)
No	0.4 (0.3, 0.5)	9.0 (8.6, 9.3)	16.7 (16.2, 17.2)	17.2 (16.5, 18.0)
Don't know/Refused/Not ascertained	0.1 (0.1, 0.2)	0.3 (0.2, 0.3)	0.3 (0.3, 0.4)	0.9 (0.7, 1.1)
Other health screenings				
Ever been tested for HIV				
Yes	12.8 (12.2, 13.3)	33.6 (33.0, 34.2)	52.6 (51.9, 53.3)	37.5 (36.5, 38.6)
No	81.2 (80.6, 81.9)	61.5 (60.8, 62.1)	43.0 (42.3, 43.7)	58.1 (57.0, 59.2)
Don't know/Refused/Not ascertained	6.0 (5.6, 6.4)	4.9 (4.7, 5.2)	4.4 (4.1, 4.6)	4.3 (4.0, 4.7)
Blood pressure check, last 12 mo				
Yes	80.8 (80.1, 81.5)	75.7 (75.3, 76.2)	68.4 (67.9, 69.0)	64.8 (63.9, 65.7)
No	4.0 (3.7, 4.4)	8.7 (8.4, 9.0)	15.9 (15.4, 16.4)	20.8 (20.1, 21.5)
Don't know/Refused/Not ascertained	15.2 (14.6, 15.8)	15.6 (15.2, 16.0)	15.6 (15.2, 16.1)	14.4 (13.8, 15.0)
Cholesterol checked last 12 mo				
Yes	74.1 (73.3, 74.9)	66.2 (65.7, 66.7)	49.5 (48.9, 50.1)	32.6 (31.8, 33.4)
No	8.9 (8.5, 9.4)	17.3 (16.9, 17.8)	33.4 (32.8, 34.0)	50.0 (49.9, 50.9)
Don't know/Refused/Not ascertained	17.0 (16.3, 17.7)	16.5 (16.0, 16.9)	17.1 (16.7, 17.6)	17.5 (16.8, 18.2)
Had colon cancer test in last 10 years (both genders age 50–75)				
Yes	20.1 (19.5, 20.7)	22.5 (22.0, 23.1)	3.0 (2.8, 3.2)	–
No	77.5 (76.9, 78.1)	75.3 (74.7, 75.8)	39.1 (38.5, 39.7)	–
Don't know/Refused/Not ascertained	2.4 (2.2, 2.7)	2.2 (2.0, 2.4)	57.9 (57.3, 58.5)	–

[‡] This table includes the general population including the special populations known to have higher rates of HCV screening including: working in healthcare, former/regular alcohol consumption, lived with someone with hepatitis, or a personal history of liver cancer, hepatitis, any liver condition, or a chronic liver condition.

[†] All variables listed were significantly different between age groups ($p < 0.0001$).



	2013	2014	2015	2016
Born pre-1945	3.90%	4.30%	4.50%	4.30%
Born 1945-1965	11.90%	11.50%	12.80%	14.10%
Born 1966-1985	13.80%	13.70%	14.90%	15.70%
Born post-1985	9.20%	10.60%	9.80%	10.40%

Fig. 1. Rate of HCV Screening by Age Group and Year (N = 137,742).[1]
[1]Among baby boomers who had been screened, the proportion who indicated they were screened *because* they were born between 1945 and 1965 was: 17.4% in 2013, 18.5% in 2014, 14.4% in 2015, and 18.8% in 2016.

sexual behaviors and illicit drug use. These risky behaviors may increase with age for younger groups but decrease with age for the older groups. Furthermore, because screening prevalence was actually highest in the group born after the baby boomers, adding further evidence that patients may be getting screened due to behavioral risk factors rather than universal age-based screening for all baby boomers.

This study does have some limitations which indicate the results should be interpreted with caution. First, while the large sample is a strength, it also resulted in even small differences being statistically significant. Therefore, a statistically significant result should be interpreted while paying attention to whether the differences are clinically significant or would have a broader public health impact. Second, HCV screening is based on self-report and has not been verified with the patient records. However, screening prevalence based on self-report in our study is actually higher than screening prevalence reported in studies using health-record verified data [13,14], suggesting our results are more likely to overestimate rather than underestimate screening. Last, these data are cross sectional and we are not able to draw cause-effect conclusions. However, despite these limitations this study expands on our previous findings and reports screening prevalence using more up-to-date nationally representative data.

5. Conclusion

These data show while HCV screening prevalence is increasing statistically over time, with only 14.1% of baby boomers reporting they have ever been screened for HCV, we are well below the recommend universal one time screening in this group [15]. Randomized controlled trials of interventions aimed at increasing HCV screening have shown promising results [14]. Future research should focus on disseminating these successful interventions and should highlight the importance of screening in the primary care setting and target groups that are disproportionately impacted by HCV-related disease (including non-Hispanic Black and Hispanic patients) or have documented lower odds of screening, including baby boomers and women.

Conflict of interest disclosures

Dr. Nelson has received research grant support from Abbvie, Gilead, and Merck.

Dr. Reich has received compensation for consulting at Sarasota Memorial Hospital.

All other authors declare no conflicts of interest.

Author contributions

ML Kasting- conception and design, acquisition of data, analysis and interpretation of data, drafting and critically revising article for important intellectual content, approved final version of manuscript to be published.

AR Giuliano- conception and design, interpretation of data, drafting and critically revising the article for important intellectual content, approved final version of manuscript to be published.

RR Reich- acquisition of data, analysis and interpretation of data, critically revising the article for content, approved final version of manuscript to be published.

RG Roetzheim- interpretation of data analysis, critically revising article for intellectual content, approved final version of manuscript to be published.

LM Duong- data analysis and interpretation, critically revising the

Table 2
Factors associated with HCV screening for the population of Baby Boomers at average risk of HCV infection.[‡]

	Univariate OR (95% CI)	Multivariable aOR (95% CI)
Born 1945–1965		
Population characteristics		
Year		
2013 (ref.)		
2014	1.11 (0.97–1.27)	**1.21 (1.06–1.38)**
2015	**1.22 (1.06–1.39)**	**1.33 (1.15–1.54)**
2016	**1.38 (1.23–1.56)**	**1.42 (1.26–1.61)**
Demographic characteristics		
Region		
Northeast (ref.)		
Midwest	**0.73 (0.62–0.85)**	**0.78 (0.67–0.92)**
South	1.03 (0.91–1.17)	1.02 (0.90–1.16)
West	**1.26 (1.08–1.46)**	**1.18 (1.01–1.38)**
Age (Continuous, 5-year increments)	**0.97 (0.97–0.98)**	**0.98 (0.97–0.98)**
Race/Ethnicity		
Non-Hispanic White (ref.)		
Non-Hispanic Black	**1.20 (1.06–1.36)**	**0.89 (0.78–1.02)**
Non-Hispanic Asian	0.78 (0.57–1.07)	0.80 (0.58–1.11)
Non-Hispanic Other	0.90 (0.69–1.17)	0.89 (0.67–1.17)
Hispanic	**0.86 (0.74–1.00)**	**0.81 (0.69–0.95)**
Gender		
Male (ref.)		
Female	**0.70 (0.64–0.77)**	**0.73 (0.67–0.80)**
Education		
Less than high school graduate (ref.)		
High school graduate or GED	1.00 (0.85–1.18)	1.03 (0.87–1.23)
Some college/Associates degree	**1.75 (1.51–2.04)**	**1.59 (1.35–1.87)**
Bachelor's degree or higher	**1.61 (1.38–1.88)**	**1.51 (1.27–1.80)**
Don't know	0.55 (0.21–1.47)	0.76 (0.28–2.07)
Marital Status		
Married/Living with partner (ref.)		
Not currently married (divorced, separated, and widowed)	**1.27 (1.15–1.39)**	**1.14 (1.02–1.27)**
Never married/unknown	1.15 (0.99–1.32)	1.01 (0.87–1.17)
Income		
< $35,000 (ref.)		
$35,000–$74,999	**0.86 (0.76–0.96)**	**0.85 (0.75–0.96)**
$75,000–$99,999	0.89 (0.77–1.04)	**0.79 (0.67–0.94)**
$100,000 +	1.07 (0.96–1.20)	**0.86 (0.75–1.00)**
Risk Factors		
Alcohol Use		
Lifetime abstainer (ref.)		
Former infrequent/unknown	**1.96 (1.66–2.31)**	**1.56 (1.31–1.85)**
Current infrequent/light/unknown frequency	**1.70 (1.48–1.95)**	**1.30 (1.12–1.50)**
Current moderate/heavy	**1.78 (1.52–2.10)**	**1.29 (1.10–1.53)**
Drinking status unknown	0.60 (0.36–1.01)	0.93 (0.54–1.59)
Health care factors		
Saw/talked to HCP in last 12 months		
Yes	**1.50 (1.34–1.67)**	**1.24 (1.10–1.40)**
No (ref.)		
Don't know/Refused/Not ascertained	**0.02 (0.00–0.18)**	**0.10 (0.01–0.91)**
Health insurance status		
Not covered (ref.)		
Covered	1.11 (0.96–1.29)	[†]
Don't know/Refused/Not ascertained	0.69 (0.30–1.61)	
Other health screenings		
Ever been tested for HIV		
Yes	**4.61 (4.18–5.09)**	**3.94 (3.56–4.37)**
No (ref.)		
Don't know/Refused/Not ascertained	1.03 (0.80–1.32)	**1.70 (1.30–2.22)**
Blood pressure check, last 12 mo		[†]
Yes	**1.96 (1.63–2.35)**	
No (ref.)		
Don't know/Refused/Not ascertained	**1.40 (1.13–1.73)**	
Cholesterol checked last 12 mo		
Yes	**1.71 (1.54–1.97)**	**1.47 (1.28–1.68)**
No (ref.)		
Don't know/Refused/Not ascertained	1.16 (0.99–1.37)	1.17 (0.98–1.40)
Had colon cancer test in last 12 months		
Yes	**1.79 (1.62–1.97)**	**1.46 (1.31–1.62)**
No (ref.)		
Don't know/Refused/Not ascertained	**0.12 (0.07–0.22)**	**0.33 (0.16–0.69)**

Bold values are significant at $p < 0.05$.

[‡] All variables listed were initially included in the multivariable model and a significance of 0.05 was required to remain in the model.

[†] Designates a variable that was eliminated from the multivariable model.

article for important intellectual content, approved final version of manuscript to be published.

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Appendix A. Factors associated with HCV screening for the population of non-Baby Boomers at average risk of HCV infection.‡

	Bivariate OR (95% CI)	Multivariable aOR (95% CI)
Born post-1985		
Population characteristics		
Year		†
2013 (ref.)		
2014	1.20 (0.98–1.48)	
2015	1.06 (0.87–1.30)	
2016	1.06 (0.87–1.30)	
Demographic characteristics		
Region		†
Northeast (ref.)		
Midwest	0.99 (0.78–1.25)	
South	1.13 (0.92–1.40)	
West	1.16 (0.93–1.45)	
Age (Continuous, 5-year increments)	**1.12 (1.10–1.14)**	**1.05 (1.02–1.08)**
Race/Ethnicity		
Non-Hispanic White (ref.)		
Non-Hispanic Black	0.92 (0.76–1.13)	**0.65 (0.53–0.81)**
Non-Hispanic Asian	0.74 (0.51–1.08)	0.88 (0.59–1.31)
Non-Hispanic Other	0.94 (0.68–1.30)	1.00 (0.71–1.41)
Hispanic	**0.76 (0.64–0.90)**	**0.70 (0.58–0.86)**
Gender		
Male (ref.)		
Female	1.04 (0.91–1.20)	**0.81 (0.70–0.94)**
Education		
Less than high school graduate (ref.)		
High school graduate or GED	**1.57 (1.20–2.05)**	**1.46 (1.12–1.92)**
Some college/Associates degree	**1.58 (1.23–2.03)**	**1.42 (1.10–1.84)**
Bachelor's degree or higher	**1.65 (1.26–2.15)**	1.19 (0.89–1.60)
Don't know	1.56 (0.53–4.58)	2.15 (0.75–6.15)
Marital Status		
Married/Living with partner (ref.)		
Not currently married (divorced, separated, and widowed)	**1.57 (1.12–2.18)**	1.37 (0.98–1.94)
Never married/unknown	**0.66 (0.57–0.76)**	0.92 (0.78–1.09)
Income		†
< $35,000 (ref.)		
$35,000-$74,999	1.03 (0.89–1.19)	
$75,000-$99,999	0.93 (0.72–1.19)	
$100,000+	**0.76 (0.58–1.00)**	
Risk Factors		
Alcohol Use		
Lifetime abstainer (ref.)		
Former infrequent/unknown	**3.43 (2.54–4.63)**	**1.96 (1.43–2.69)**
Current infrequent/light/unknown frequency	**2.08 (1.72–2.51)**	**1.38 (1.13–1.70)**
Current moderate/heavy	**2.31 (1.89–2.83)**	**1.44 (1.14–1.81)**
Drinking status unknown	0.70 (0.32–1.51)	0.61 (0.27–1.39)
Health care factors		
Saw/talked to HCP in last 12 months		
Yes	**1.35 (1.18–1.55)**	†
No (ref.)		
Don't know/Refused/Not ascertained	*	
Health insurance status		
Not covered (ref.)		
Covered	1.06 (0.91–1.23)	1.16 (0.98–1.38)
Don't know/Refused/Not ascertained	**0.17 (0.05–0.52)**	**0.21 (0.07–0.64)**
Other health screenings		
Ever been tested for HIV		
Yes	**6.31 (5.40–7.37)**	**6.24 (5.29–7.36)**
No (ref.)		
Don't know/Refused/Not ascertained	1.39 (0.89–2.17)	1.54 (0.96–2.47)

	Univariate OR (95% CI)	Multivariable aOR (95% CI)
Born 1966–1985		
Population characteristics		
Year		
2013 (ref.)		
2014	1.02 (0.91–1.14)	1.04 (0.93–1.17)
2015	**1.15 (1.03–1.28)**	**1.21 (1.07–1.37)**
2016	**1.13 (1.00–1.27)**	1.11 (0.99–1.25)
Demographic characteristics		
Region		
Northeast (ref.)		

Midwest	**0.77 (0.66–0.89)**	**0.76 (0.65–0.89)**
South	0.98 (0.87–1.11)	1.02 (0.90–1.16)
West	1.05 (0.93–1.19)	1.05 (0.92–1.20)
Age (Continuous, 5-year increments)	**0.99 (0.98–0.99)**	**0.98 (0.98–0.99)**
Race/Ethnicity		
Non-Hispanic White (ref.)		
Non-Hispanic Black	1.01 (0.90–1.13)	**0.72 (0.63–0.82)**
Non-Hispanic Asian	**0.67 (0.53–0.84)**	**0.78 (0.62–0.99)**
Non-Hispanic Other	0.91 (0.74–1.11)	0.91 (0.73–1.14)
Hispanic	**0.66 (0.60–0.74)**	**0.67 (0.59–0.76)**
Gender		
Male (ref.)		
Female	**0.86 (0.80–0.94)**	**0.67 (0.61–0.73)**
Education		
Less than high school graduate (ref.)		
High school graduate or GED	**1.37 (1.17–1.61)**	**1.20 (1.02–1.43)**
Some college/Associates degree	**1.92 (1.66–2.24)**	**1.49 (1.26–1.77)**
Bachelor's degree or higher	**1.60 (1.38–1.86)**	**1.30 (1.08–1.56)**
Don't know	0.65 (0.23–1.84)	0.73 (0.26–2.04)
Marital Status		
Married/Living with partner (ref.)		
Not currently married (divorced, separated, and widowed)	**1.45 (1.30–1.62)**	**1.30 (1.16–1.47)**
Never married/unknown	**1.31 (1.21–1.43)**	**1.19 (1.08–1.32)**
Income		
< $35,000 (ref.)		
$35,000-$74,999	**0.88 (0.80–0.97)**	**0.81 (0.73–0.91)**
$75,000-$99,999	0.96 (0.84–1.09)	0.88 (0.76–1.02)
$100,000 +	0.90 (0.80–1.00)	**0.80 (0.69–0.93)**
Risk Factors		
Alcohol Use		
Lifetime abstainer (ref.)		
Former infrequent/unknown	**2.02 (1.70–2.40)**	**1.47 (1.22–1.76)**
Current infrequent/light/unknown frequency	**1.71 (1.50–1.96)**	**1.24 (1.08–1.42)**
Current moderate/heavy	**1.72 (1.50–1.98)**	1.13 (0.97–1.31)
Drinking status unknown	0.62 (0.34–1.14)	0.63 (0.34–1.18)
Health care factors		
Saw/talked to HCP in last 12 months		
Yes	**1.35 (1.24–1.47)**	†
No (ref.)		
Don't know/Refused/Not ascertained	*	
Health insurance status		
Not covered (ref.)		
Covered	**1.31 (1.17–1.47)**	**1.15 (1.01–1.31)**
Don't know/Refused/Not ascertained	1.44 (0.67–3.07)	1.08 (0.51–2.33)
Other health screenings		
Ever been tested for HIV		
Yes	**4.66 (4.20–5.17)**	**4.54 (4.08–5.06)**
No (ref.)		
Don't know/Refused/Not ascertained	1.29 (0.97–1.72)	**1.48 (1.08–2.03)**
Blood pressure check, last 12 mo		
Yes	**1.95 (1.71–2.23)**	**1.62 (1.40–1.87)**
No (ref.)		
Don't know/Refused/Not ascertained	**1.36 (1.15–1.61)**	**1.22 (1.01–1.47)**

	Univariate OR (95% CI)	Multivariable aOR (95% CI)
Born pre-1945		
Population characteristics		
Year		†
2013 (ref.)		
2014	1.03 (0.79–1.35)	
2015	1.11 (0.84–1.46)	
2016	1.05 (0.78–1.40)	
Demographic characteristics		
Region		
Northeast (ref.)		
Midwest	1.05 (0.73–1.52)	1.07 (0.73–1.55)
South	1.37 (0.99–1.91)	1.25 (0.89–1.75)
West	**2.18 (1.57–3.04)**	**1.89 (1.35–2.64)**
Age (Continuous, 5-year increments)	**0.94 (0.92–0.96)**	**0.98 (0.96–1.00)**
Race/Ethnicity		†
Non-Hispanic White (ref.)		
Non-Hispanic Black	**1.60 (1.23–2.08)**	
Non-Hispanic Asian	**2.48 (1.51–4.07)**	
Non-Hispanic Other	1.66 (0.93–2.97)	
Hispanic	1.07 (0.77–1.48)	
Gender		

Male (ref.)		
Female	**0.61 (0.51–0.74)**	**0.77 (0.63–0.94)**
Education		
Less than high school graduate (ref.)		†
High school graduate or GED	0.92 (0.69–1.23)	
Some college/Associates degree	**1.38 (1.06–1.81)**	
Bachelor's degree or higher	**1.49 (1.12–1.98)**	
Don't know	0.41 (0.11–1.47)	
Marital Status		†
Married/Living with partner (ref.)		
Not currently married (divorced, separated, and widowed)	**0.80 (0.66–0.98)**	
Never married/unknown	0.71 (0.43–1.17)	
Income		
< $35,000 (ref.)		
$35,000-$74,999	1.22 (0.97–1.52)	1.14 (0.90–1.45)
$75,000-$99,999	**1.64 (1.17–2.29)**	1.39 (0.98–1.97)
$100,000 +	**1.84 (1.36–2.49)**	**1.56 (1.11–2.20)**
Risk Factors		
Alcohol Use		
Lifetime abstainer (ref.)		
Former infrequent/unknown	**1.39 (1.04–1.84)**	1.12 (0.84–1.50)
Current infrequent/light/unknown frequency	**1.33 (1.02–1.75)**	1.04 (0.77–1.40)
Current moderate/heavy	1.17 (0.84–1.63)	0.76 (0.53–1.10)
Drinking status unknown	**0.25 (0.06–1.01)**	**0.18 (0.04–0.76)**
Health care factors		
Saw/talked to HCP in last 12 months		†
Yes	0.90 (0.68–1.20)	
No (ref.)		
Don't know/Refused/Not ascertained	0.16 (0.02–1.18)	
Health insurance status		
Not covered (ref.)		
Covered	**0.33 (0.14–0.79)**	**0.39 (0.16–0.91)**
Don't know/Refused/Not ascertained	*	*
Other health screenings		
Ever been tested for HIV		
Yes	**6.05 (4.91–7.44)**	**5.10 (4.08–6.37)**
No (ref.)		
Don't know/Refused/Not ascertained	**1.55 (1.02–2.34)**	**1.67 (1.13–2.46)**
Blood pressure check, last 12 mo		†
Yes	1.47 (0.81–2.69)	
No (ref.)		
Don't know/Refused/Not ascertained	1.12 (0.59–2.12)	
Cholesterol checked last 12 mo		†
Yes	1.58 (1.03–2.41)	
No (ref.)		
Don't know/Refused/Not ascertained	1.15 (0.72–1.83)	
Had colon cancer test in last 12 months		
Yes	**2.02 (1.64–2.49)**	**1.66 (1.34–2.07)**
No (ref.)		
Don't know/Refused/Not ascertained	0.97 (0.41–2.26)	1.12 (0.48–2.64)

Bold values are significant at $p < 0.05$.

‡All variables listed were initially included in the multivariable model and a significance of 0.05 was required to remain in the model.
†Designates a variable that was eliminated from the multivariable model
*No one in this category reported having an HCV screening test. Therefore, an odds ratio cannot be calculated.

Appendix B. Supplementary data

Supplementary material related to this article can be found, in the online version, at doi:https://doi.org/10.1016/j.canep.2019.03.007.

References

[1] Centers for Disease Control and Prevention, CDC Fact Sheet: Viral Hepatitis and Liver Cancer, (2016) (Accessed 24 February 2016), https://www.cdc.gov/nchhstp/newsroom/docs/factsheets/viral-hep-liver-cancer.pdf.
[2] A.E. Mitchell, H.M. Colvin, R. Palmer Beasley, Institute of medicine recommendations for the prevention and control of hepatitis B and C, Hepatology 51 (3) (2010) 729–733.
[3] A.B. Ryerson, C.R. Eheman, S.F. Altekruse, et al., Annual report to the nation on the status of cancer, 1975–2012, featuring the increasing incidence of liver cancer, Cancer 122 (9) (2016) 1312–1337.
[4] R. Mahajan, J. Xing, S.J. Liu, et al., Mortality among persons in care with hepatitis C virus infection: the Chronic Hepatitis Cohort Study (CHeCS), 2006–2010, Clin. Infect. Dis. 58 (8) (2014) 1055–1061.
[5] B.D. Smith, R.L. Morgan, G.A. Beckett, et al., Recommendations for the identification of chronic hepatitis C virus infection among persons born during 1945–1965, MMWR Morb. Mortal. Wkly. Rep. 61 (RR-4) (2012) 1–32.
[6] M.L. Kasting, S. Wilson, T.W. Zollinger, B.E. Dixon, N.W. Stupiansky, G.D. Zimet, Differences in cervical cancer screening knowledge, practices, and beliefs: an examination of survey responses, Prev. Med. Rep. 5 (2017) 169–174.
[7] M.L. Kasting, A.R. Giuliano, R.R. Reich, et al., Hepatitis C virus screening trends: serial cross-sectional analysis of the National Health Interview Survey population, 2013–2015, Cancer Epidemiol. Biomark. Prev. 27 (4) (2018) 1–11.
[8] E.J. Benjamin, M.J. Blaha, S.E. Chiuve, et al., Heart disease and stroke statistics—2017 update: a report from the American Heart Association, Circulation 135

(10) (2017) e146–e603.
[9] N. Breen, J.F. Gentleman, J.S. Schiller, Update on mammography trends: comparisons of rates in 2000, 2005, and 2008, Cancer 117 (10) (2011) 2209–2218.
[10] C.A. Campbell, L. Canary, N. Smith, E. Teshale, A.B. Ryerson, J.W. Ward, State HCV incidence and policies related to HCV preventive and treatment services for persons who inject drugs – United States, 2015–2016, MMWR Morb. Mortal. Wkly. Rep. 66 (2017) 465–469.
[11] E.W. Hall, E.S. Rosenberg, P.S. Sullivan, Estimates of state-level chronic hepatitis C virus infection, stratified by race and sex, United States, 2010, BMC Infect. Dis. 18 (1) (2018) 224.
[12] S.L. Stewart, S.L. Kwong, C.L. Bowlus, et al., Racial/ethnic disparities in hepatocellular carcinoma treatment and survival in California, 1988–2012, World J. Gastroenterol. 22 (38) (2016) 8584–8595.
[13] A.H. Litwin, B.D. Smith, M.L. Drainoni, et al., Primary care-based interventions are associated with increases in hepatitis C virus testing for patients at risk, Dig. Liver Dis. 44 (6) (2012) 497–503.
[14] M.A. Konerman, M. Thomson, K. Gray, et al., Impact of an electronic health record alert in primary care on increasing hepatitis C screening and curative treatment for baby boomers, Hepatology 66 (6) (2017) 1805–1813.
[15] U.S. Preventive Services Task Force, Final Recommendation Statement: Hepatitis C Screening, (2016) https://www.uspreventiveservicestaskforce.org/Page/Document/UpdateSummaryFinal/hepatitis-c-screening.