Viral Hepatitis Surveillance in Colorado

2017 Annual Report

January 2019

colorado.gov/cdphe/hepatitis

About this report

This report is published by the STI/HIV/VH Branch, Disease Control and Environmental Epidemiology Division, Colorado Department of Public Health and Environment, Denver, Colorado.

This report describes the epidemiology of hepatitis A, B and C in Colorado. The Colorado Department of Public Health and Environment (CDPHE) used available data resources to report the burden and distribution of disease, as well as trends over time. A summary of each of the three types of viral hepatitis is followed by a more detailed description. Data are presented for all hepatitis A, B, and C cases reported to CDPHE by December 31, 2017.

Acknowledgements

This Viral Hepatitis Annual Surveillance Report was produced by the STI/HIV/Viral Hepatitis Branch, Colorado Department of Public Health & Environment.

This report was prepared by:

Jessie Gunter, MPH – Lead author
Erin Starzyk, PhD, MPH
Christopher Grano, BA
LeAnna Kent, BS
Briana Sprague, BS
Gerry Makaya, MD, MPH
Kaitlyn Probst, BA
Kerri Brown, MSPH
Nicole Comstock, MSPH
Rachel Jervis, MPH
Megan Duffy, MPH

Other contributors to the production and dissemination of this publication:

Data Integration Unit Staff
Registries and Vital Statistics Branch Staff
Colorado Central Cancer Registry Staff

We gratefully acknowledge the health care providers, local public health agencies, infection control practitioners, laboratories and coroners throughout the state whose cooperation made it possible to produce this report.

This publication is available on the web at colorado.gov/cdphe/hepatitis-data. This report complies with data release guidelines established by CDPHE's Department of Disease Control and Environmental Epidemiology to ensure the protection of sensitive health information.

Table of contents

Acronyms

AIDS	Acquired Immunodeficiency Syndrome
APCD	All Payer Claims Database
CCCR	Colorado Central Cancer Registry
CDAF	Center for Disease Analysis Foundation
CDC	Centers for Disease Control and Prevention
CDOC	Colorado Department of Corrections
CDPHE	Colorado Department of Public Health and Environment
CEDRS	Colorado Electronic Disease Reporting System
CHED	Center for Health and Environmental Data
CHI	Colorado Health Institute
eHARS	enhanced HIV/AIDS Reporting System
ELR	Electronic Laboratory Reporting
HAV	Hepatitis A Virus
HBIG	Hepatitis B immune globulin
HBsAg	HBV surface Antigen
HBV	Hepatitis B Virus
HCC	Hepatocellular Carcinoma
HCV	Hepatitis C Virus
HIV	Human Immunodeficiency Virus
HSR	Heath Statistics Region
ICP	Infection Control Practices
IDRP	Integrated Disease Reporting Program
IDU	Injection Drug Use
MSM	Men who have Sex with Men
NAT	Nucleic Acid Test
NH	Non-Hispanic
NHANES	National Health and Nutrition Examination Survey
NHBS	National HIV Behavioral Surveillance
NH	Non-Hispanic
NH NA/AN	Non-Hispanic Native American/Alaska Native
NH Asian/PI	Non-Hispanic Asian/Pacific Islander
NNDSS	National Notifiable Disease Surveillance System
NSDUH	National Survey on Drug Use and Health
PLWH	People Living with HIV
PrEP	Pre-exposure Prophylaxis
PWID	People Who Inject Drugs
RNA	Ribonucleic Acid
SSP	Syringe Services Program
STI	Sexually Transmitted Infections

Definitions

Baby boomers refers to people born in the United States between 1945 and 1965.

Case definition is defined by the Centers for Disease Control and Prevention (CDC) as "a set of uniform criteria used to define a disease for public health surveillance. Case definitions enable public health to classify and count cases consistently across reporting jurisdictions, and should not be used by health care providers to determine how to meet an individual patient's health needs."

CDPHE is the Colorado Department of Public Health and Environment. The Colorado Department of Public Health and Environment is the principal department of the Colorado state government responsible for public health and environmental regulation.

CEDRS refers to the Colorado Electronic Disease Reporting System. This database is used to capture reportable conditions across Colorado.

Cirrhosis is a chronic disease of the liver marked by degeneration of cells, inflammation, and fibrous thickening of tissue.

Cisgender refers to people whose gender identity aligns with the sex they were assigned at birth.

ELR refers to electronic lab reports that are sent by certain hospitals and labs directly to CDPHE.

Five-year average rates per 100,000 are calculated by dividing the average number of case counts over a five-year period by the average population during that period.

Front Range refers to the following counties in Colorado: Larimer, Weld, Boulder, Denver, Arapahoe, Adams, Jefferson, Douglas, Broomfield, Elbert, Park, Clear Creek, Gilpin, El Paso, Teller, Fremont and Pueblo.

Gender non-binary/non-conforming is an umbrella term for individuals who do not identify as strictly a woman or a man.

Generation X refers to persons born between 1966 and 1980.

HBsAb is the hepatitis B surface antibody. If a person has a positive hepatitis B surface antibody, it indicates immunity to the hepatitis B virus.

HBsAg is the hepatitis B surface antigen. HBsAg is a marker of infectivity. Its presence indicates either acute or chronic HBV infection.

HCV antibody testing, also referred to as anti-HCV, indicates past or present infection with HCV. If a person has spontaneously cleared the virus or has been cured, they will still test positive for HCV antibodies.

HSRs represent either counties or aggregations of counties according to statistical and demographic criteria and were developed by CDPHE and state and local public health professionals. The state is divided into 21 HSRs.

Incidence represents the number of new infections per year of a disease in a population.

Millennials refers to persons born between 1981 and 1986.

Post-millennials refers to persons born after 1997.

Prevalence represents the total number of people living with a disease.

Rates per 100,000 people are calculated by dividing the number of cases by the population for a given time period and multiplying by 100,000.

Reported cases refer to cases that were reported to CDPHE through electronic lab reporting and come from 22 different feeds representing 46 different commercial laboratories and hospital laboratories in Colorado.

RNA refers to the existence of genetic material in the blood. As opposed to a positive test for HCV antibodies, which may indicate past or present HCV infection, HCV RNA signifies current infection with HCV.

Rural counties in Colorado, according to the Office of Rural Health Policy, are Alamosa, Archuleta, Baca, Bent, Chaffee, Cheyenne, Clear Creek, Conejos, Costilla, Crowley, Custer, Delta, Dolores, Eagle, Elbert, Fremont, Garfield, Gilpin, Grand, Gunnison, Hinsdale, Huerfano, Jackson, Kiowa, Kit Carson, La Plata, Lake, Las Animas, Lincoln, Logan, Mineral, Moffat, Montezuma, Montrose, Morgan, Otero, Ouray, Park, Phillips, Pitkin, Prowers, Rio Grande, Rio Blanco, Routt, Saguache, San Juan, Sedgwick, San Miguel, Summit, Teller, Washington, and Yuma counties.

Sex assigned at birth is the assignment of people as male, female, intersex, or another sex assigned at birth -- often based on physical anatomy at birth.

Signal-to-cutoff ratio is a calculation for specific HCV antibody tests that is predictive of a true antibody-positive result.

Urban counties in Colorado, according to the Office of Rural Health Policy, are Adams, Arapahoe, Boulder, Broomfield, Denver, Douglas, El Paso, Jefferson, Larimer, Mesa, Pueblo, and Weld counties.

Viremia (viremic cases) refers to the presence of HCV RNA in the blood.

Executive summary

Viral hepatitis is one of the leading causes of death and disability worldwide (1) and continues to be a significant public health challenge in Colorado. Reducing the disease burden and improving health outcomes of Hepatitis A (HAV), Hepatitis B (HBV), and Hepatitis C (HCV) in Colorado is feasible with the implementation of cross-cutting strategies. Such strategies include strengthening surveillance activities for acute and chronic viral hepatitis, expanding testing, linkage to care and treatment, access to direct-acting antiviral (DAA) medications for HCV, and immunizations with a focus on priority populations including men who have sex with men (MSM), people who inject drug (PWID), detained and incarcerated populations.

While HAV, HBV, and HCV can be transmitted in different ways, each virus causes damage to the liver and may affect its function. This report provides a summary of viral hepatitis cases reported to CDPHE in 2017 and includes data from previous years to examine trends in reported data.

Acute hepatitis A

The National Notifiable Diseases Surveillance System (NNDSS) case definition for HAV only includes confirmed acute HAV. Therefore, all references to "HAV" in this report refer to confirmed acute HAV and do not include probable cases.

- In 2017, 65 cases (1.2 per 100,000 population) of HAV were reported to CDPHE.
- The rate of newly reported HAV cases increased to 1.2 per 100,000 population in 2017 from 0.4 per 100,000 population in 2016.
- Of the 65 reported cases, 63 cases were associated with an outbreak. Over 50 percent of the cases involved in the outbreak were hospitalized, and there was one death associated with the outbreak.
- Men accounted for 70.8 percent of cases (n=46), while women accounted for 29.2 percent (n=19) cases.
- In 2017, 20-39 year olds made up the majority of cases (n=27, 1.7 per 100,000 population), followed by 40-59 year olds (n=26, 1.8 per 100,000 population).
- Non-Hispanic (NH) whites made up 61.5 percent of cases in 2017, followed by Hispanics (all races), who accounted for 13.8 percent of cases, while race/ethnicity was unknown for 21.5 percent of cases.
- Cases were reported from 15 different counties, 93.6 percent of which were urban.

Acute hepatitis B

The NNDSS case definition for acute HBV only includes criteria for confirmed acute HBV. Therefore, all references to "acute HBV" in this report refer to confirmed acute HBV cases.

- In 2017, 32 cases (0.6 per 100,000 population) of acute hepatitis B virus (HBV) were reported to CDPHE.
- The rate of newly reported acute HBV cases increased to 0.6 per 100,000 population in 2017 from 0.5 per 100,000 population in 2016.
- In 2017, 84.4 percent (n=27) of acute HBV cases were reported in men and 15.6 percent (n=5) in women
- The number of reported acute HBV cases was highest in 40-59 year olds (n=17, 5-year average rate = 1.0 per 100,000 population).
- NH whites made up 56.3 percent (n=18) of all cases.
- Acute HBV cases were reported in 12 of the 64 Colorado counties in 2017. Urban counties accounted for 87.5 percent (n=28) of cases. Rural counties accounted for 9.4 percent (n=3) of reported cases, and 3.1 percent (n=1) of cases were reported from prisons.
- Among acute HBV cases in 2017, 14.9 percent (n=5) reported injection drug use (IDU) behavior or contact with PWID or within the last six weeks to six months as their only risk factor, and 12.5 percent (n=4) reported MSM as the sole risk factor. For 59.4 percent (n=19) of reported cases in 2017, there was no clear risk factor identified.

Chronic hepatitis B

The NNDSS case definition for chronic HBV has included criteria for probable and confirmed chronic HBV since 2008. Therefore, all references to "chronic HBV" in this report include probable and confirmed chronic HBV.

- In 2017, 505 cases (9.0 per 100,000 population) of chronic HBV were reported to CDPHE.
- The rate of newly reported chronic HBV cases decreased to 9.0 per 100,000 population in 2017 from 11.3 per 100,000 population in 2016.
- Men accounted for 57 percent of cases (n=289), while women accounted for 43 percent (n=216) cases.
- In 2017, 20-39 year olds had the highest number of reported cases (n=232) and the highest rate (14.2 per 100,000 population).
- Data on race and/or ethnicity are not routinely collected for chronic cases, but NH Asians accounted for 20 percent of the 48 percent of available data on race/ethnicity in 2017.

- At least one case of chronic HBV was reported in 34 of Colorado's 64 counties in 2017.
- In 2017, 87.5 percent of cases were reported from urban counties, while 6.7 percent were reported from rural counties and 2.6 percent of cases were reported from prisons.

Perinatal hepatitis B

The NNDSS case definition for perinatal HBV changed in 2017 to include criteria for probable and confirmed definitions of perinatal HBV, while the previous definition (established in 1995) included only a definition for confirmed cases. However, there were no perinatal HBV cases in 2017. Therefore, all references to "perinatal HBV" in this report include only confirmed cases.

- There were no new perinatal HBV cases reported or cases among people under 18 years old in 2017.
- HBV birth dose vaccination coverage was 82 percent in Colorado in 2017, and three-dose vaccination coverage among children ages 19 to 35 months was 92.1 percent.

Acute hepatitis C

The NNDSS case definition for acute HCV included a definition for probable acute HCV starting in 2016. In the 2007, 2011, and 2012 case definitions, there were no criteria for defining probable cases. Therefore, all references to "acute HCV" in this report include only confirmed acute HCV according to the definition in the reported year, unless otherwise specified. In addition, the case definition for confirmed acute HCV changed significantly in 2016 and is discussed in detail in the "Hepatitis C in Colorado" section of this report.

- In 2017, 43 cases (0.8 per 100,000 population) of acute HCV were reported to CDPHE.
- The rate of newly reported acute HCV cases increased to 0.8 per 100,000 population in 2017 from 0.6 per 100,000 population in 2016.
- In 2017, 67.4 percent (n=29) of acute HCV cases were among men, while 34.6 percent (n=14) of cases were among women
- 20-39 year olds accounted for 88.4 percent (n=38) of cases in 2017. The rate per 100,000 population in this age group was 2.3 in 2017.
- Acute HCV was reported in 15 of the 64 counties in 2017.
- Urban counties accounted for 83.7 percent (n=36) of cases. Rural counties accounted for 11.6 percent (n=5) of reported cases, and 4.7 percent (n=2) of cases were reported from prisons.
- IDU was the primary cause of reported acute HCV cases in 2017, with 81.3 percent (n = 35) of acute HCV cases reported having injected drugs in the last six months.

Chronic hepatitis C

The NNDSS case definition for chronic HCV has included definition criteria for probable and confirmed chronic HCV since 2003. However, the criteria for both probable and confirmed chronic HCV changed significantly in 2016, resulting in misrepresentation of trends over time.

Chronic HCV cases were evaluated based on whether or not they had a reported Nucleic Acid Test (NAT) at any time indicating the presence of HCV RNA in the blood. Cases that meet this criteria are referred to in this report as "viremic chronic HCV" and indicate unresolved, current infection with HCV, unless otherwise noted. For consistency, the numbers and rates of confirmed chronic HCV in 2016 and 2017, are also referred to as "viremic chronic HCV" throughout the report. The impact of the probable and confirmed case definition criteria changes is discussed in detail in the "Hepatitis C in Colorado" section of this report.

- In 2017, 2,812 (50.1 per 100,000 population) cases of chronic viremic HCV were reported to CDPHE.
- The rate of newly reported chronic viremic HCV cases decreased to 50.1 per 100,000 population in 2017 from 52.4 per 100,000 population in 2016.
- In 2017, 67.5 percent (n=1,897) of cases were among men, while 32.6 percent (n=915) of cases were among women.
- The number of reported viremic cases among 20-39 year olds (n=1,080, 66.2 per 100,000 population) exceeded the number of reported cases among (n=1,074, 73.67 per 100,000 population) for the first time in 2017.
- At least one case of confirmed chronic HCV was reported in 58 of the 64 Colorado counties in 2017, and more reported cases came from prisons than from any single county in Colorado.
- Urban counties accounted for 65.4 percent (n=1,838) of cases. Rural counties accounted for 12.6 percent (n=354) of reported cases, and 16.3 percent (n=458) of cases were reported from prisons.

Data sources

Colorado law requires both laboratories and health care providers to report cases of viral hepatitis to CDPHE. Reports of diagnosis for HBV, HCV and other viral hepatitis must be submitted to CDPHE within four days. HAV reports must be submitted to CDPHE within one working day.

Viral hepatitis surveillance in Colorado is primarily based on laboratory reporting of serologic results. Negative test results are not reportable, and data on routine screening rates and medical cure of the virus are not collected. The data that form the basis of this report are principally reports of hepatitis among people living in

Colorado at the time of their diagnosis. Cases are reported via electronic lab reporting (ELR) and are triaged by the Integrated Disease Reporting Program (IDRP) and entered into the Colorado Electronic Disease Reporting System (CEDRS). Hepatitis laboratory results come to CDPHE via ELR from 22 different feeds representing 46 different commercial laboratories and hospital laboratories. Laboratories must report all tests indicative of hepatitis, such as antibody tests and hepatitis viral loads. Upon receipt of these reports, CDPHE uses established case definitions to assign the appropriate diagnosis for each patient. If a case is listed as "probable" in CEDRS and a new test confirms the case, the case is reassigned as "confirmed" but retains the original reporting year.

In 2017, CDPHE received approximately 15,200 HBV test results and 47,100 HCV test results via ELR. People who have acute HBV or HCV that becomes chronic may be entered as both diagnoses in CEDRS, but all case counts included in this report are de-duplicated for each diagnosis.

Risk factor data can be obtained through patient interviews, medical record reviews, and information provided by a physician, hospital, or other health care provider. Behavioral data that is collected include, but are not limited to, IDU, household contacts, sexual partners, MSM, and people born outside the U.S. Information is more complete for those who are interviewed. These risk behavior data are collected with options of "Yes", "No", and "Unknown" when indicated, or as checkboxes. The time period of inquiry is generally the six months prior to onset of symptoms for acute cases.

CDPHE attempts to interview all newly reported HAV, acute HBV, and acute HCV cases, in addition to chronic HCV cases reported among people between the ages of 3 and 29 years old. Age 3 is used as a cutoff because HCV antibodies from the mother can last until 18 months of age, and treatment is not recommended for children under age 3 (2). Limiting interviews to those under age 30 is due to lack of resources to investigate all chronic reports.

Additionally, CDPHE follows all women 14 to 45 years of age who are reported to be living with HBV to ensure that if they become pregnant, they are enrolled in the Perinatal Hepatitis B Prevention Program to help prevent perinatal transmission.

Birth cohorts for this report were determined using data from the CDC and the Pew Research Center (3,4). The CDC defines Baby Boomers as individuals born between 1945 and 1965 but does not define other generations, so Pew Research Center definitions were used for the remaining birth cohorts. The Pew Research Center definitions were slightly modified to align with the CDC definition of Baby Boomers.

Population information from the Colorado Division of Local Affairs, State Demography Office (DOLA) is used to compare the population to people reported with hepatitis by gender, age, race, ethnicity and county. If a person reported with hepatitis is incarcerated in a county jail, that event is assigned to the county of the jail location; however, if an event is identified in a state or federal prison, a county is not assigned. Instead, an institution type is selected in the event, and for the purposes of this report, the county is labeled "Prison."

The Vital Statistics Branch of CDPHE provided cause of death data from certificates filed with the department for birth and deaths from 2000 to 2017. The Colorado Central Cancer Registry (CCCR) Branch of CDPHE provided data on liver cancer from 2000 to 2017.

Past and present case definitions for acute HAV, acute and chronic HBV, and acute and chronic HCV are determined by the NNDSS and can be found at https://wwwn.cdc.gov/nndss/conditions/.

Strengths and limitations of the data

Hepatitis has been reportable in Colorado since the 1990s. Surveillance is affected by several factors, including the ability to routinely identify: 1) all positive tests; 2) people who spontaneously clear infection; 3) people in treatment; 4) people who are cured and are no longer infected; 5) deaths due to the virus or other causes; 6) co-infections; or 7) re-infection with viral hepatitis.

Since most HCV events are reported by laboratories, and since most events are not followed up, most demographic and risk information remain missing for chronic events.

For some types of viral hepatitis, low reported case counts could be due to low prevalence and effective public health prevention strategies in Colorado. However, it is likely that many people living with viral hepatitis have not yet been diagnosed due to the often "silent" nature of liver infection (5).

People who identified as transgender were included in the case counts of the gender with which they identify. Data collection options that included transgender identities were not available until March 2017, and case counts are small. No data collection options currently exist to track viral hepatitis among gender non-binary/non-conforming individuals. Additionally, some of the data may represent the sex assigned at birth rather than the gender identity of individuals, but this level of detail does not exist within the data. Health disparities among transgender individuals are well documented, but there is a paucity of data about disparities in viral hepatitis prevalence and outcomes between cisgender and transgender individuals (6,7). Routine viral hepatitis testing is often excluded from publicly funded sexually transmitted infections (STI) testing programs (7).

Between the publication of the 2016 Viral Hepatitis Surveillance Report and this report, many duplicate profiles due to a previous database transition were identified and merged. The numbers in this report reflect the most up-to-date information available to CDPHE.

The presentation of data in this report are often limited by small numbers, from which it can be difficult to draw reliable inferences. Rates based on a small number of cases are often statistically unreliable, especially for counties with small populations or where rates are calculated for age, gender, or race/ethnicity with small cell sizes. A sample size of 20 cases is typically considered the minimum for stability of rates per 100,000 population (8). However, rates based on sample sizes less than 20 are presented in this report to ensure representation of, for example, rural counties and minority races. Five-year average rates per 100,000 population (2013 to 2017)

are often presented to help stabilize the rates. However, in the mapping visualizations of rates by county, only counties with more than one case between 2013 and 2017 are included.

Hepatitis A in Colorado

- In 2017, 65 cases (1.2 per 100,000 population) HAV were reported to CDPHE.
- Of the 65 reported cases, 63 cases were associated with an outbreak. Over 50 percent of the cases involved in the outbreak were hospitalized, and there was one death associated with the outbreak.
- Men accounted for 70.8 percent of cases (n=46), while women accounted for 29.2 percent (n=19) cases.
- In 2017, 20-39 year olds made up the majority of cases (n=27, 1.7 per 100,000 population), followed by 40-59 year olds (n=26, 1.8 per 100,000 population).
- NH whites made up 62 percent of cases in 2017, followed by Hispanics (all races), who accounted for 14 percent of cases.
- Cases were reported from 15 different counties.
- Interventions conducted by CDPHE to address the outbreak included education and vaccination campaigns targeting priority groups, press releases and health alerts, and encouraging prompt public health follow-up.

Acute HAV background

HAV is typically a foodborne illness that appears only as an acute (newly occurring) infection that does not become chronic. The virus is transmitted by eating or drinking contaminated food or water or by contact with a person with HAV. People with HAV can have a mild illness lasting a few weeks to a more severe illness requiring hospitalization, but most people improve without treatment. A safe and effective vaccine to prevent hepatitis A infection was introduced in 1995 (1). If a person knows they have been exposed to HAV, post-exposure prophylaxis (either immune globulin or hepatitis A vaccine) can be administered within two weeks of exposure to prevent illness.

The acute HAV case definition can be found at https://wwwn.cdc.gov/nndss/conditions/hepatitis-a-acute/case-definition/2012/.

Acute HAV data

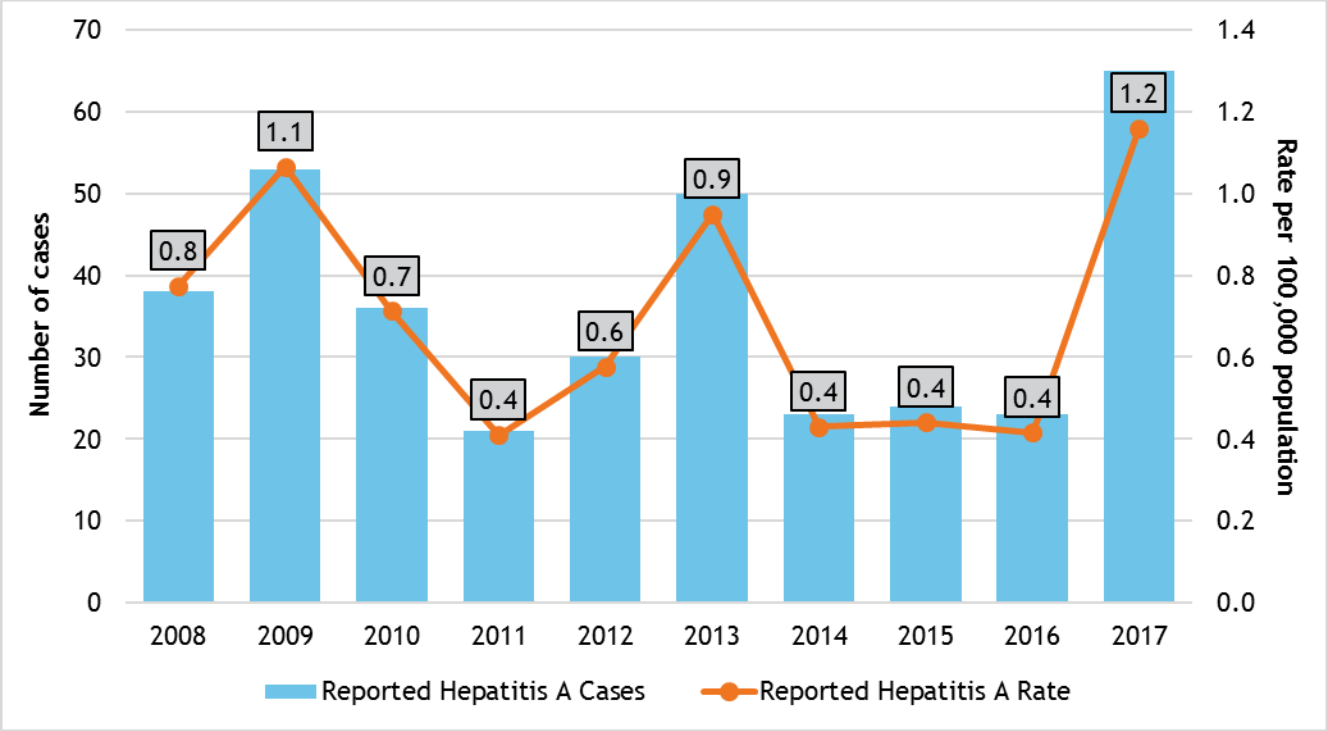
In 2017, there were 65 HAV cases diagnosed and reported for a statewide rate of 1.2 per 100,000 population. Figure 1 shows annual reported case counts and rates of HAV in Colorado from 2008 to 2017. In 2017, Colorado experienced an increase in HAV cases due to an outbreak, resulting in more than double the number of cases reported in 2016 and the highest reported rate per 100,000 population in the last decade. Ninety-seven percent (n=63) of the HAV cases in 2017 were attributed to the outbreak.

Table 1. Hepatitis A Virus (HAV) 2017 demographics

	2017 cases	Percent	2013-2017 cases	Percent	2013-2017 avg. rate per 100,000 pop.
Total	65	---	185	---	
Gender					
Men	46	71	104	56	0.8
Women	19	29	81	44	0.6*
Race/Ethnicity					
Hispanic (all races)	9	14	21	11	0.3*
NH black**	1	2	4	2	0.4*
NH white	40	62	129	70	0.7
NH Asian/PI	1	2	8	4	0.8*
NH NA/AN	0	0	0	0	0.0*
Unknown	14	22	23	12	----
Age Group					
0-19	2	3	17	9	0.2*
20-39	27	42	63	34	0.8*
40-59	26	40	64	35	0.9*
60-79	9	14	33	18	0.8*
80-99	1	2	8	4	1.0*
Unknown	0	0	0	0.0	---

*Rates may be unstable due to small case counts and should be interpreted with caution.
**See list of Acronyms on page 5 for race/ethnicity acronyms

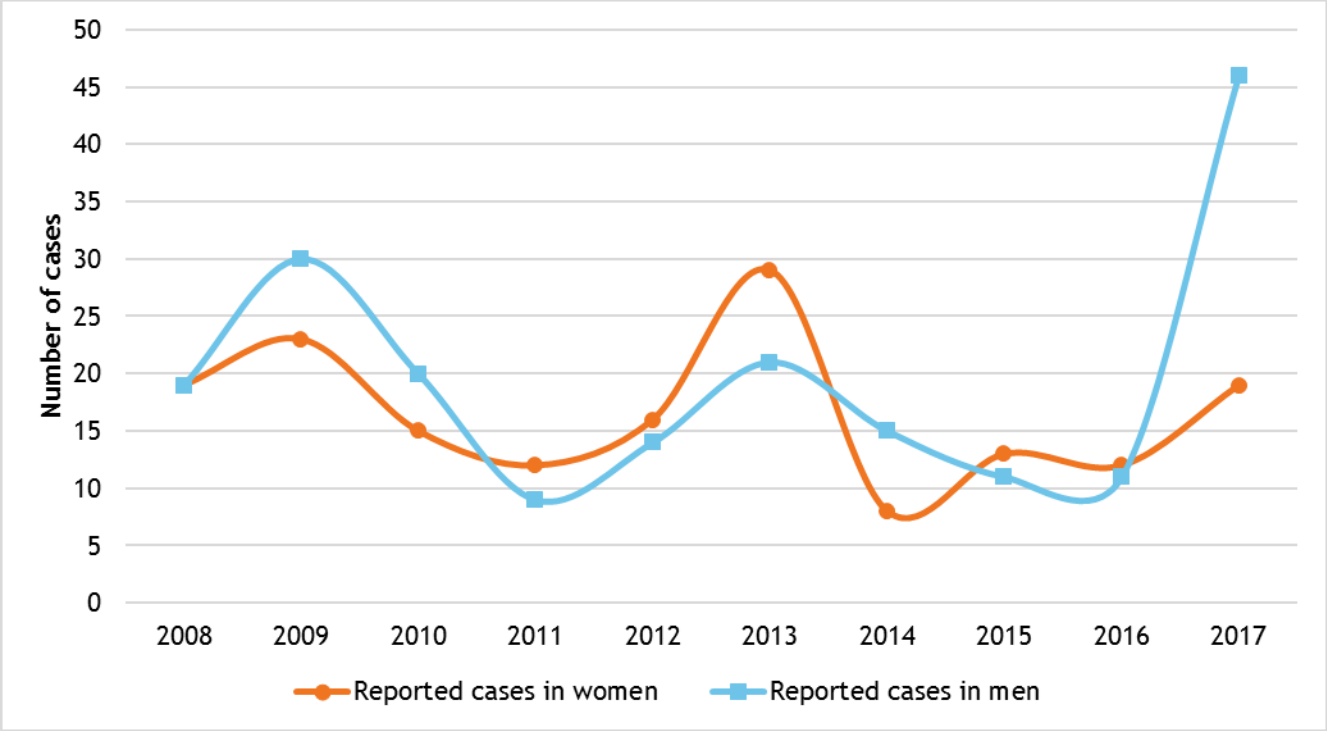
Figure 1. Reported HAV cases and rate per 100,000 population in Colorado, 2008-2017



Gender

Men accounted for 70.8 percent of cases (n=46), while women accounted for 29.2 percent (n=19) cases, which is shown in Figure 2. The larger proportion of men is largely attributable to MSM transmission during the 2017 outbreak.

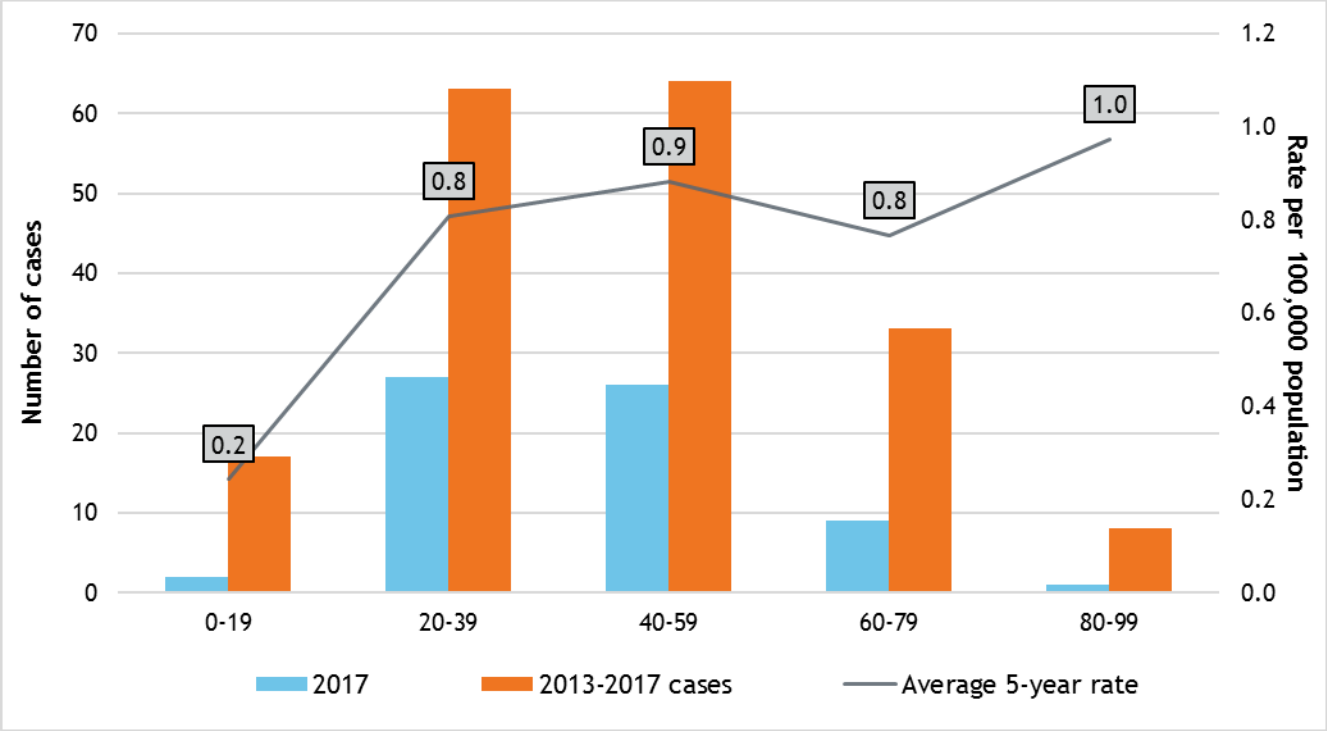
Figure 2. Reported HAV cases by gender, 2008-2017



Age

In 2017, and from 2013 to 2017, the median age of reported acute HCV cases was 44. In 2017, 20-39 year olds made up the majority of cases (n=27, 1.7 per 100,000 population), followed by 40-59 year olds (n=26, 1.8 per 100,000 population). Figure 3 depicts case counts and average five-year rates of HAV by age group. Rates of HAV were lowest during this period among people under 20 years old (0.2 per 100,000 population), which is likely due to use of the pediatric hepatitis A vaccine. Between 2013 and 2017, the highest average rate was among people aged 80 years and older (1.0 per 100,000 population). The largest burden of illness is among adults, for whom vaccination is not routinely offered.

Figure 3. Reported HAV cases by age group, 2013-2017



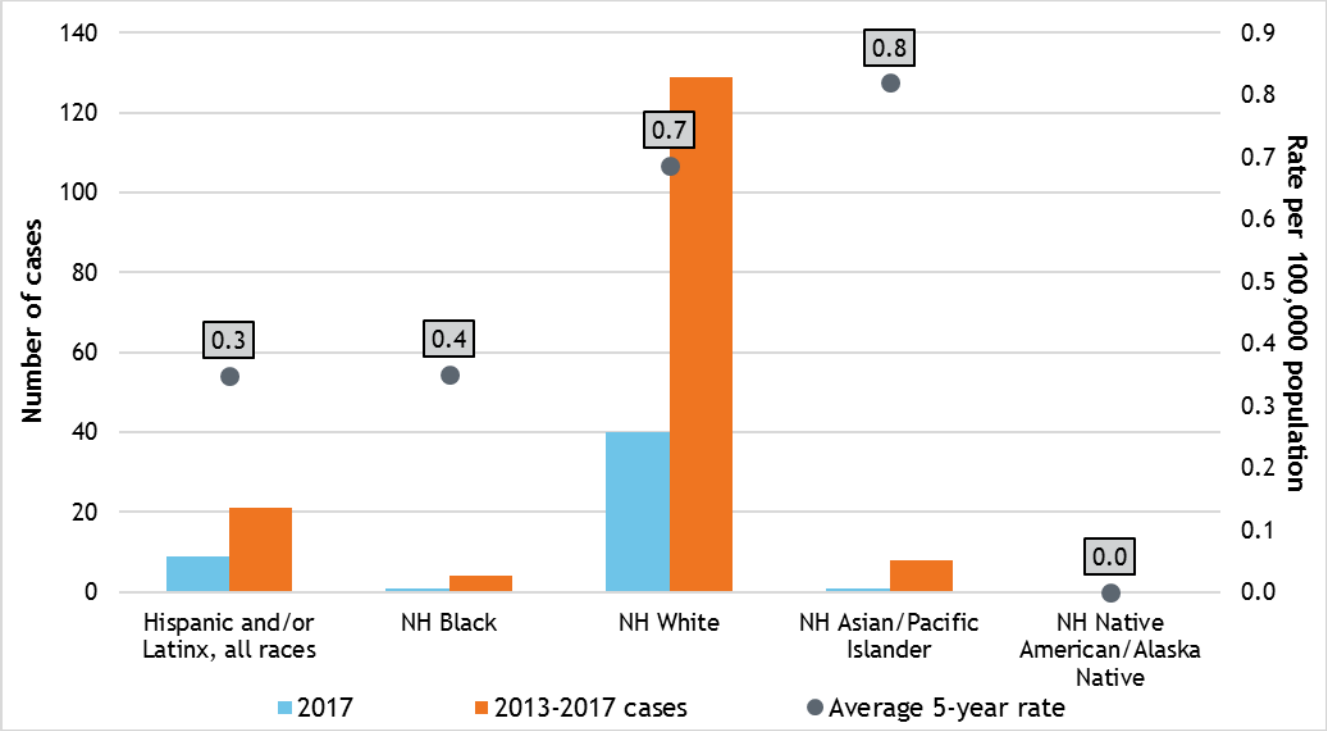
Rates may be unstable due to small case counts and should be interpreted with caution.

Race/ethnicity

Among 2017 cases, data on race/ethnicity were available for 78.5 percent (n=51) of cases. Of cases with known race/ethnicity, 78.4 percent were NH whites and 17.6 percent were Hispanics (all races), as shown in Figure 4.

From 2013 to 2017, the average rate of reported HAV cases per 100,000 population was highest among NH Asians; however, the rates are based on small case counts and should be interpreted with caution.

Figure 4. Reported HAV cases by Race/Ethnicity, 2013-2017



Rates may be unstable due to small case counts and should be interpreted with caution.

Geographic distribution

Cases from the outbreak were identified in 15 counties, shown in Figure 5. The largest number of cases from the 2017 HAV outbreak were from El Paso (n =12) and Denver (n=12) counties, followed by Adams (n=9) and Pueblo (n=7). The counties of the two cases reported during 2017 that were not associated with the outbreak were not able to be identified.

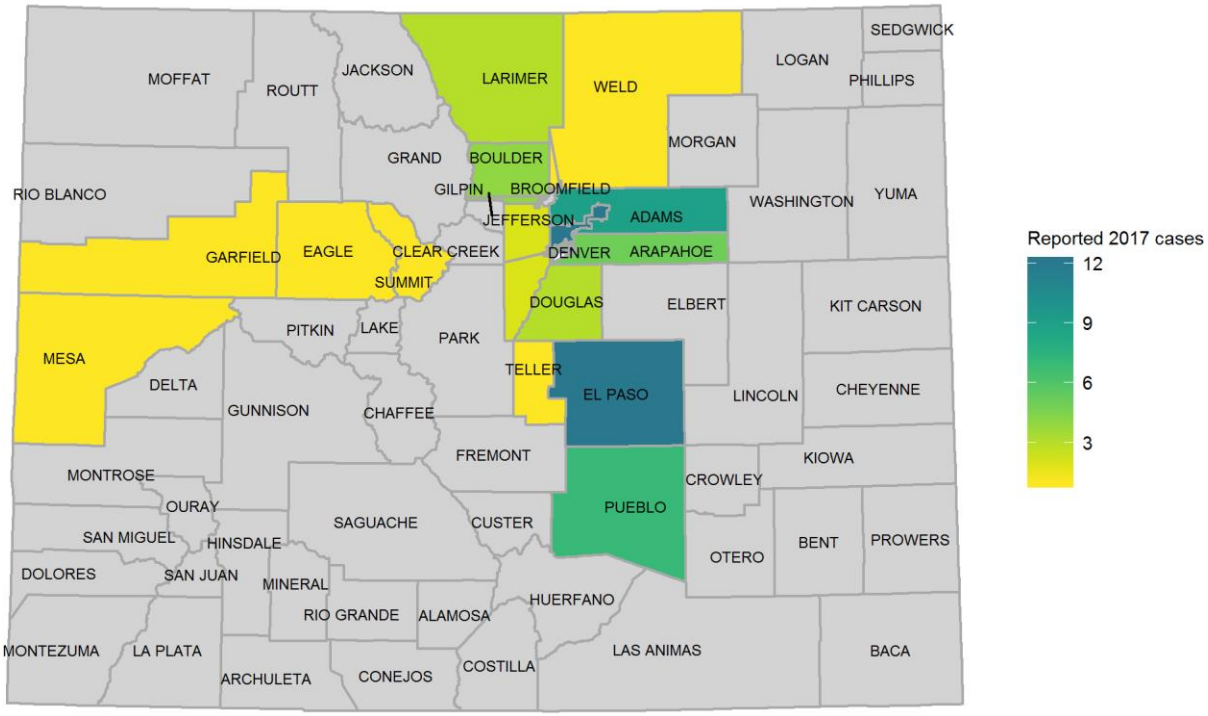
2017 outbreak

The 2017 hepatitis A outbreak in Colorado primarily affected MSM in Front Range counties. There were 63 cases identified as part of the outbreak, 32 (51 percent) of whom were hospitalized. There was one death attributed to the outbreak. Among the 63 cases, 44 (69.8 percent) were among men. Sexual contact in adult entertainment venues (such as adult video arcades/bookstores) was an identified risk factor for some of the MSM cases. Other risk factors identified in the outbreak investigation included international travel, IDU, and homelessness.

The outbreak began in December 2016 and peaked in April 2017, when 14 new cases were identified. Interventions conducted by CDPHE to address the outbreak included education and vaccination campaigns targeting high-risk groups, press releases and health alerts, and encouraging prompt public health follow-up.

Vaccine clinics were held at a number of adult entertainment stores and bath houses in the Denver metropolitan area, as well as at homeless shelters in two metropolitan areas. Social media outreach targeted MSM, using platforms including Grindr, Scruff, and Facebook. Overall, Facebook outreach (including paid ads) reached more than 10,000 people outside CDPHE's usual network of followers. Scruff and Grindr ads had more than 3.5 million impressions, resulting in over 6,000 clicks. In addition, CDPHE developed educational materials in English and Spanish that were distributed at venues such as adult entertainment stores, bath houses, Pride week activities, and doctors' offices. In addition to organizing the vaccination clinics, local public health also worked with adult entertainment stores to educate them on appropriate disinfection techniques. During the outbreak, CDPHE issued press releases and provider communications, and routinely updated its website and 24-hour help line.

Figure 5. Counties affected by the 2017 HAV outbreak



Hepatitis B in Colorado

- In 2017, 32 cases (0.6 per 100,000 population) of acute HBV and 505 cases (9.0 per 100,000 population) of chronic HBV were reported.
- The number of newly reported acute HBV cases increased from 2016 to 2017, while the number of newly reported chronic HBV cases decreased from 2016 to 2017.

- In 2017, men accounted for 84.4 percent (n=27) of acute HBV cases and 57 percent (n=289) of chronic HBV cases.
- In 2017, the number of reported acute HBV cases was highest in 40-59 year olds (n=17, five-year average rate = 1.0 per 100,000 population). Among reported chronic HBV cases, 20-39 year olds had the highest number of reported cases (n=232, 14.2 per 100,000 population).
- NH whites made up 56.3 percent of acute cases in 2017, followed by Hispanics (all races) at 18.8 percent of cases.
- In 2017, 15.6 percent (n=5) of reported acute HBV cases reported IDU as the sole risk factor, while 12.5 percent (n=4) reported contact with MSM with no IDU risk behavior.
- At least one case of chronic HBV was reported in 34 of Colorado's 64 counties in 2017. Denver, Arapahoe, and Morgan counties had the highest average five-year rates per 100,000 population of reported cases.
- There were no new perinatal HBV cases reported or cases among people under 18 years old.

HBV background

HBV is a bloodborne illness that can occur as an acute or chronic infection. It can range in severity from a mild illness that clears on its own to a serious, lifelong illness that can result in death. The virus can replicate in the liver for years causing damage, often without symptoms. However, HBV is preventable and can be managed if treated appropriately.

Transmission of HBV occurs most often by three routes: through perinatal transmission, direct contact with blood, or semen or vaginal fluids. The likelihood of perinatal transmission ranges from 30 percent when the person who is pregnant is HBsAg-positive and hepatitis B e-antigen (HBeAg)-negative to 85 percent when the person who is pregnant is positive for both HBsAg and HBeAg (9). 90 percent of infants who perinatally acquire HBV will develop a chronic infection, whereas only 5 percent of adults who acquire acute HBV will develop chronic HBV (9).

The CDC recommends routine testing and follow-up for HBV in special populations. These populations include: persons born in endemic regions, U.S.-born persons who were not vaccinated as infants and whose parents were born in high endemic regions; PWID; MSM; people needing immunosuppressive therapy; people with elevated ALT/AST of unknown etiology; donors of blood, plasma, organs, tissues, or semen; hemodialysis patients; infants at risk for perinatal transmission; people who engage in household needle sharing, or sex contacts of people known to be HBsAg positive; people who are the source of blood or body fluid resulting in an exposure that might require post-exposure prophylaxis; and people living with HIV (PLWH) (10).

In Colorado, HBV vaccination became a school entry requirement in 1997. Currently, all students aged 15 months through twelfth grade are required to have three doses of the vaccine. Three doses of the HBV vaccine confer greater than 95 percent immunity. Vaccination has helped decrease rates of HBV particularly among school-age children.

Acute HBV background

Acute HBV is a short-term illness that occurs within the first six months of infection with HBV. Symptoms are usually mild to moderate. Children greater than five years old and adults are more likely to develop symptoms as compared to children under the age of five. CDPHE uses case definitions published by the NNDSS to define an acute case. The acute HBV case definition has not changed since 2012 and can be found at https://wwwn.cdc.gov/nndss/conditions/hepatitis-b-acute.

Chronic HBV background

Chronic HBV results when HBV remains in the body after the acute phase of illness. Over time, chronic HBV can result in liver disease, cirrhosis, and/or cancer.

According to the most recently published HBV prevalence estimates, the prevalence of chronic, unresolved HBV is 0.3 percent (0.2percent - 0.4 percent) in the U.S. with little change since 2010 (11). Multiplying 0.3 percent by the Colorado State Demography Office 2017 Forecast population of 5,630,986, would result in an estimated 168,930 (112,620 - 225,240) people in Colorado living with chronic, unresolved HBV infection (12). The prevalence estimate of 0.3 percent is not, however, specific to Colorado. In the U.S., NH Asians make up about 6 percent of the population but experience approximately 60 percent of the burden of chronic HBV (13); In Colorado, NH Asians made up 3.8 percent of the state's population (14). It is possible that the prevalence of chronic HBV may be lower in Colorado due to a lower NH Asian population compared to the U.S. as a whole.

Many people living with chronic HBV are unaware of their infection. Nationally, an estimated 35 percent of people living with chronic HBV have been diagnosed (11). The prevalence of chronic HBV in the United States disproportionately affects people born in countries where HBV is endemic, such as countries in East Asia and sub-Saharan Africa (15). Vaccination of all high-risk groups, not just children, can help reduce the number of new infections.

The chronic HBV case definition has not changed since 2012 and can be found at https://wwwn.cdc.gov/nndss/conditions/hepatitis-b-chronic.

Perinatal HBV background

Perinatal HBV is defined as HBsAg positivity in any infant aged 1-24 months who was born in the United States or in U.S. territories to an HBsAg-positive pregnant person.

A dose of HBV vaccine combined with hepatitis B immune globulin (HBIG) administered within 12 hours of birth and completing the full series of three vaccines can help prevent transmission to the infant. Additionally, the infant receives post-vaccine serologic testing at nine to 12 months to verify conversion to immunity from the vaccine. Infants that remain susceptible after completing the three dose series are recommended to receive an additional three dose series in order to achieve immunity. Without proper immunoprophylaxis given at birth, infants can acquire HBV and 90 percent of those infants will develop chronic HBV and carry the disease for life.

The perinatal HBV case definition changed in 2017 and can be found at https://wwwn.cdc.gov/nndss/conditions/hepatitis-b-perinatal-virus-infection.

Acute HBV data

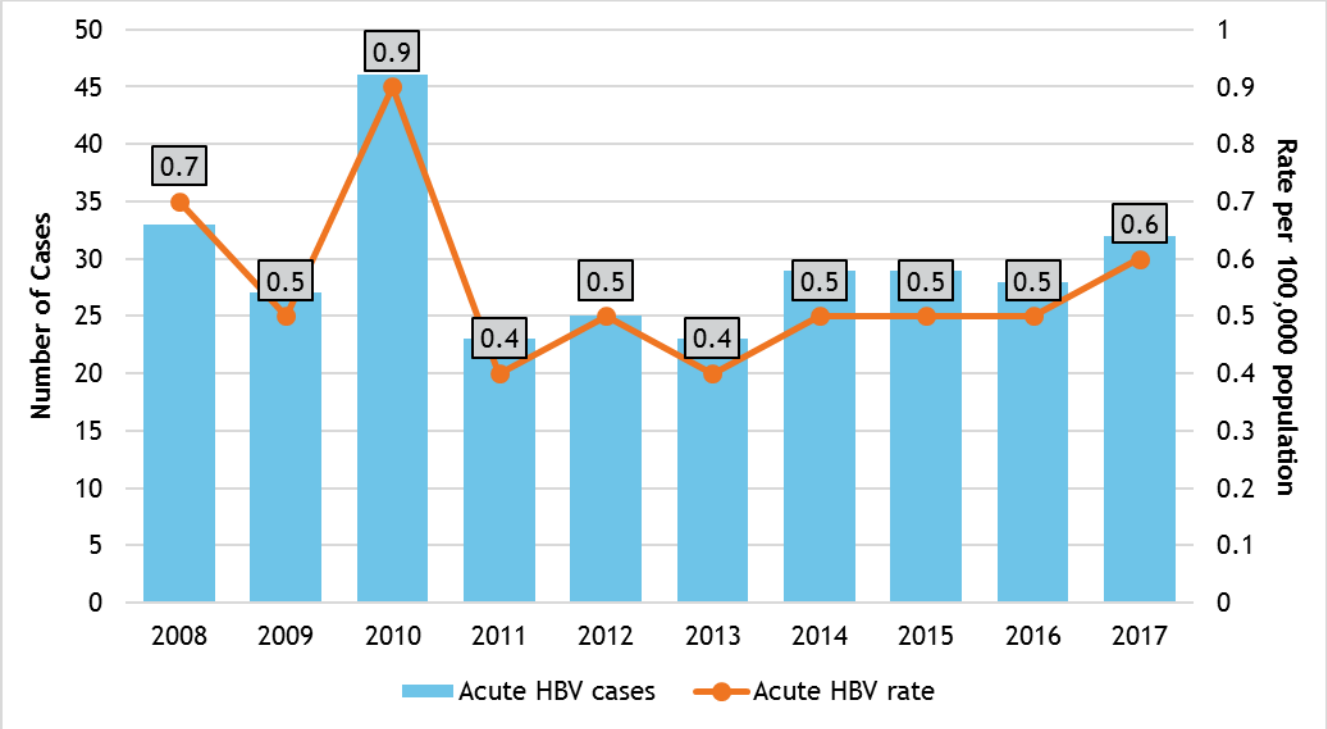
There were 32 cases (0.6 per 100,000 population) of acute HBV reported in 2017. Figure 6 shows acute HBV cases and rates per 100,000 population reported in Colorado by year. The rate of acute HBV cases remained stable from 2014 to 2016 but increased in 2017 by four cases. Applying published multipliers to adjust for under-ascertainment and underreporting to the 32 acute HBV case reports in 2017, CDPHE estimates that there were a total of 253 acute HBV cases in Colorado in 2017 (10).

Table 2. Acute Hepatitis B Virus (HBV) demographics

	2017 cases	Percent	2013-2017 cases	Percent	2013-2017 avg. rate per 100,000 pop.
Total	32	---	141	---	0.5
Gender					
Men	27	84.4	108	76.6	0.8
Women	5	15.6	33	23.4	0.2*
Race/Ethnicity					
Hispanic (all races)	6	18.8	19	13.5	0.3*
NH Black	3	9.4	14	9.9	1.2*
NH White	18	56.3	87	61.7	0.5
NH Asian/PI	1	3.1	5	3.5	0.5*
NH NA/AN	0	0.0	1	0.7	0.4*
Unknown	4	12.5	15	10.6	----
Age Group					
0-19	0	0.0	1	0.7	0.0*
20-39	13	40.6	43	30.5	0.6*

40-59	17	53.1	76	53.9	1.0*
60-79	2	6.3	19	13.5	0.4*
80-99	0	0.0	2	1.4	0.2*
Unknown	0	0.0	0	0.0	---
*Rates may be unstable due to small case counts and should be interpreted with caution.					

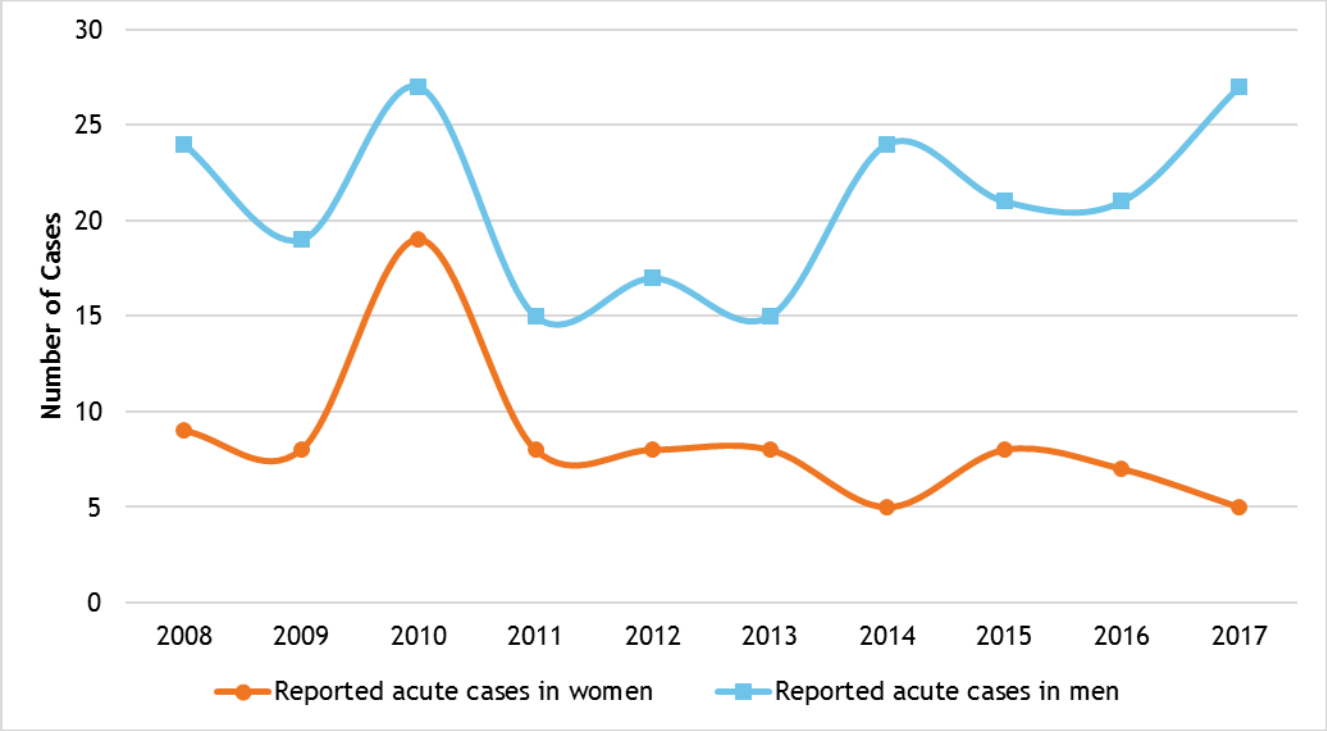
Figure 6. Reported acute HBV cases and rate per 100,000 population, 2008-2017



Gender

In 2017, 84.4 percent (n=27) of acute HBV cases were reported in men and 15.6 percent (n=5) in women. Among acute HBV cases reported from 2013 to 2017, 76.6 percent (n=108) of cases were reported in men, and 23.4 percent (n=33) in women, likely due to MSM as a risk factor for acute HBV. Figure 7 illustrates this trend.

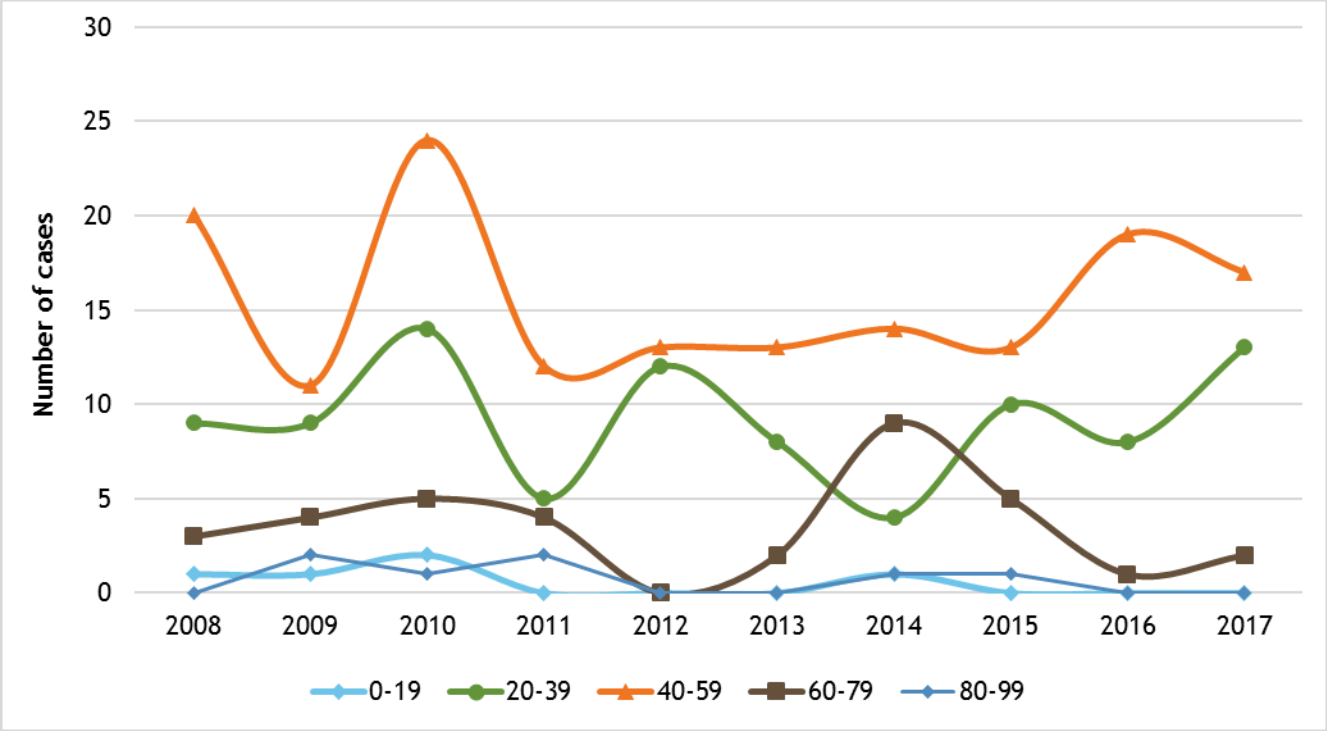
Figure 7. Reported acute HBV cases by gender, 2008-2017



Age

In 2017, the median age of reported acute HBV cases was 43.5, while the median age between 2013 and 2017 was 45. Figure 8 shows that since 2011, there has only been one reported acute case in an individual less than 20 years old. People older than 19 years are less likely to be immunized for HBV based on a school-entry requirement that began in 1997. The higher rate of acute cases in people older than 19 years suggests that vaccine coverage of individuals in these age groups is significantly lower. The relatively high numbers of acute cases individuals ages 40 to 59 illustrates the importance of catch-up vaccination, particularly for individuals in high-risk groups.

Figure 8. Reported acute HBV cases by age group, 2008-2017

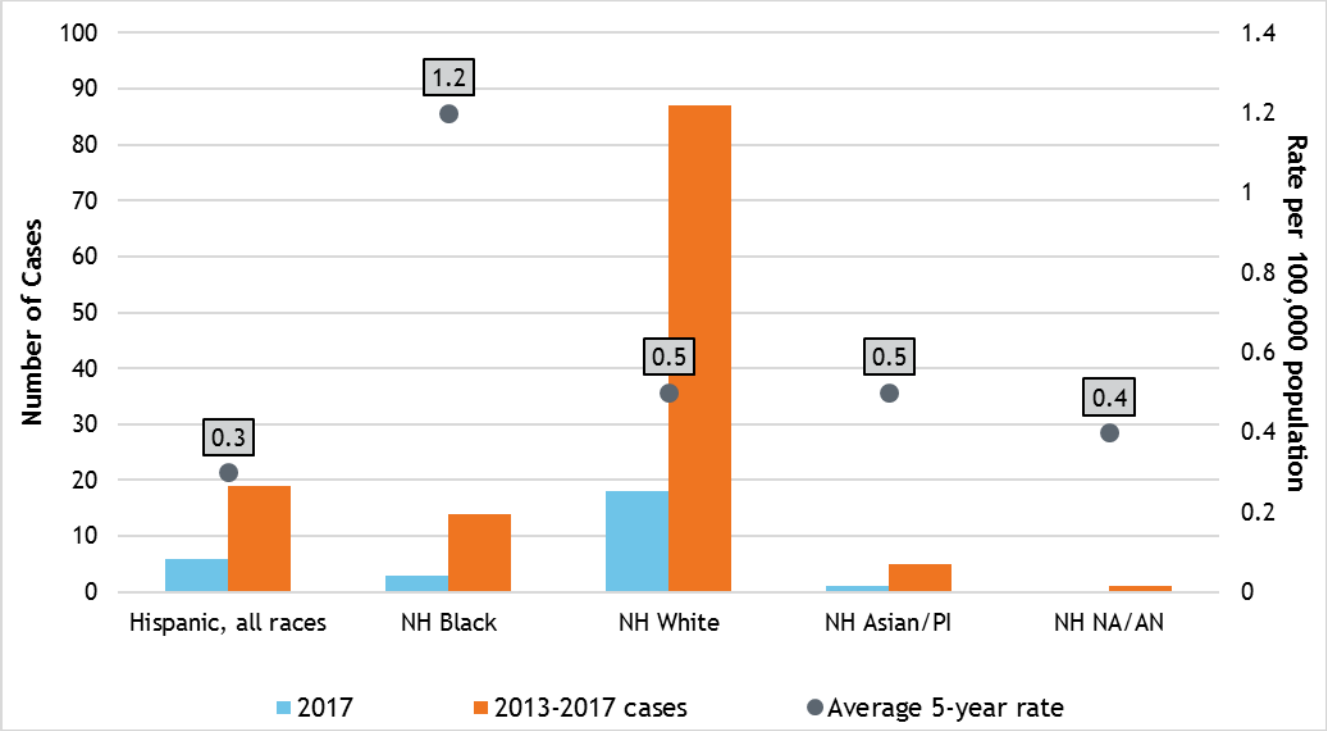


Race/ethnicity

In 2017, data on race and/or ethnicity were available for 87.5 percent of acute cases, shown in Figure 9. Data on race and/or ethnicity were available for 89.4 percent of acute cases from 2013 to 2017. In 2017, NH whites made up 56.3 percent (n=18) of all acute HBV cases. Between 2013 and 2017, 61.7 percent (n=87) of cases were reported among NH whites. Hispanics (all races) accounted for the next largest proportion of acute cases at 13.5 percent (n=19).

From 2013 to 2017, the average rate per 100,000 population for NH blacks was the highest at 1.2, however, case counts were low and rates should be interpreted with caution. Nationally, rates of acute HBV have been consistently higher for NH blacks compared to all other racial/ethnic groups (16). The CDC estimates that rates of HBV vaccination among adults and those at high risk for infection were significantly lower among NH blacks than among NH whites (16), highlighting a health disparity in catch-up vaccination at the national level.

Figure 9. Reported acute HBV cases and average 5-year rate per 100,000 population by race/ethnicity, 2013-2017



Rates may be unstable due to small case counts and should be interpreted with caution.

Geographic distribution

Acute HBV cases were reported in 12 of the 64 Colorado counties in 2017. Four counties (Denver, Arapahoe, Adams, and Jefferson) accounted for 65.6 percent (n=21) of all reported acute HBV cases, and all urban counties accounted for 87.5 percent (n=28) of cases. Rural counties accounted for 9.4 percent (n=3) of reported cases, and 3.1 percent (n=1) of cases were reported from prisons.

However, average five-year rates per 100,000 population were highest in Bent, Delta, Denver, and Mesa, although case counts were low and the rates should be interpreted with caution. Figure 10 shows the number of reported cases by county in 2017, while Figure 11 shows the average five-year rates per 100,000 population of acute cases by county. Counties with fewer than two cases between 2013 and 2017 were excluded from Figure 11 due to statistical instability. Quantile ranges in Figure 11 were determined using Jenks Natural Breaks. Table 3 shows case counts by county from 2013 to 2017 when there was at least one case reported in 2017.

Figure 10. Reported acute HBV case counts by county, 2017

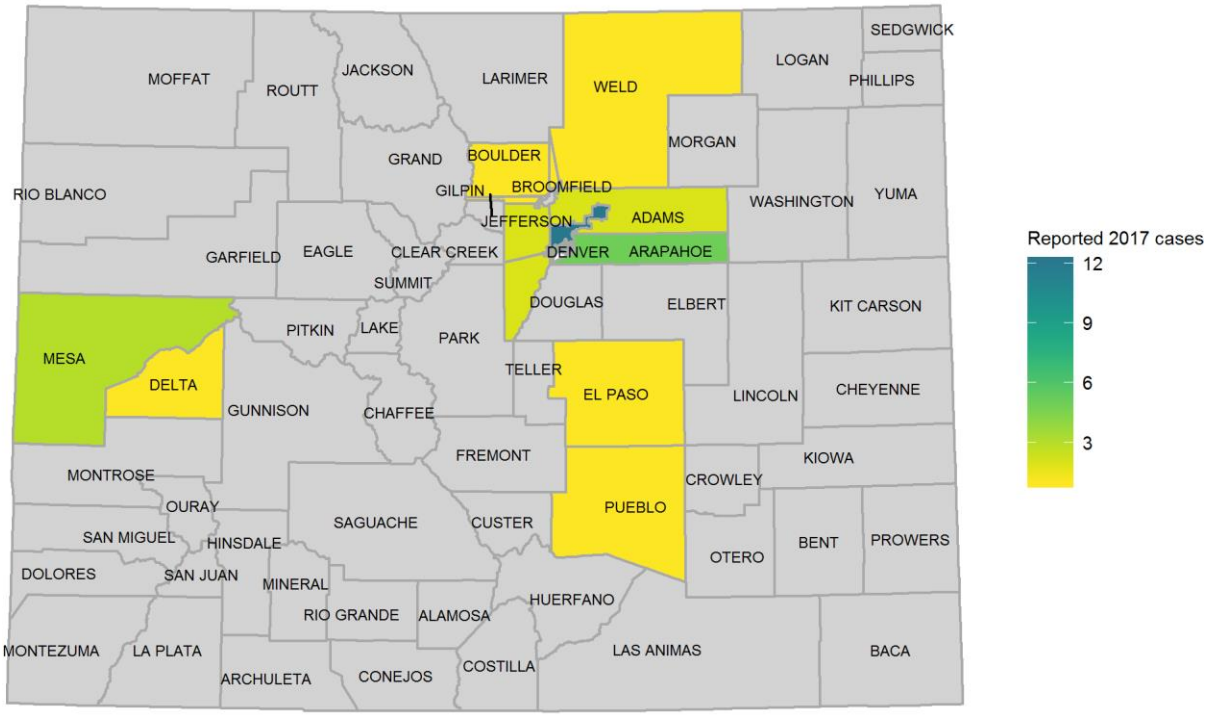
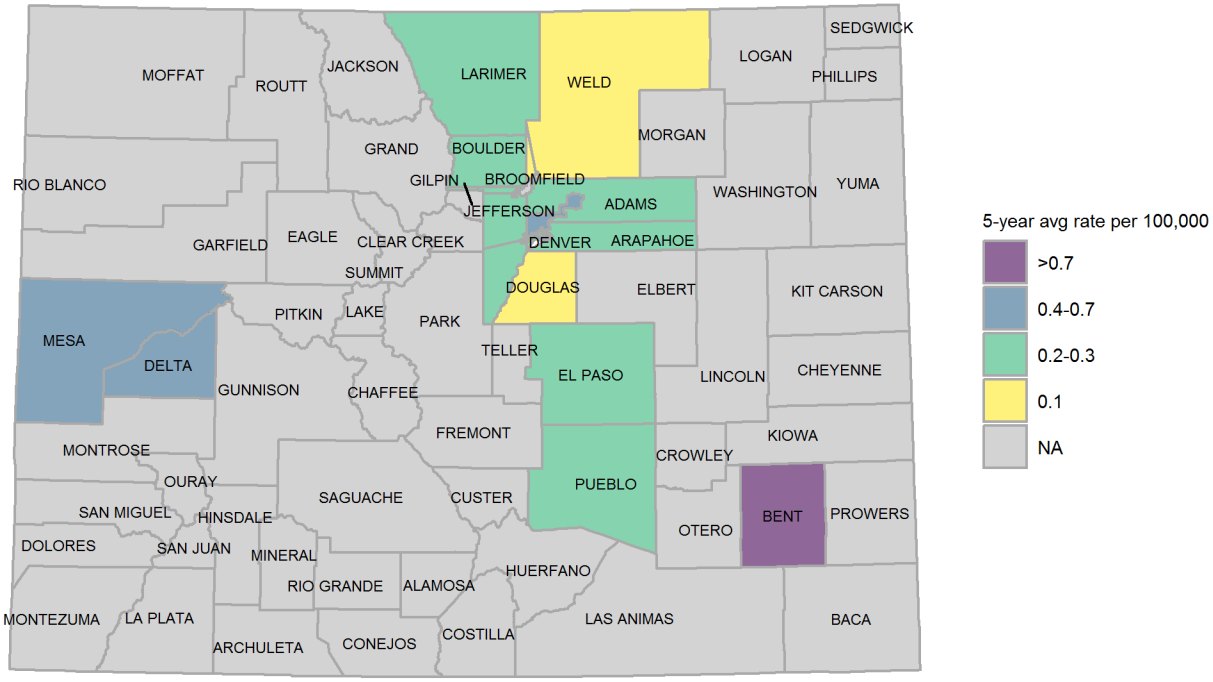


Figure 11. Average rates per 100,000 population of reported acute HBV cases by county, 2013-2017



Rates suppressed for counties with <2 cases between 2013-2017. High rates do not necessarily mean high case counts.

Table 3. Case counts by county where at least one case was reported in 2017

County	2013	2014	2015	2016	2017	Sum of cases 2013-2017
Adams	3	7	0	0	2	12
Arapahoe	1	3	2	4	5	15
Boulder	0	2	2	0	1	5
Delta	1	0	0	0	1	2
Denver	6	6	7	13	12	44
Eagle	0	0	0	0	1	1
El Paso	3	0	6	3	1	13
Jefferson	6	4	4	2	2	18
Mesa	1	2	2	0	3	8
Montezuma	0	0	0	0	1	1
Pueblo	0	1	0	1	1	3
Weld	0	0	2	1	1	4

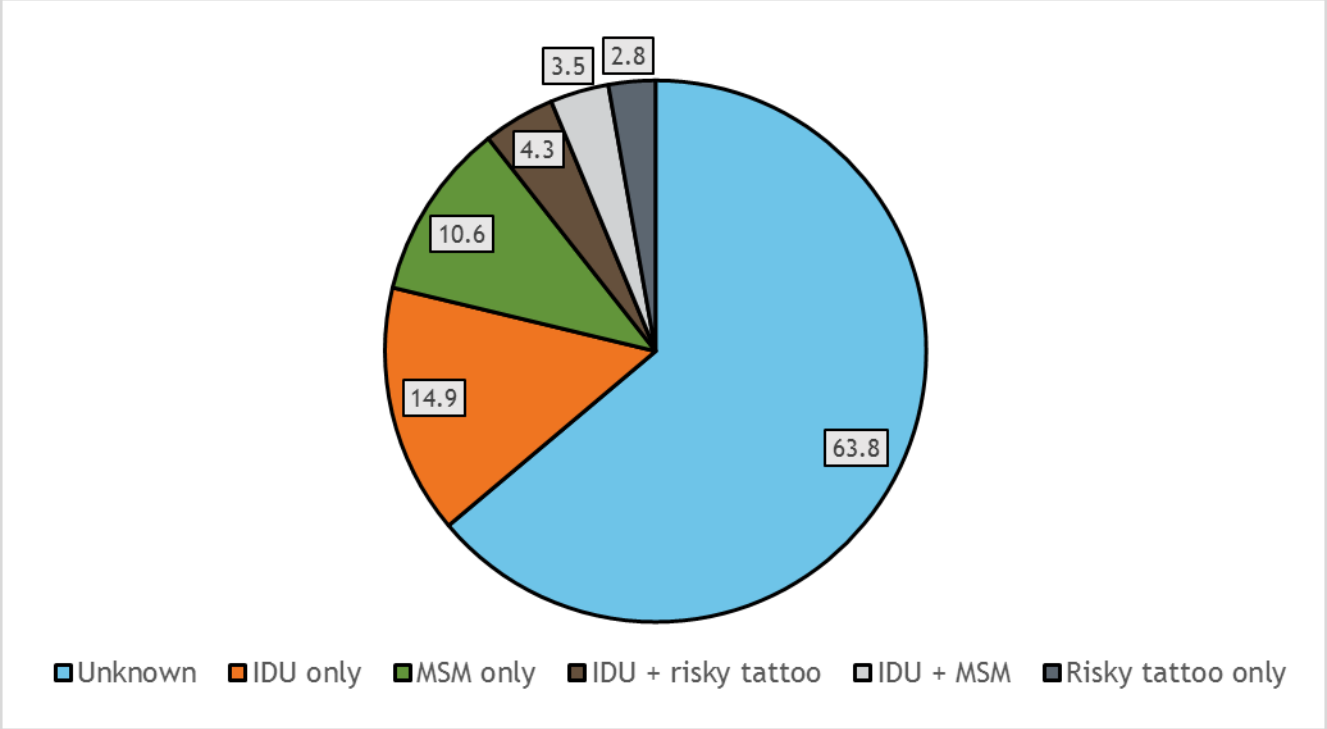
Prison	0	0	0	1	1	2

Behavioral risk factors

Among acute HBV cases in 2017, 15.6 percent (n=5) reported contact with PWID or IDU behavior within the last six weeks to six months as their only risk factor, and 12.5 percent (n=4) reported MSM as the sole risk factor. For 59.4 percent (n=19) of reported cases in 2017, there was no clear risk factor identified.

From 2013 to 2017, 14.9 percent (n=21) of cases reported contact with PWID or IDU behavior within the last six weeks to six months as their only risk factor, while 10.6 percent (n=15) reported MSM as the sole risk factor. For 63.8 percent (n=90) of reported cases, there was no risk factor identified. Nationally, IDU was the most commonly reported risk factor for acute HBV cases; 34.4 percent of people included information on use of injection drugs (10). The breakdown of reported risk from 2013 to 2017 is shown in Figure 12.

Figure 12. Reported risk factors for acute HBV cases, 2013-2017



Chronic HBV data

In 2017, 505 (9.0 per 100,000 population) cases of chronic HBV were reported. The number of chronic HBV cases increased annually from 2013 to 2016. There were 628 (11.3 per 100,000 population) chronic cases reported in 2016, a 10 percent increase from the number reported in 2015. However, in 2017 the number of reported chronic cases fell by 19.5 percent to 505. This trend is illustrated in Figure 13. Risk factor data for chronic HBV cases are

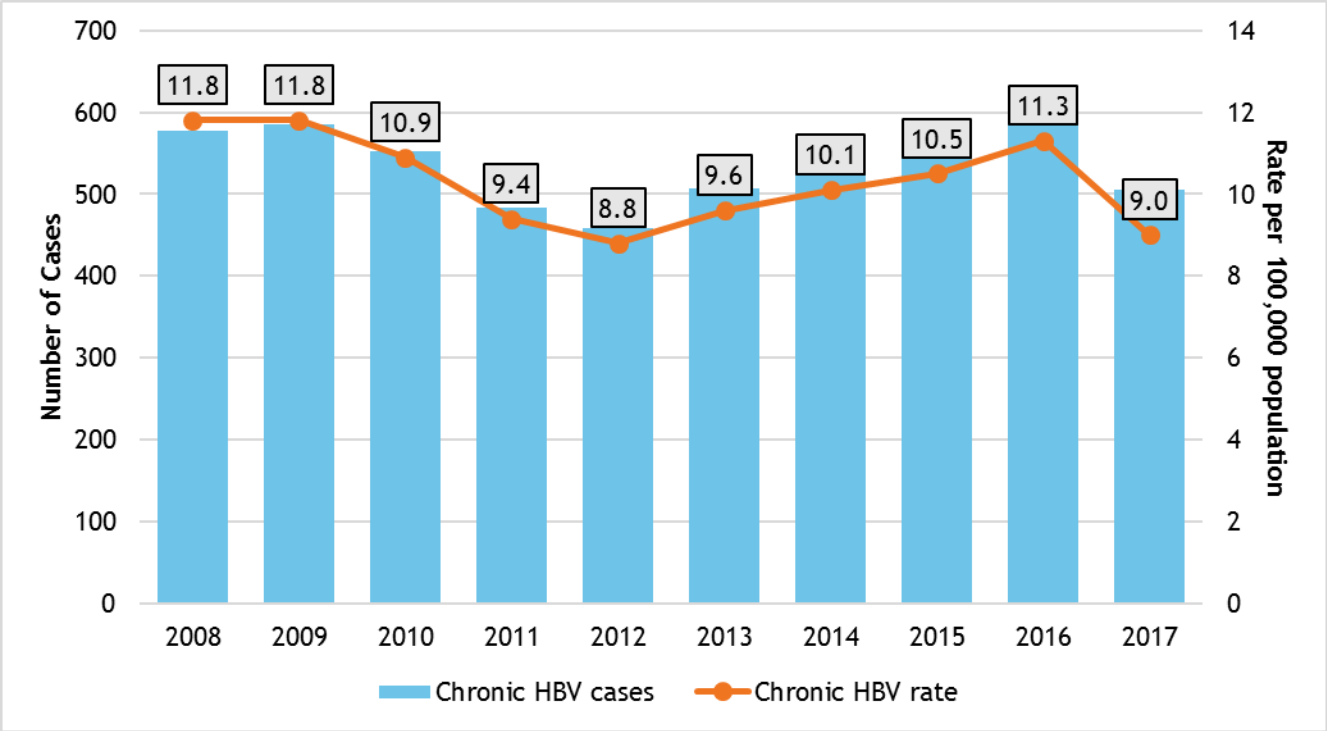
not routinely collected, and the reason for the increase in reported cases in 2016 and subsequent decline in 2017 is unknown. In terms of case counts and rates per 100,000 population, 2016 was an exceptionally high year for reporting of chronic HBV. The number of reported cases in 2016 was greater than two standard deviations above the mean number of reported cases (512.2) and mean rate (9.7 per 100,000 population) from 2011 to 2015. In 2017, the number reported and rate per 100,000 was less than two standard deviations from the same mean. So, rather than interpreting 2017 as an exceptionally low year for reported HBV cases, 2016 should be seen as the outlier year in which an exceptionally high number of cases was reported. Changes in immigration patterns from endemic countries is one possible explanation, but net migration in Colorado fell in 2016 compared to 2015 (12), and there are insufficient data about the country of birth among chronic HBV cases to explore this. A comparison to national data on reported chronic HBV cases would be difficult as a different number of states reports cases to the CDC each year, and the total number of reported cases was highly variable between 2013 and 2016 (17).

Table 4. Chronic HBV demographics

	2017 cases	Percent	2013-2017 cases	Percent	2013-2017 avg. rate per 100,000 pop.
Total	505	---	2,752	---	10.1
Gender					
Men	289	57.2	1,572	57.1	11.6
Women	216	42.8	1,180	42.9	8.7
Race/Ethnicity					
Hispanic (all races)	23	4.6	106	3.9	1.8
NH Black	46	9.1	337	12.2	29.5
NH White	69	13.7	357	13.0	1.9
NH Asian/PI	106	21.0	721	26.2	73.9
NH NA/AN	2	0.4	12	0.4	4.6*
Unknown	259	51.3	1,219	44.3	----
Age Group					
0-19	13	2.6	117	4.3	1.7
20-39	232	45.9	1,270	46.1	16.3
40-59	175	34.7	960	34.9	13.2
60-79	83	16.4	385	14.0	9.0
80-99	2	0.4	20	0.7	2.4*
Unknown	0	0	0	0	---

*Rates may be unstable due to small case counts and should be interpreted with caution.

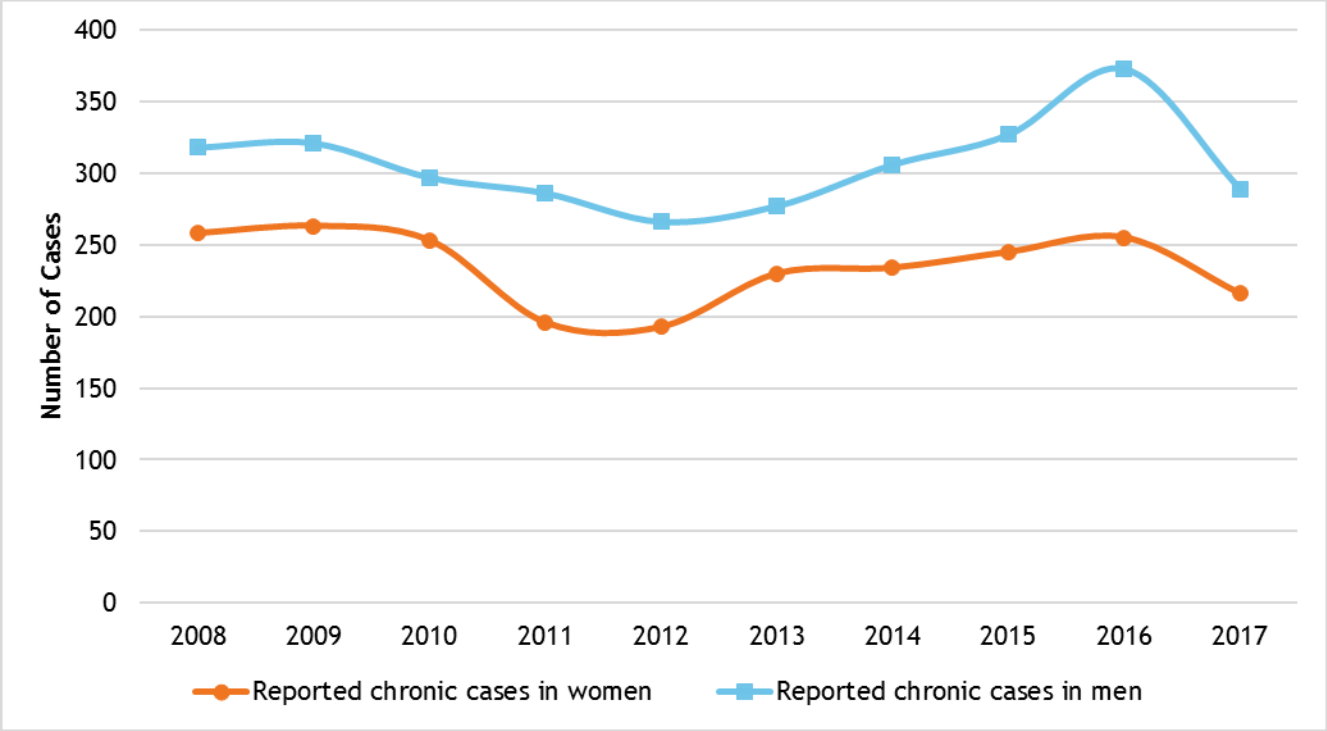
Figure 13. Reported chronic HBV cases and rate, 2008-2017



Gender

More than half of the reported chronic HBV cases were among men (57.2 percent) in 2017. Similarly, 57.1 percent of cases reported between 2013 and 2017 were among men. Figure 14 demonstrates that men are consistently reported with chronic HBV more frequently than women; however, the difference between the number of reported cases among men and women is smaller among chronic HBV cases than among acute cases.

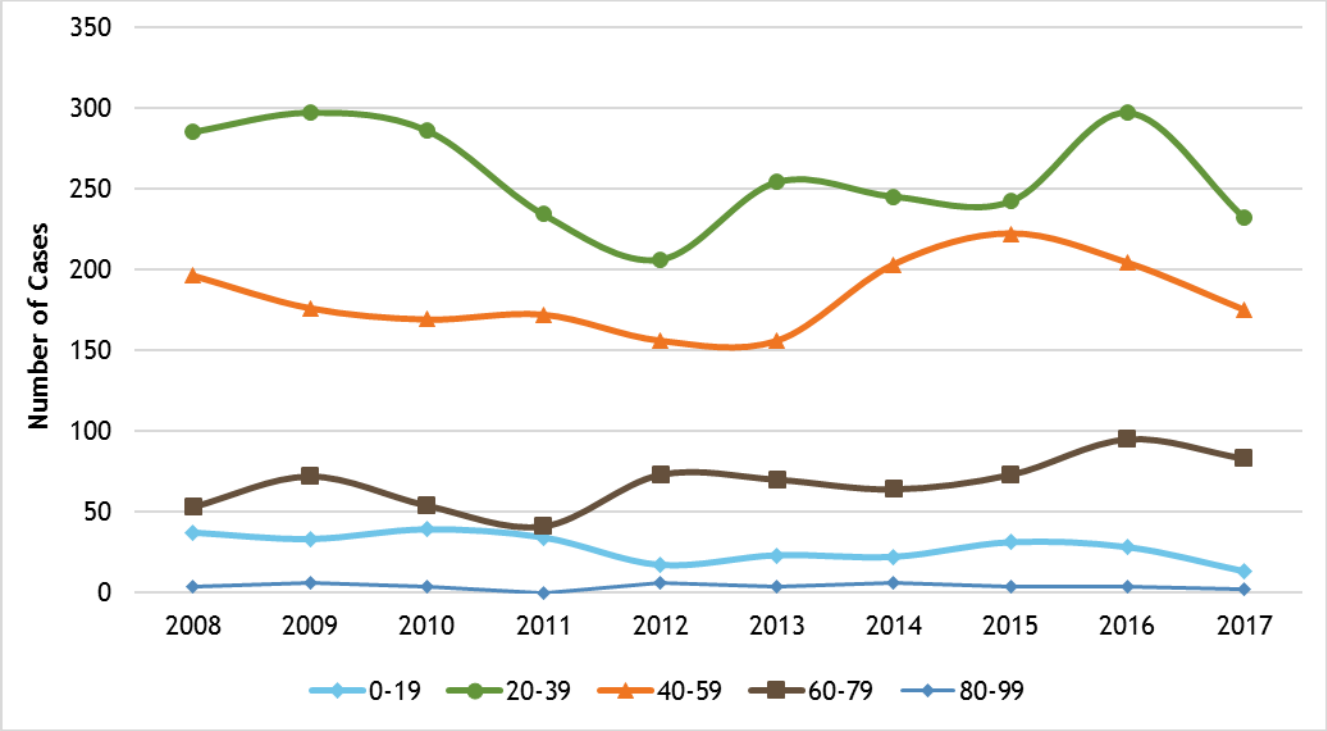
Figure 14. Reported chronic HBV cases by gender, 2008-2017



Age

In 2017, the median age of reported chronic HBV cases was 40, while the median age between 2013 and 2017 was 39. Figure 15 shows that people ages 20-39 years represented the greatest proportion of chronic cases in 2017 (45.9 percent). It is important to note that, as with all surveillance data presented in this report, the number of reported cases does not represent incidence, or new infections, in these groups. Individuals may live with chronic HBV for many years without being aware of their infection. Increases in reported chronic infections may reflect increased screening for the virus, rather than an increase in new infections.

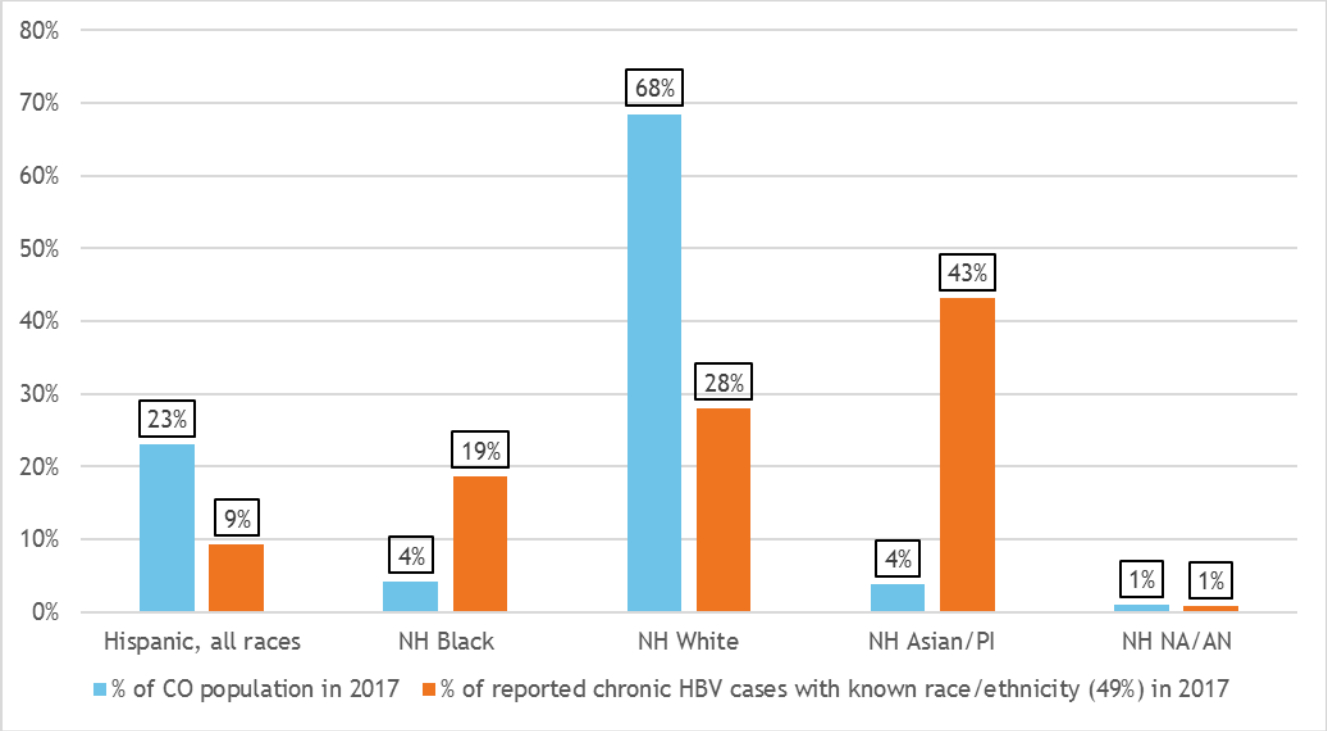
Figure 15. Reported chronic HBV cases by age group, 2008-2017



Race/ethnicity

In 2017, race/ethnicity data were available for 47.9 percent of cases. Data on race and/or ethnicity were available for 55.5 percent of chronic HBV cases reported from 2013 to 2017. Among the cases with known race and/or ethnicity in 2017, 42.6 percent were among NH Asians, while 28.5 percent were among NH whites and 18.6 percent were among NH blacks. Figure 16 illustrates the disproportionate burden of chronic HBV faced by NH Asians and, to a lesser extent, NH blacks. Nationally, the prevalence of chronic HBV is estimated to be 10-fold higher in the NH Asian population than in the general population (18). Data from Colorado's Perinatal Hepatitis B Program indicate that foreign-born pregnant people are significantly more likely to be reported with HBV than other pregnant people born in the U.S.

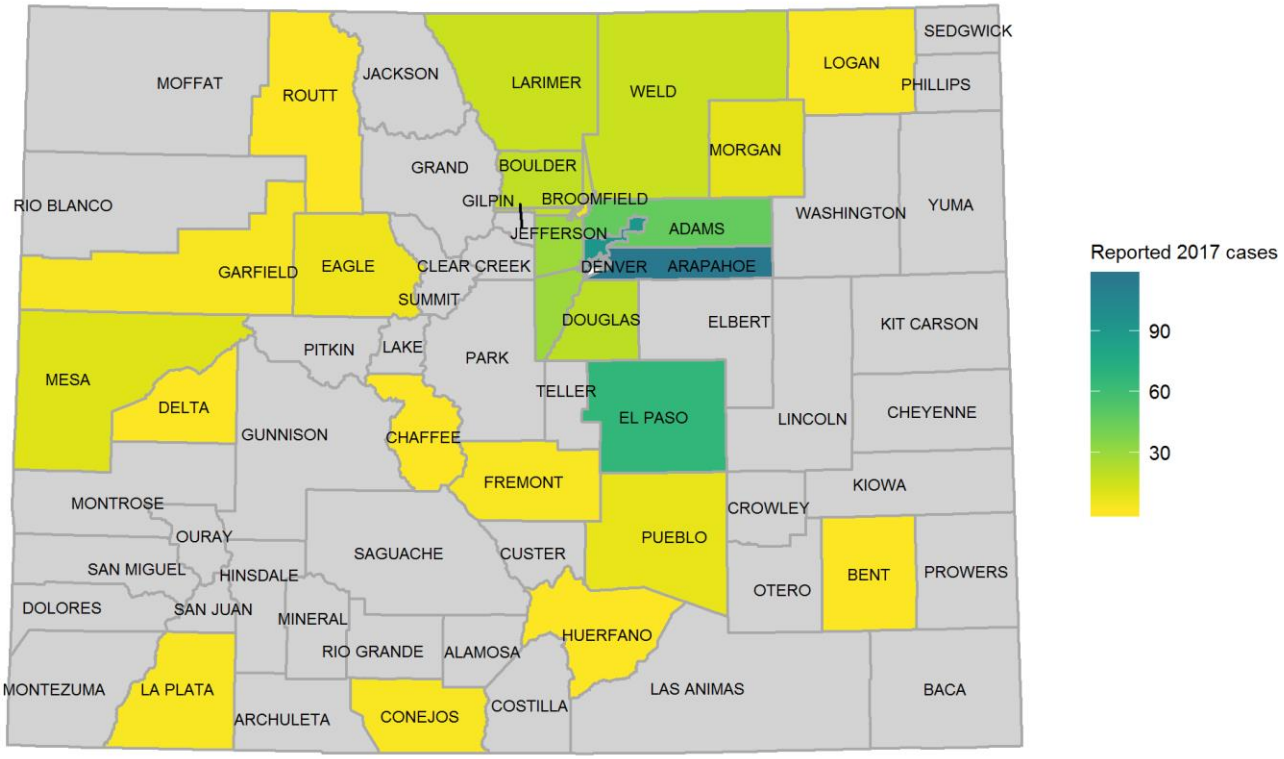
Figure 16. Proportion of total population and percentage of chronic HBV cases by race/ethnicity, out of 49% of cases with known race/ethnicity (n=246)



Geographic distribution

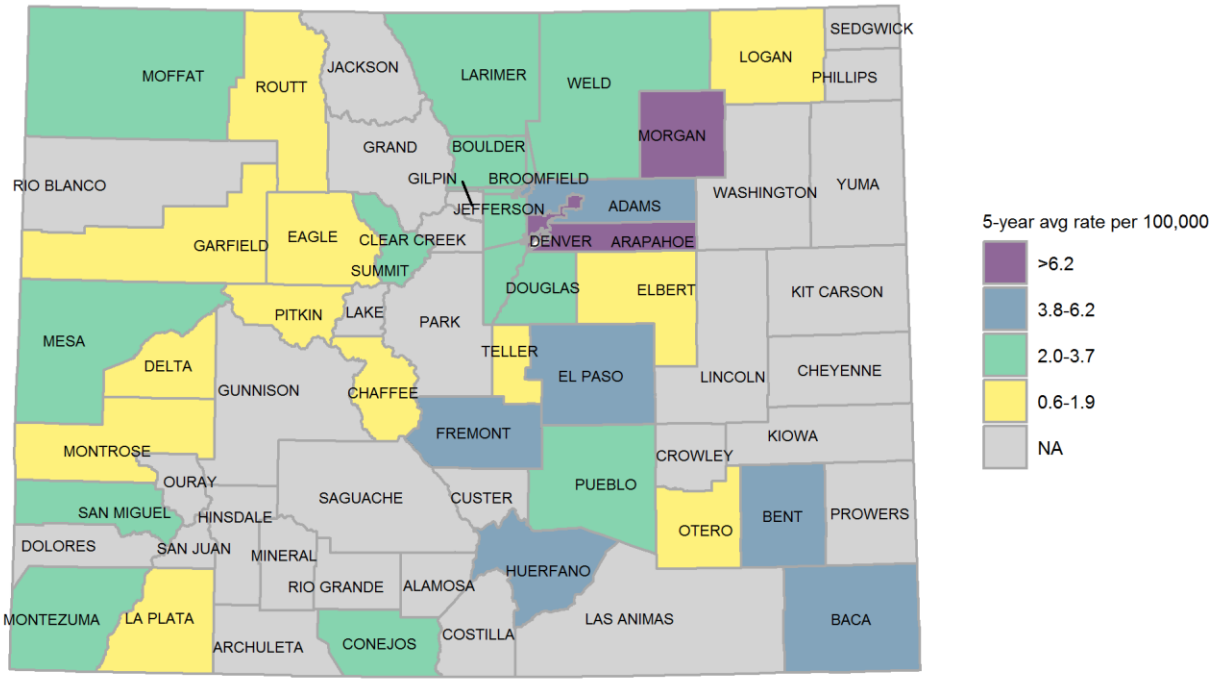
Out of the 64 counties in Colorado, 34 had at least one chronic HBV case reported in 2017. Between 2013 and 2017, 53 counties reported at least one case. In 2017, 87.5 percent (n=442) of cases were reported from urban counties, while 6.7 percent (n=34) were reported from rural counties and 2.6 percent (n=13) were reported from prisons. Figure 17 and Figure 18 show the number of chronic HBV cases by county in 2013 and the average rate per 100,000 population from 2013 to 2017, respectively. Counties with fewer than two cases reported between 2013 and 2017 were excluded from Figure 18 due to statistical instability. Quantile ranges in Figure 18 were determined using Jenks Natural Breaks.

Figure 17. Reported chronic HBV cases by county, 2017



.

Figure 18. Average rates per 100,000 population of reported chronic HBV cases by county, 2013-2017



Rates suppressed for counties with <2 cases between 2013-2017. High rates do not necessarily mean high case counts.

Risk factors

Nationally, having been born in an endemic country is the most common risk factor for chronic HBV. However, data on risk factors for chronic HBV in Colorado is not routinely collected. Data on whether or not an individual was born outside of the U.S. was only available for 12.2 percent of chronic HBV cases reported in 2017. Of these 12.2 percent, 95 percent were foreign-born.

Perinatal HBV data

There were zero perinatal HBV cases reported in Colorado in 2017. CDPHE had 157 women enrolled in the Perinatal Hepatitis B Prevention Case Management Program in the same time period. Of those 157 women, 42 had never before been enrolled in the program, and 115 had previously been enrolled in the program but had a new pregnancy in 2017.

The CDC, ACIP, and the U.S. Preventive Services Taskforce recommends that all women are screened for HBV during pregnancy. Colorado birth certificate data for 2017 show that of 64,950 total births, 63,326 pregnant people had known screening status (97.5 percent).

Colorado had an HBV birth dose vaccination rate of 82 percent in 2017, up from 80 percent in 2016. Additionally, Colorado maintained an effective vaccination coverage level of three doses of HBV vaccine among children ages 19 to 35 months old with a rate of 92.1 percent in 2017.

Hepatitis C in Colorado

- In 2017, 43 cases (0.8 per 100,000 population) of acute HCV and 2,812 cases (50.1 per 100,000 population) of chronic viremic (confirmed) HCV were reported to CDPHE.
- In 2017, 67.4 percent (n=29) of acute HCV cases and 67.5 percent (n=1,897) of chronic viremic HCV cases were among men.
- In 2017, 88.4 percent (n=38) of reported acute HCV cases were between ages 20 and 39.
- Average five-year rates per 100,000 population of reported acute HCV were highest in Moffat, Rio Grande, Pueblo, Otero, and Alamosa counties, though case counts were low, and rates should be interpreted with caution.
- IDU is the primary cause of new acute HCV cases. In 2017, 81.3 percent (n = 35) percent of cases reported IDU as a risk factor.
- The number of reported viremic cases among 20-39 year olds (n=1,080, 66.2 per 100,000 population) exceeded the number of reported cases among (n=1,074, 73.67 per 100,000 population) for the first time in 2017, indicating both a high level of diagnosis in these age groups and a likely increase in new infections among younger populations.
- At least one case of chronic HCV was reported in 58 of the 64 Colorado counties in 2017.

HCV background

HCV is one of the most commonly reported infectious diseases worldwide and is the single most common bloodborne pathogen in the U.S. (19). HCV can occur as an acute or chronic infection and can range in severity from a mild illness that clears due to an individual's own antibody response to a serious, lifelong illness that can result in death. The virus can replicate in the liver for years causing damage, often without symptoms.

HCV is transmitted through contact with infected blood, such as contact with used injectable drug equipment, blood monitoring devices, razors, tattoo equipment, or other sharps that can contain blood. Currently, PWID are at highest risk of acquiring HCV (20).

While sexual transmission of HCV is possible, recent articles have found that previous evidence for increased risk of HCV acquisition in HIV-negative individuals with a higher number of sex partners did not adjust for confounding

factors, such as IDU (21). However, the risk of sexual transmission of HCV warrants more research in people not living with HIV.

HCV can also be spread through perinatal transmission. For pregnant people who do not have a detectable viral load, 3 to 10 percent of infants will acquire HCV perinatally (22). However, one analysis found that perinatal transmission occurred at a rate of 7.1 percent when the parent giving birth with a high viral load (22). A meta-analysis of HIV-HCV coinfection found that coinfection increased the odds of perinatal transmission by 90 percent (23). In pregnant people living with HIV and HCV with high viral loads of HCV, the odds of transmission were 2.82-fold greater than the odds for people who did not have HCV RNA during pregnancy (23).

HCV is preventable and curable. Several DAA treatments are now available for chronic HCV that can cure the infection, with sustained virologic response (SVR) in more than 95 percent of patients, with few associated side effects (24). However, barriers to prevention, testing, and treatment of HCV persist.

Acute HCV background

Acute HCV is the first stage of infection and may cause symptoms within an average of 14 (two to 26) weeks after exposure to the virus. Approximately 70 to 80 percent of people with acute HCV will not exhibit symptoms, and most remain unaware of the infection (2). Abnormal liver function tests are one of the most characteristic features of HCV infection. CDPHE uses case definitions published by the NNDSS to define an acute case of HCV.

The acute HCV case definition was updated in 2016. This case definition can be found at https://wwwn.cdc.gov/nndss/conditions/hepatitis-c-acute/case-definition/2016/. There are differences in both the clinical criteria and the laboratory criteria components of the acute HCV case definitions before and after January 1, 2016. Under the previous case definition, which was established in 2012, the clinical criteria could be established with elevated serum alanine aminotransferase (ALT) levels greater than 400 IU/L. In 2016, this requirement was lowered to ALT levels greater than 200 IU/L. The laboratory criteria prior to 2016 included the requirement that antibody tests for HCV also included a signal-to-cutoff ratio indicative of a true positive, according to CDC criteria for each test. In 2016, the signal-to-cutoff ratio requirement was eliminated from the case definition. In addition, the time to seroconversion (a documented negative HCV result followed by a positive result) was lowered from 12 months to 6 months.

Chronic HCV background

The screening test for probable HCV infection is an antibody test that, if positive, indicates a past or present exposure to HCV. An estimated 15 to 25 percent of people exposed to the virus will clear it spontaneously, while the remainder will develop chronic infection (2). HCV is often asymptomatic until later stages of disease and can result in liver fibrosis, cirrhosis, cancer and/or death. Of people who live with unresolved chronic HCV, 10 to 20 percent will develop cirrhosis over a period of 20 to 30 years (2).

The case definition for chronic HCV was updated in 2016 (**https://wwwn.cdc.gov/nndss/conditions/hepatitis-c-chronic/case-definition/2016/**). In order to make meaningful comparisons of chronic HCV data across years before and after the case definition change, chronic HCV cases were evaluated based on whether or not they had a reported Nucleic Acid Test (NAT) at any time indicating the presence of HCV RNA in the blood. Only viremic (RNA positive) cases are presented in tables and figures unless otherwise noted. Under the 2016 case definition, for a probable chronic HCV event, antibody tests for HCV no longer require a signal-to-cutoff ratio predictive of a true positive. Before and after 2016, an event is considered confirmed if HCV RNA is identified via molecular testing.

CDPHE collaborated with the Center for Disease Analysis Foundation (CDAF), a Colorado-based non-profit organization specializing in HCV disease modeling, to adapt the CDAF model to Colorado-specific parameters and estimate the prevalence of HCV in the state. The report can be found at https://www.colorado.gov/pacific/cdphe/hepatitis-data. Primary outcomes from the model include HCV prevalence and incidence projections for 2015 through 2025 (25). In 2017, there were an estimated 45,898 HCV RNA-positive individuals in Colorado, with a projected decline in prevalence to 36,744 (95 percent CI: 17,752 – 47,836) by 2025 (25). The decline in overall prevalence is driven by increased diagnoses and curative treatment rates, primarily among Baby Boomers. However, the prevalence in 15-44 year olds is projected to increase from 2020 through 2025. Additionally, HCV incidence is projected to continue increasing through 2025 due to large increases in the 15-44 year old age group, indicating a shift in the demographics of HCV in Colorado. As more of the aging prevalent population receives treatment, people under the age of 45 (and more specifically, PWID) will make up an increasing proportion of the epidemic, unless significant harm reduction efforts to prevent transmission of HCV are implemented and expanded.

Nationally, although the prevalence of HCV is falling due to increases in screening and curative treatment (26,27), the incidence, or number of new cases per year, is increasing. According to the CDC, the rise in acute cases in recent years is associated with rising rates of IDU (10).

Acute HCV data

There were 43 acute HCV cases (0.8 per 100,000 population) reported in 2017. Figure 19 reveals an upward trend in reported acute HCV cases from 2016 to 2017. However, the impact of the case definition change in 2016 is shown in Figure 20.

In 2016, an NNDSS case definition of probable acute HCV was added. In 2016 and 2017, there were six and five newly reported probable acute HCV cases. Including both probable and confirmed acute HCV cases in 2017, there were 49 cases (0.9 per 100,000 population) in Colorado. CDPHE conducted an analysis based on the change in case definition in 2016 and found that there would have been a 30.3 percent decrease in reported cases in 2017, from 43 to 33, if the case definition had not been changed. Similar results were found in Michigan (28). If the 2012 criteria had remained in place, there would have been an estimated 30 (0.5 per 100,000 population)

reported acute HCV cases in 2016 and 33 (0.6 per 100,000 population) in 2017 in Colorado. The 2016 case definition became less restrictive, resulting in the reporting of additional acute HCV cases. The purpose of this adjustment is to accurately compare data from recent years using a consistent definition. If the case definition had been changed earlier, it is likely that more acute HCV cases would have been reported in years prior to 2016.

However, when considering only the updated case definition and the number of confirmed reported acute cases in 2016 (n=34) and 2017 (n=43), there was a 26.5 percent increase in reported acute cases in 2017. Additionally, the number of reported cases is likely a vast underestimate. CDC estimates that for each reported case, there are 13.9 additional cases on average nationally (29). However, a modeling study conducted in Colorado estimated that the true incidence of acute HCV cases, including cases that spontaneously resolve, was 1,698 in 2017 (25).

Many factors may contribute to under-ascertainment of acute HCV cases. Only 20 to 30 percent of those newly infected with HCV experience symptoms of acute illness (2). Many new cases of HCV may be among PWID, who often face many barriers to accessing care, such as stigma and poverty (30). Lack of face-to-face follow up with reported acute cases due to lack of funding could be a potential barrier to the identification of additional cases through contact follow up.

Table 5. Acute HCV demographics

	2017 cases	Percent	2013-2017 cases	Percent	2013-2017 avg. rate per 100,000 pop.
Total	43	---	172	---	0.6
Gender					
Men	29	67.4	97	56.4	0.7
Women	14	32.6	75	43.6	0.6
Race/Ethnicity					
Hispanic (all races)	7	16.3	35	20.3	0.6*
NH Black	1	2.3	1	0.6	0.1*
NH White	34	79.1	116	67.4	0.6
NH Asian/PI	0	0.0	0	0.0	0.0*
NH NA/AN	0	0.0	3	1.7	1.1*
Unknown	1	2.3	17	9.9	----
Age Group					
0-19	0	0.0	7	4.1	0.1*
20-39	38	88.4	133	77.3	1.7

40-59	4	9.3	30	17.4	0.4
60-79	1	2.3	2	1.2	0.0*
80-99	0	0.0	0	0.0	0.0*
Unknown	0	0.0	0	0.0	---
*Rates may be unstable due to small case counts and should be interpreted with caution.					

Figure 19. Reported acute HCV cases and rate per 100,000 population, 2008-2017

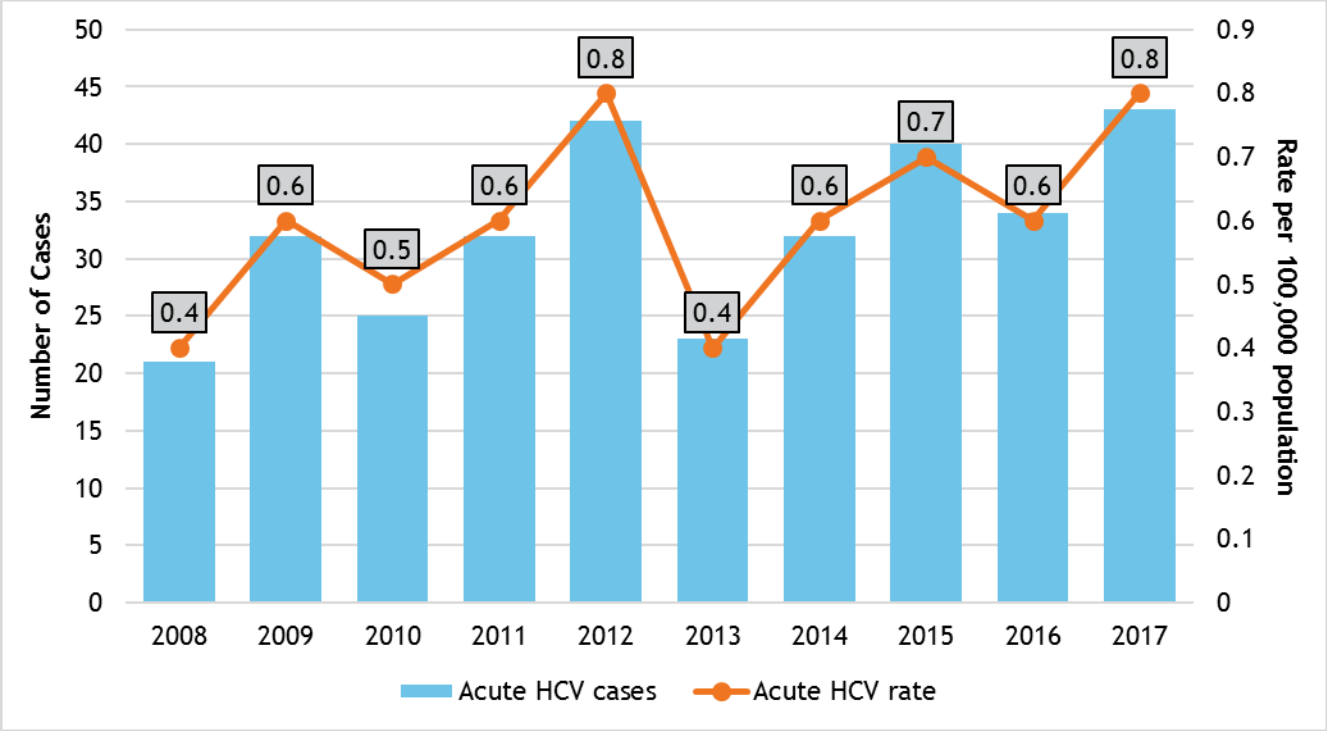
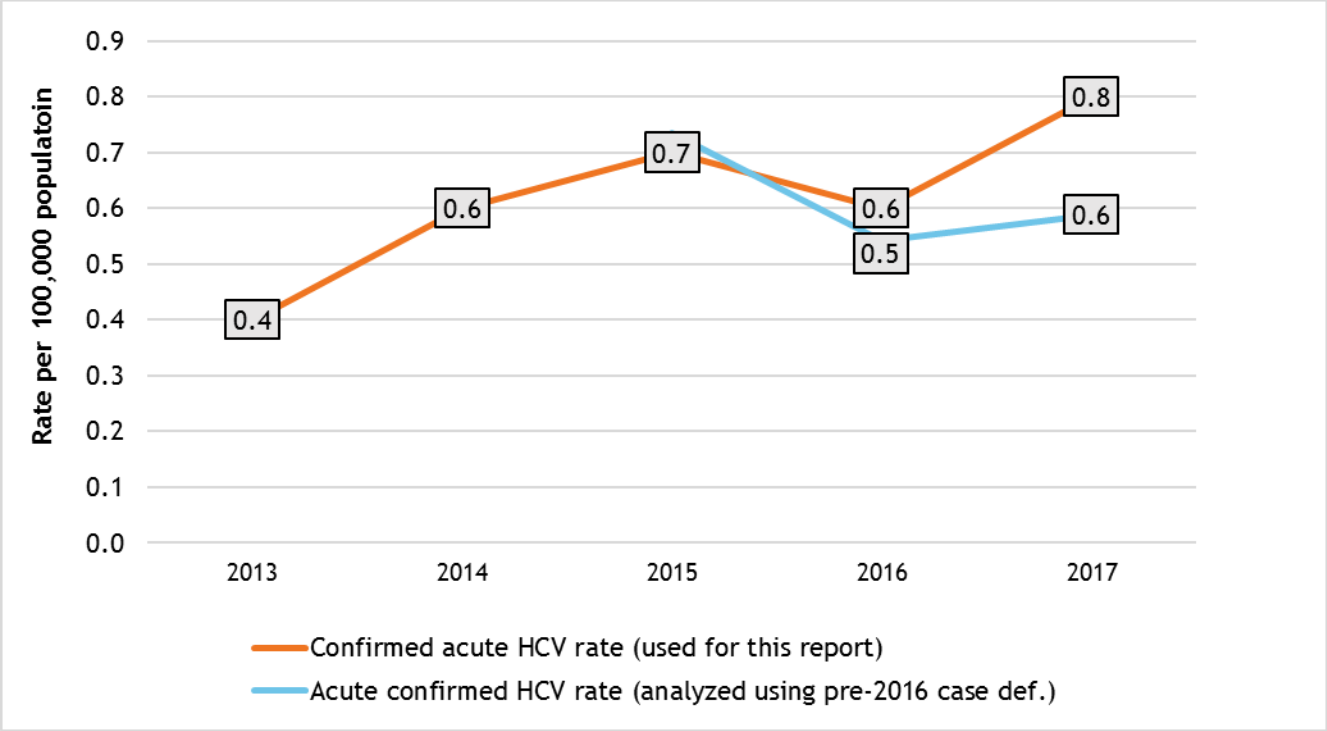


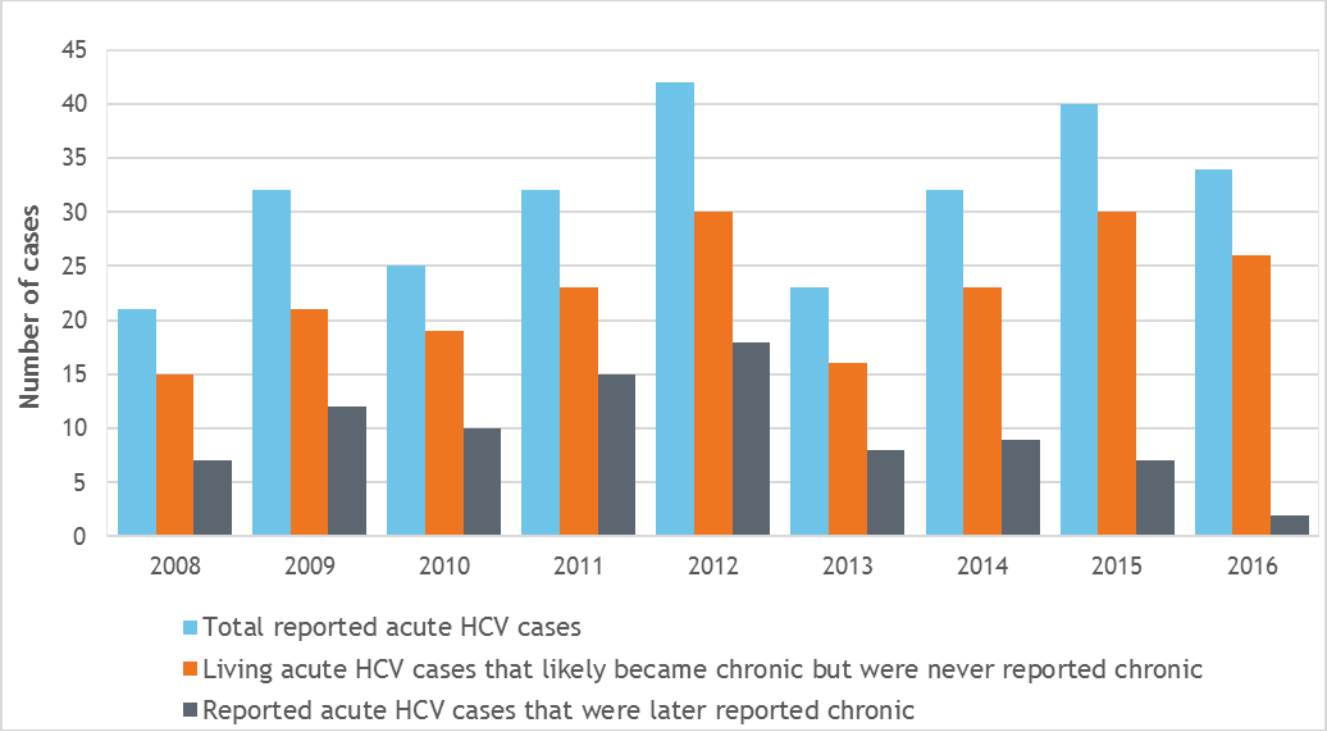
Figure 20. The effect of the 2016 case definition change on confirmed acute HCV rates per 100,000



Rates may be unstable due to small case counts and should be interpreted with caution.

It is estimated that approximately 75-85 percent of acute cases go on to become chronic (2). Among reported acute cases in Colorado, relatively few go on to be reported as chronic cases. In 2015, 40 acute cases were reported to CDPHE. Assuming 25 percent of these cases spontaneously cleared the virus, 30 of these cases likely went on to become chronic. However, only 8 individuals also had a later diagnosis of chronic viremic HCV in CEDRS between their acute diagnosis and 2016, leaving 26 cases that likely became chronic but have not yet been reported to CDPHE. The number of acute cases likely to become chronic in 2016 (depicted in orange in Figure 21) is larger due to the lag in additional testing and reporting due to the possibility of spontaneous clearance of the virus. For this reason, 2017 was not included in this analysis. The disparity between acute cases that likely became chronic and were reported as such is expected to be smaller among older cases, who have had more time to be tested for chronic HCV. Figure 21 highlights the relatively high number of acute cases that are still living, according to a match with vital records data on deaths,. These cases are likely to have progressed to chronic HCV but have not been reported as such in CEDRS.

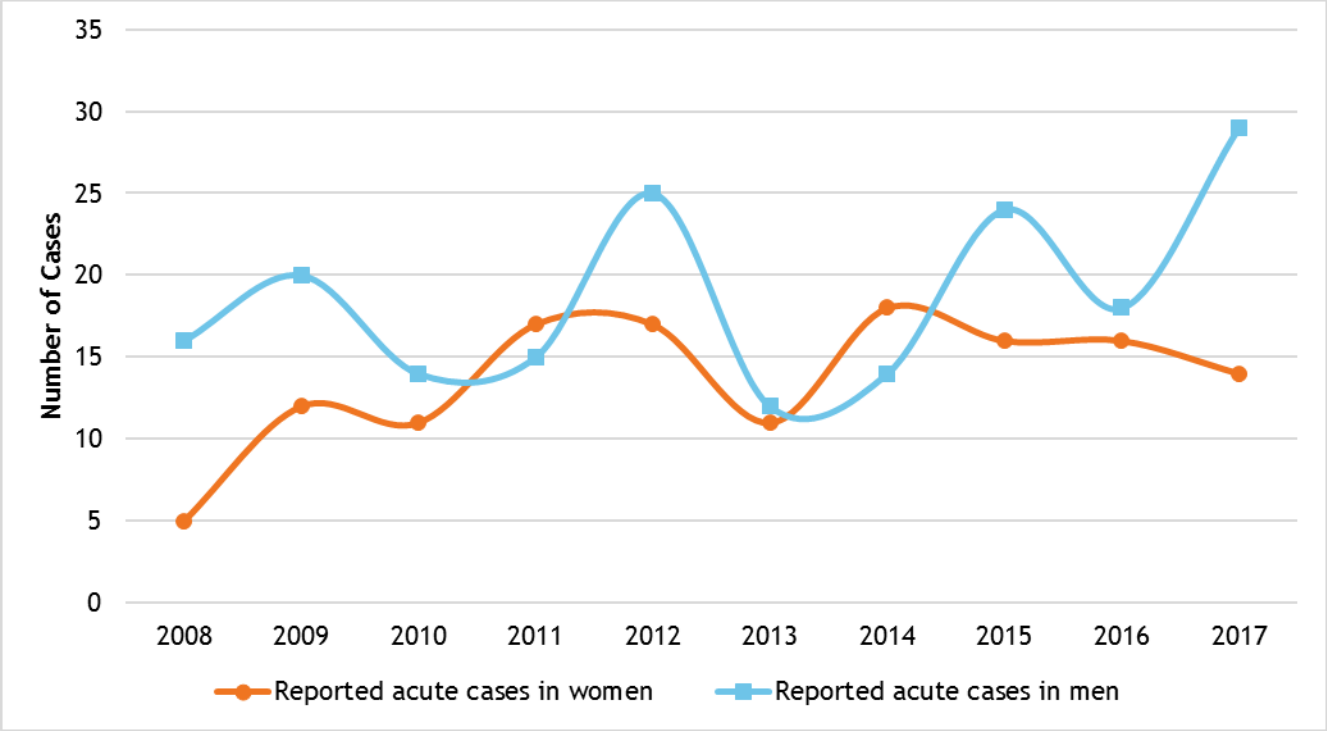
Figure 21. Under-ascertainment of chronic HCV cases among reported acute HCV cases, 2008-2017



Gender

In 2017, 67.4 percent (n=29) of acute HCV cases were among men, while 34.6 percent (n=14) of cases were among women (Figure 22**Error! Reference source not found.**). Since 2013, 56.4 (n=97) of cases have been among men.

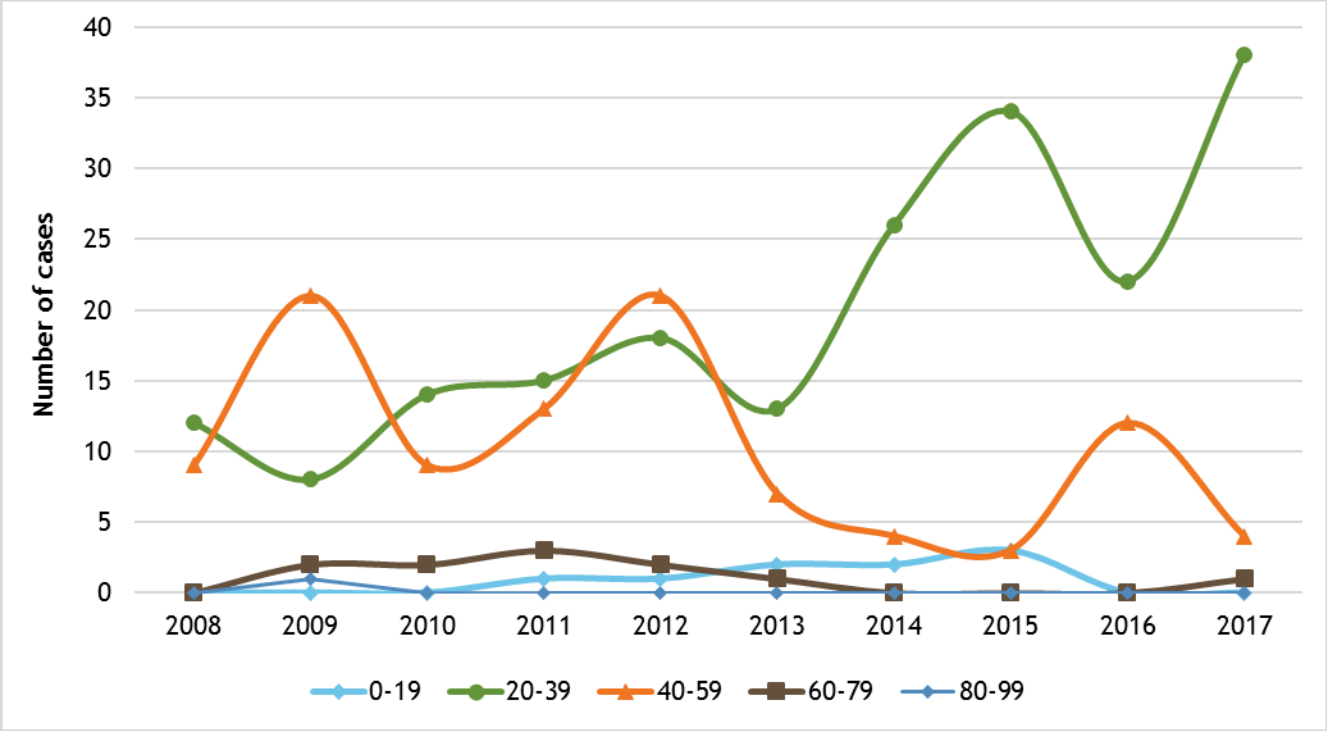
Figure 22. Reported acute HCV cases by gender, 2008-2017



Age

In 2017, the median age of reported acute HCV cases was 28, while the median age between 2013 and 2017 was 28.5. Figure 23 illustrates that people between the ages of 20 and 39 years had the highest number of reported acute HCV cases in Colorado each year from 2013 to 2017. This age group accounted for 88.4 percent (n=38) of cases in 2017. The rate per 100,000 population of reported acute HCV cases among 20 to 39 year olds was 2.3 in 2017.

Figure 23. Reported acute HCV cases by age group, 2008-2017

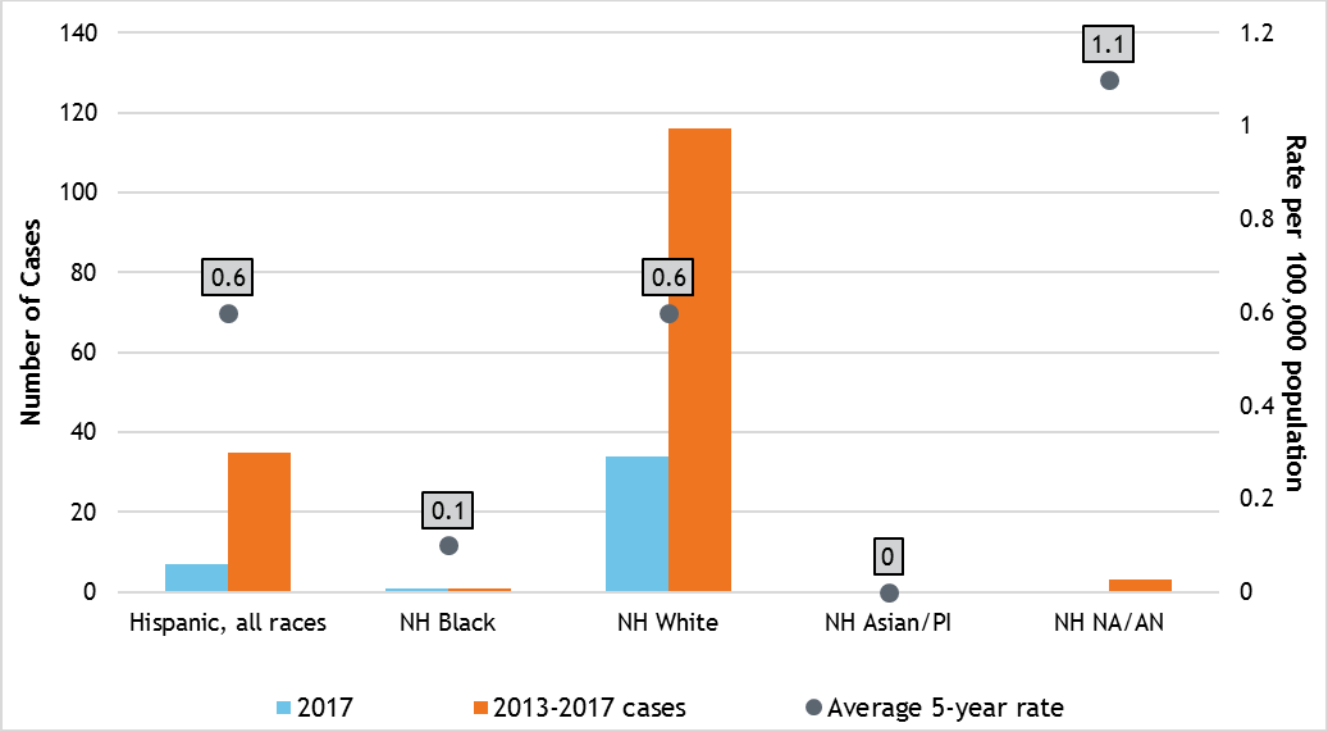


Race/ethnicity

Data on race and ethnicity, shown in Figure 24, were available for 97.7 percent of acute cases in 2017. For 2013 to 2017 combined, race/ethnicity data were available for 90.1 percent of cases. Among the reported cases where race/ethnicity data were available in 2017, NH whites had the highest number of acute cases (n=34, 0.9 per 100,000 population), followed by Hispanics (all races) with seven reported cases.

Nationally, rates of acute HCV have been consistently higher for NH NA/AN compared to all other racial/ethnic groups (26), but there were only a total of three cases reported in this group from 2013 to 2017 in Colorado. There was one case of acute HCV reported among NH blacks between 2013 and 2017 and zero cases among NH Asians during this time.

Figure 24. Acute HCV cases and average 5-year rate per 100,000 by race/ethnicity, 2013-2017



Rates may be unstable due to small case counts and should be interpreted with caution.

Geographic distribution

Acute HCV was reported in 15 of the 64 Colorado counties in 2017. Five counties (Denver, Arapahoe, Adams, Jefferson, and Douglas) accounted for 65.1 (n=28) percent of reported acute HCV cases, and all urban counties accounted for 83.7 percent (n=36) of cases. Rural counties accounted for 11.6 percent (n=5) of reported cases, and 4.7 percent (n=2) of cases were reported from prisons. However, average five-year rates per 100,000 population were highest in Moffat, Rio Grande, Alamosa, and Otero counties, though case counts in these counties were low, and the rates should be interpreted with caution. Figure 25 shows the number of reported cases by county in 2017, while Figure 26 shows the average five-year rates per 100,000 population of acute cases by county. Counties with fewer than two cases between 2013 and 2017 were excluded from **Error! Reference source not found.** due to statistical instability. Quantile ranges in Figure 26 were determined using Jenks Natural Breaks. Table 6 shows case counts by county from 2013 to 2017 where there was at least one case reported in 2017.

Figure 25. Reported acute HCV cases by county, 2017

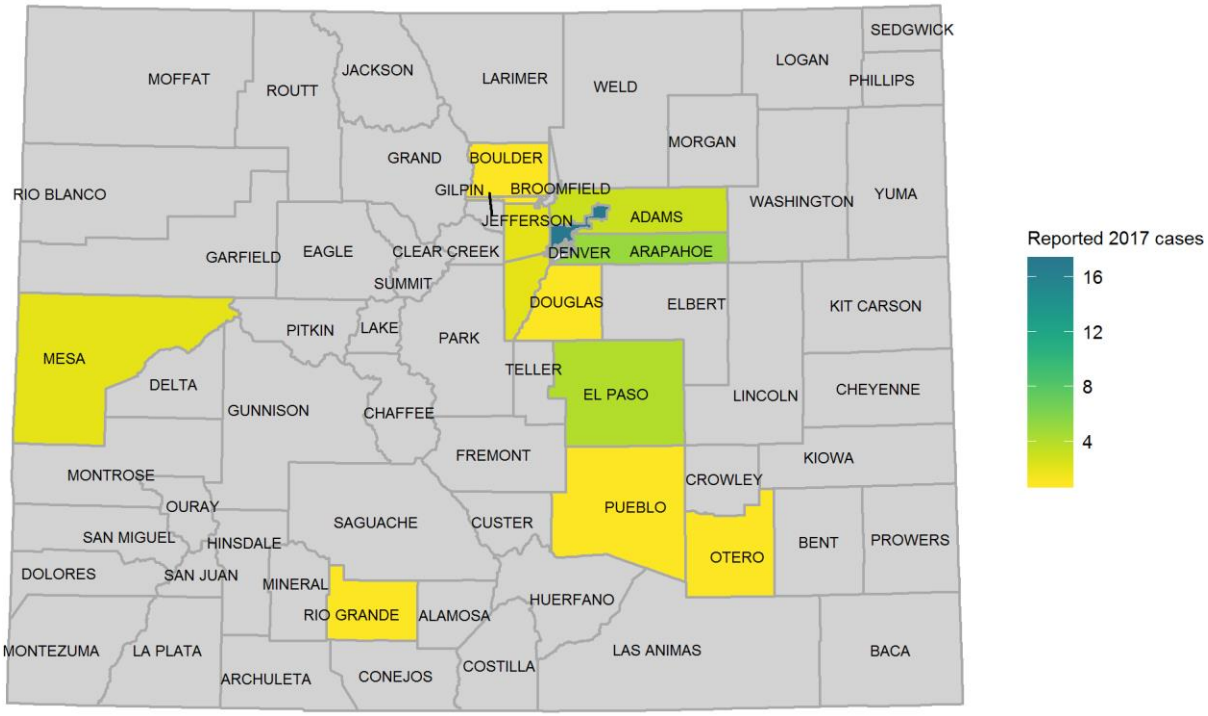
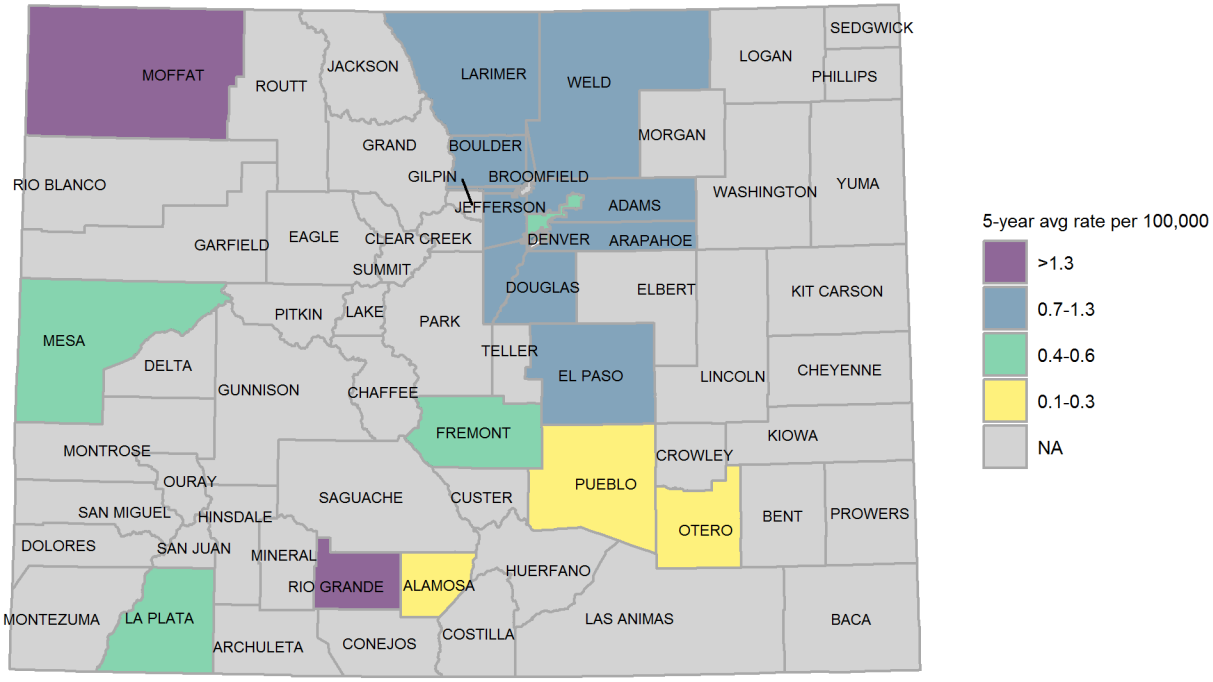


Figure 26. Average rates per 100,000 population of reported acute HCV cases by county, 2013-2017



Rates suppressed for counties with <2 cases between 2013-2017. High rates do not necessarily mean high case counts.

Table 6. Acute HCV case counts by county where at least one case was reported in 2017

County	2013	2014	2015	2016	2017	Sum of cases 2013-2017
Adams	1	1	1	2	3	8
Arapahoe	1	4	4	1	5	15
Baca	0	0	0	0	1	1
Boulder	1	2	3	0	1	7
Broomfield	0	0	0	0	1	1
Denver	4	4	5	8	17	38
Douglas	0	1	1	1	1	4
Eagle	0	0	0	0	1	1
El Paso	4	2	5	2	4	17
Grand	0	0	0	0	1	1
Jefferson	2	3	3	1	2	11
Mesa	1	2	1	0	2	6

Otero	0	1	0	0	1	2
Rio Grande	0	1	0	0	1	2

Behavioral risk factors

From 2013 to 2017, 53.5 (n = 92) percent of cases reported IDU as their only risk factor, while 4.7 percent (n = 8) reported receiving a tattoo outside of a commercial shop or parlor as their sole risk factor. One case reported only MSM risk. This breakdown is shown in Figure 27.

In 2017, 74.4 percent (n = 32) of acute HCV cases reported IDU as their only risk factor. An acute HCV case can have more than one risk factor, but Figure 28 shows the number of cases that reported IDU as a risk factor, possibly in combination with other risk factors. From 2013 to 2017, 61.6 percent (n= 106) reported having injected drugs in the last six months.

Figure 27. Reported acute HCV risk factors, 2013-2017

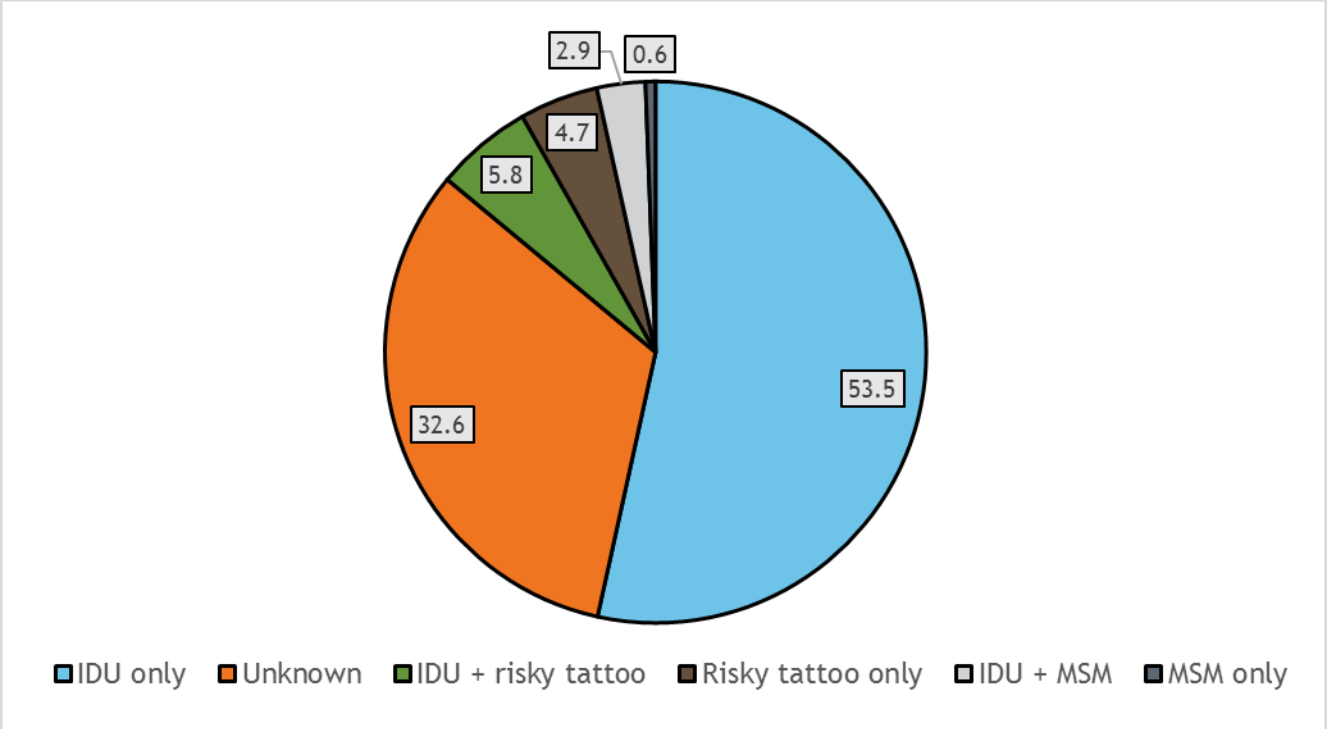
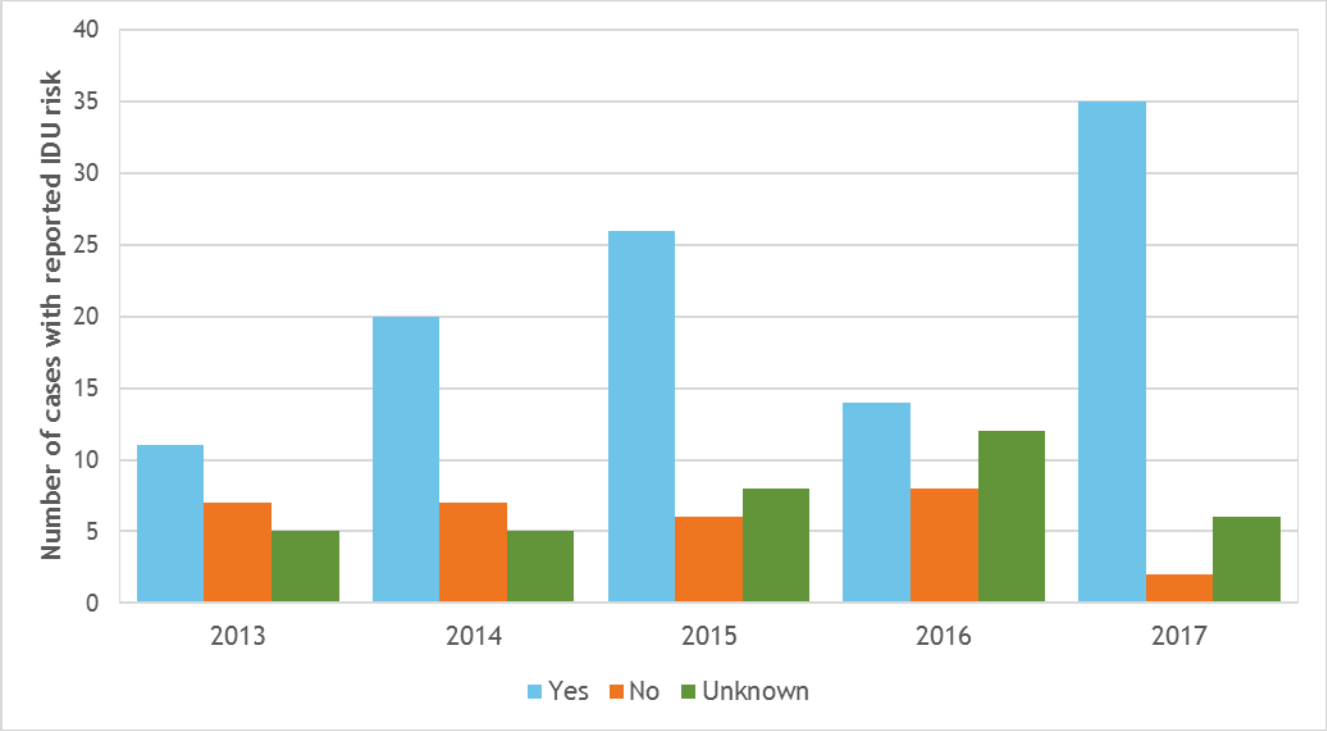


Figure 28. Reported acute HCV cases with IDU risk, 2013-2017



Chronic HCV data

In 2017, there were 2,812 (50.1 per 100,000 population) reported chronic viremic (confirmed) HCV cases in Colorado (Figure 29). CDPHE received an additional 2,715 reports of probable chronic HCV. Like acute HCV, the case definition of chronic HCV was updated in 2016. This case definition can be found at https://wwwn.cdc.gov/nndss/conditions/hepatitis-c-chronic/case-definition/2016/. The major difference in the laboratory criteria component of the chronic HCV case definition before and after January 1, 2016 is the elimination of the signal-to-cutoff ratio indicative of a true positive for HCV antibody tests.

Under the previous case definition, which was established in 2012, a chronic HCV case could be confirmed if an antibody test was accompanied by a signal-to-cutoff ratio specific to each test indicative of a true positive, or if ALT levels were above normal. Under the 2016 case definition, a case is classified as a probable chronic HCV case if it does not meet clinical criteria indicative of acute infection, does not have a test conversion within the last 12 months or has no report of test conversion, and has a positive HCV-antibody test, but no report of a positive HCV antigen or NAT test (31). No signal-to-cutoff ratio is required per the 2016 definition. In order to confirm a case, it must meet also meet these conditions but have a positive NAT or HCV antigen test (31). The impact of this case definition is shown in Figure 30.

In past reports, CDPHE has included a sum of probable and confirmed cases. If comparing present case counts to counts prior to 2016, this would result in a substantial increase in 2016 and 2017, due mostly to the change in case definition and the spike in probable cases, which include past and present infection (shown in Figure 30). To

mitigate this, all figures that include chronic HCV data depict only cases that at some point had a positive NAT or HCV antigen test indicative of the presence of HCV RNA (viremia). The RNA lab results were not necessarily added to CEDRS during the same year that the case was first reported to CDC, but the case is still reported according to the year it was first reported to CDPHE.

Table 7. Chronic viremic HCV demographics					
	2017 cases	Percent	2013-2017 cases	Percent	2013-2017 avg. rate per 100,000 pop.**
Total	2,812	---	13,217	---	48.5
Gender					
Men	1,897	67.5	8,823	66.8	65.0
Women	915	32.6	4,394	33.2	32.3
Race/Ethnicity					
Hispanic (all races)	130	4.6	685	5.2	---
NH Black	25	0.9	292	2.2	---
NH White	454	16.1	2,842	21.5	---
NH Asian/PI	7	0.2	60	0.5	---
NH NA/AN	9	0.3	65	0.5	---
Unknown	2,187	77.8	9,273	70.2	---
Age Group					
0-19	7	0.2	116	0.9	1.7
20-39	1,080	38.4	4,252	32.2	54.4
40-59	1,074	38.2	6,094	46.1	83.9
60-79	632	22.5	2,669	20.2	62.1
80-99	17	0.6	68	0.5	8.3
Unknown	2	0.1	18	0.1	---

*Rates may be unstable due to small case counts and should be interpreted with caution.
**Rates not calculated for race/ethnicity due to high proportion of missing data.

Figure 29. Reported chronic viremic cases and rate, 2008-2017

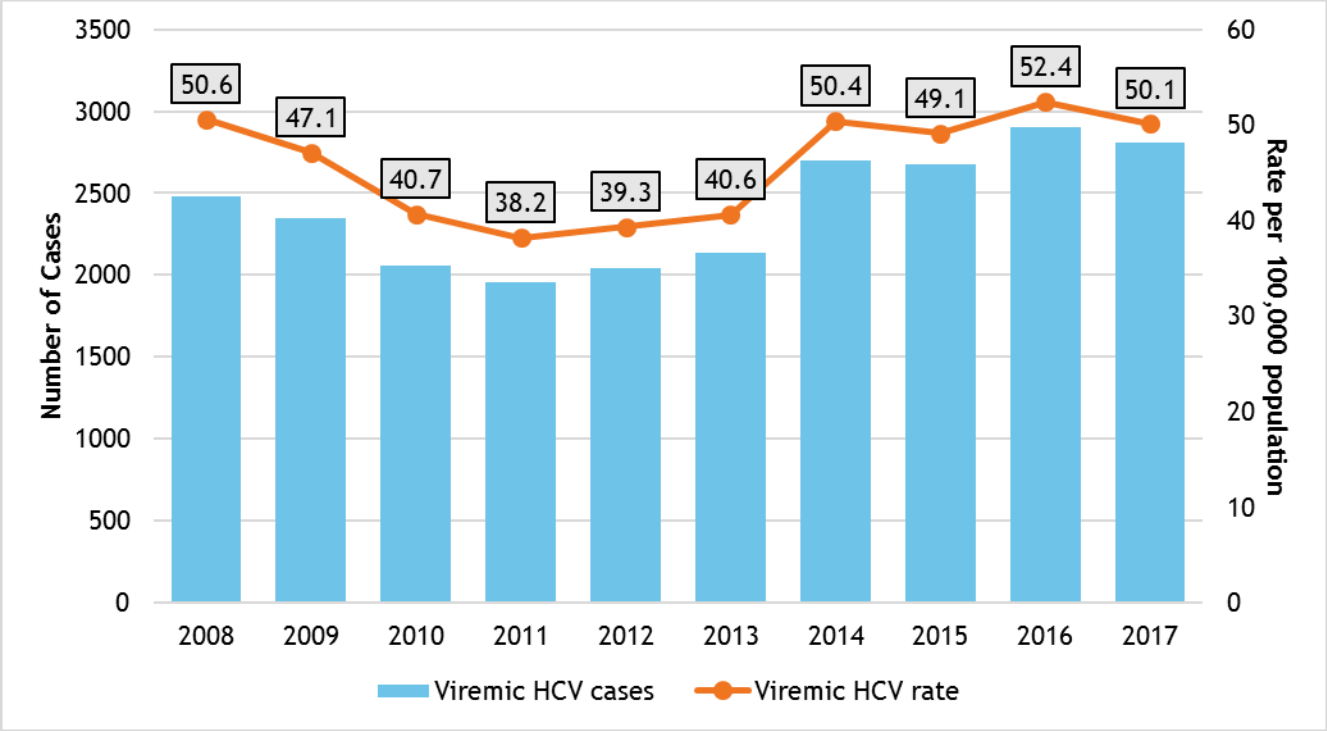
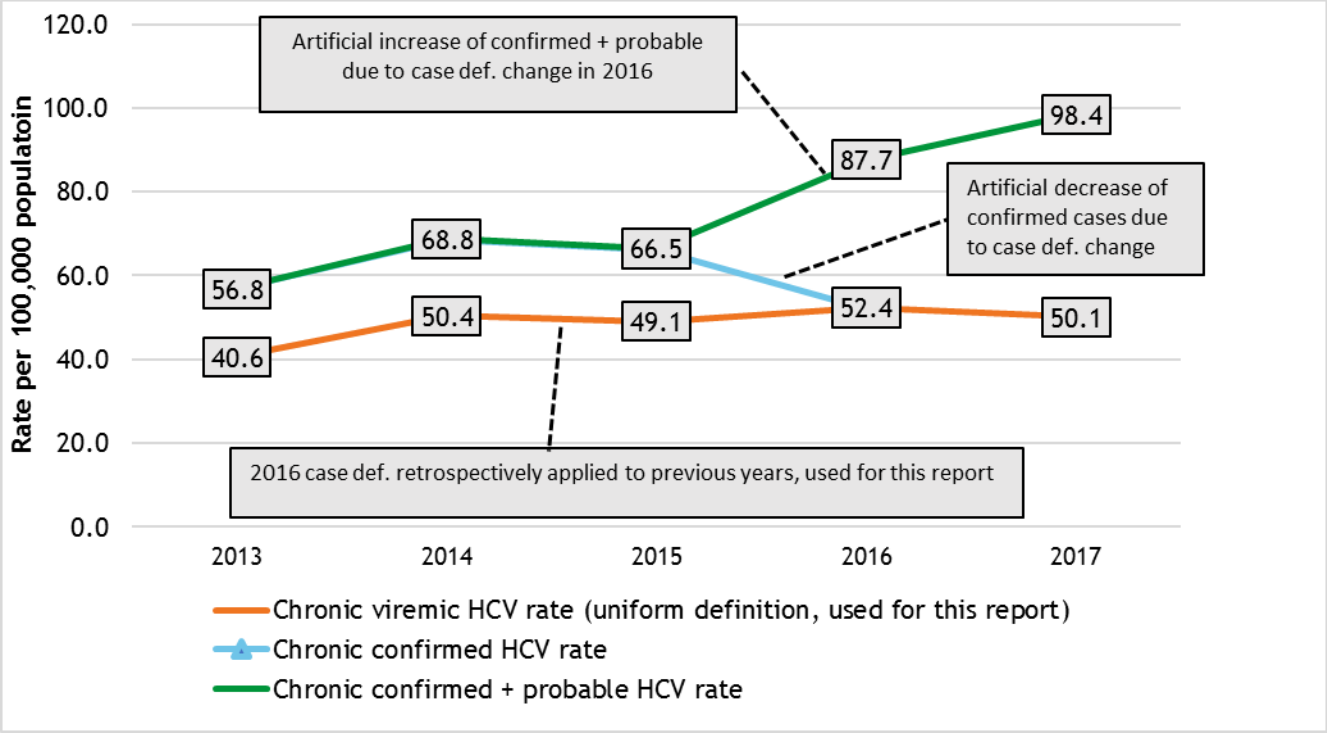


Figure 30. The effect of the 2016 case definition change on confirmed and probable HCV rates compared to chronic viremic HCV rates

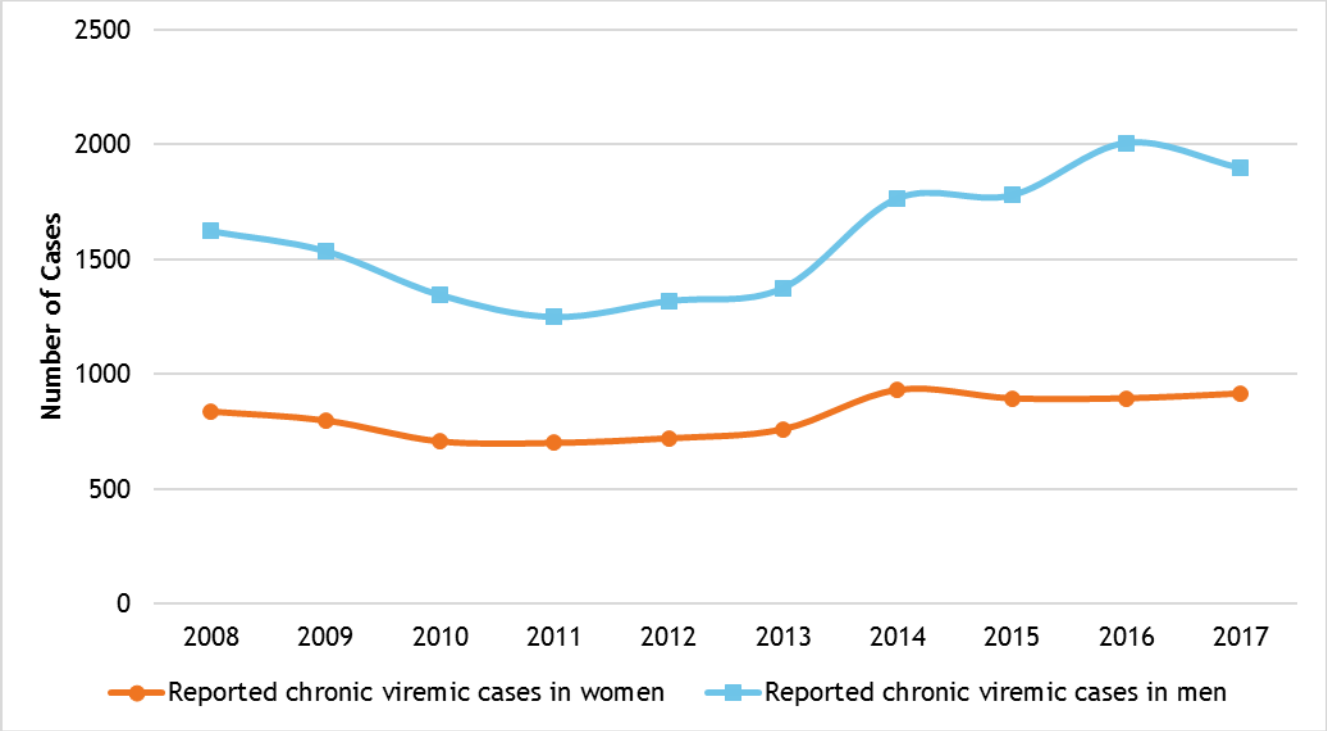


The largest increase in chronic viremic HCV reported rates was between 2013 (40.6 per 100,000 population) and 2014 (50.4 per 100,000 population). In 2014, Medicare began covering screening costs, and a Colorado law was enacted that recommended providers test Baby Boomers (32). Additionally, the FDA approved a daily pill to treat HCV with cure rates over 90 percent.

Gender

The majority of the reported chronic viremic HCV cases in 2017 and historically were reported in men. In 2017, 67.5 percent (n=1,897) of cases were among men. Figure 31 illustrates that men are consistently reported with viremic HCV more frequently than women.

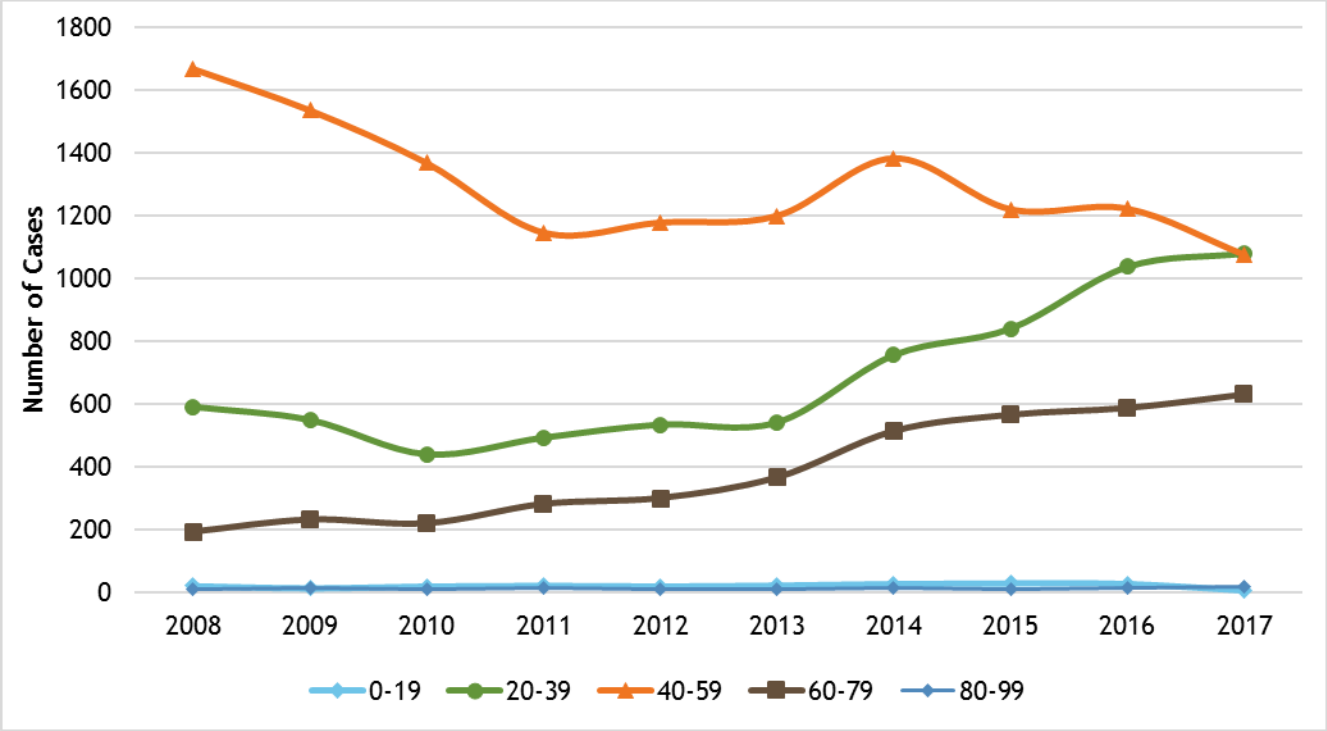
Figure 31. Reported chronic viremic HCV cases by gender, 2008-2017



Age

In 2017, the median age of reported chronic viremic HCV cases was 47, while the median age between 2013 and 2017 was 50. Figure 32 and Figure 33 illustrate the changing nature of the HCV epidemic by age group. The number of reported viremic cases among 20-39 year olds (n=1,080, 66.2 per 100,000 population) was greater than the number of reported cases among 40-59 year olds (n=1,074, 73.67 per 100,000 population) in 2017.

Figure 32. Reported chronic viremic HCV cases by age group, 2008-2017

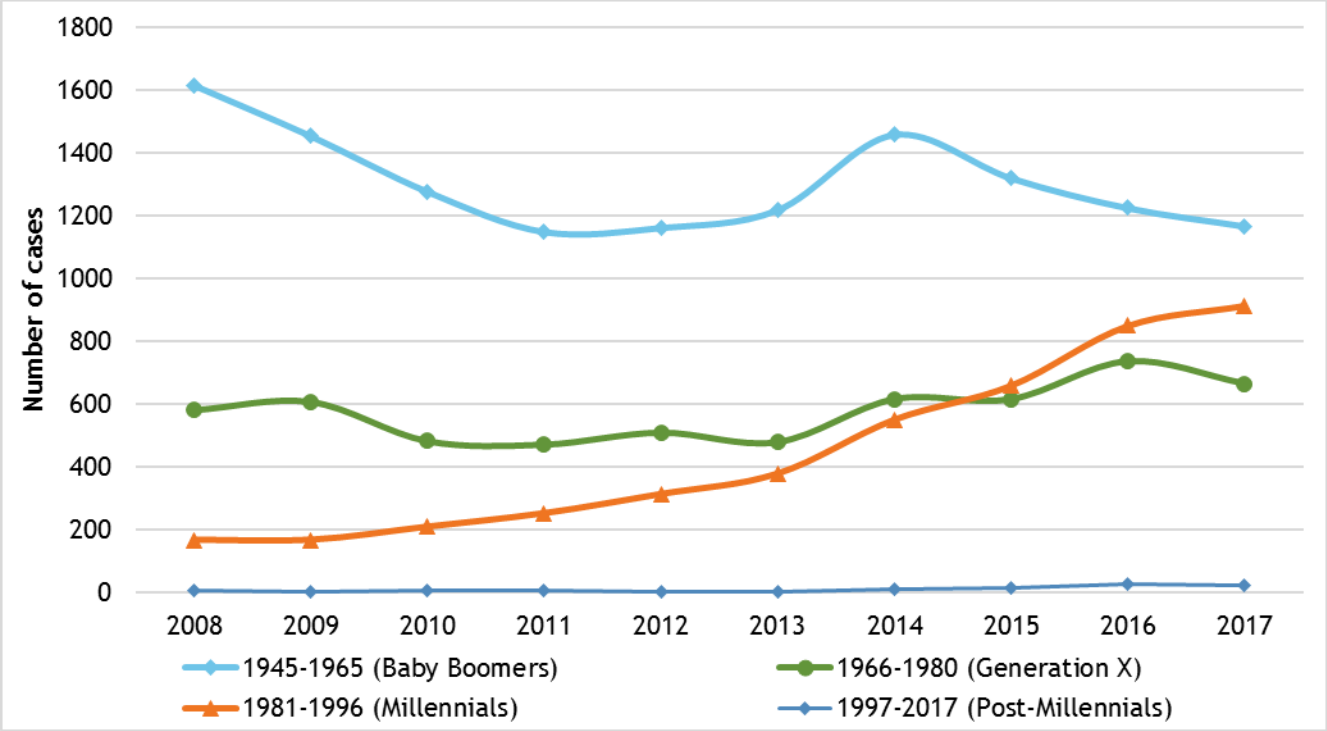


A 2018 report by the Colorado Health Institute showed a nearly threefold increase in HCV screening in Colorado between 2011 and 2016. Rates of screening during this period increased fivefold among Baby Boomers between the ages of 55 and 64, but individuals between the ages of 25 and 34 had the highest annual screening rates each year (32). The total number of screened individuals in 2016 was 63,000 (32). Data for 2017 were not available.

Chronic HCV disproportionately affects Baby Boomers (who likely were exposed before HCV was discovered in 1989), NH blacks, and people incarcerated in jail and prison. Nationally, CDC estimates that Baby Boomers account for 75 percent of all HCV cases in the U.S. (26). The rate of antibody-positive HCV is three percent in this birth cohort, which is six times higher than the prevalence in the rest of the population (26).

Figure 33 illustrates how Baby Boomers have represented the age cohort most affected by HCV. While this is still true in Colorado in the prevalent population, the number of reported cases and likely the true incidence of cases among younger people is rising. As more Baby Boomers are screened and subsequently treated for HCV and mortality rates increase with age, they will make up a smaller proportion of the total number of cases in Colorado (25).

Figure 33. Number of reported chronic viremic HCV cases by birth cohort, 2008-2017



Between 2008 and 2017, 57.0 percent of all reported cases were among Baby Boomers. However, in 2008, 69.2 percent of all reported cases were among individuals in this generation, while they made up 43.4 percent of reported cases in 2017. Baby Boomers have likely been treated at the highest rate, since they are more likely to have had advanced fibrosis scores and access to care than young people who may have recently acquired HCV (25). Mortality rates are also higher in this population, contributing to the decreased proportion of cases among Baby Boomers (25).

The ongoing transmission of HCV, particularly among PWID, represents a significant public health concern in Colorado. Expanding access to treatment is important for people of all ages, but outreach to PWID populations and the bolstering of harm reduction efforts around the state are also critical to stemming the epidemic and reducing the need for future treatment.

Race/ethnicity

Data on race and/or ethnicity are not routinely collected for chronic HCV cases. CDPHE only received race and/or ethnicity data for 22.2 percent of cases in 2017. From 2013 to 2017, CDPHE received race and/or ethnicity data for 29.8 percent of cases. Among cases with known race and/or ethnicity, 72.6 percent of cases were among NH whites and 20.8 percent were among Hispanics (all races). Rates were not calculated due to the large percentage of missing data, and these percentages should be interpreted with caution. Nationally, the highest prevalence of HCV in 2010 was among NH blacks, followed by NH whites (19).

Geographic distribution

In 2017, 58 of the 64 counties had at least one chronic viremic HCV case reported. Every county in Colorado except Kiowa had at least one chronic viremic HCV case reported between 2013 and 2017.

In 2017, urban counties accounted for 65.4 percent (n=1,838) of cases. Rural counties accounted for 12.6 percent (n=354) of reported cases, and 16.3 percent (n=458) of cases were reported from prisons. More reported cases came from prisons than from any single county in Colorado.

Figure 34 shows the number of chronic viremic HCV cases by county in 2017. Figure 35 shows average five-year rates per 100,000 population from 2013 to 2017 of chronic viremic HCV cases. The highest average five-year rates per 100,000 population were in Bent, Costilla, Alamosa, Dolores, Crowley, Custer, Hinsdale, and Pueblo, although case counts in several of these counties (Bent, Costilla, Dolores, Crowley, Custer, and Hinsdale) were low and rates should be interpreted with caution. Quantile ranges in Figure 35 were determined using Jenks Natural Breaks.

Figure 34. Reported chronic viremic HCV cases by county, 2017

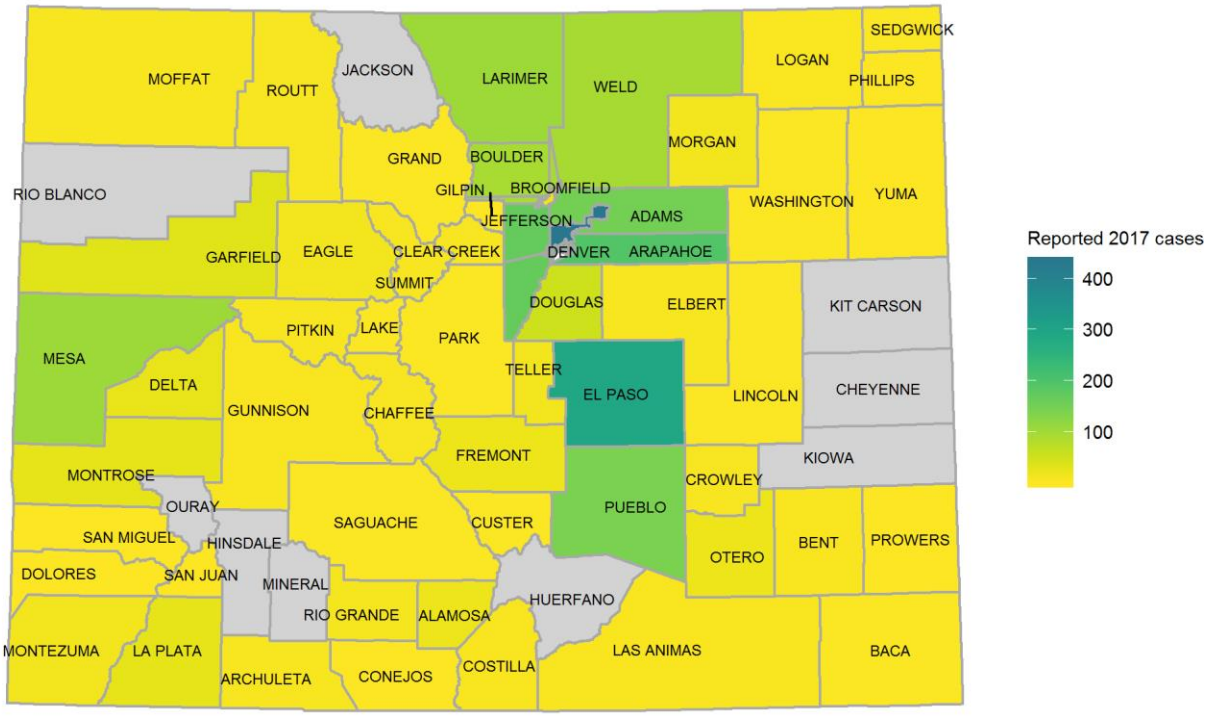
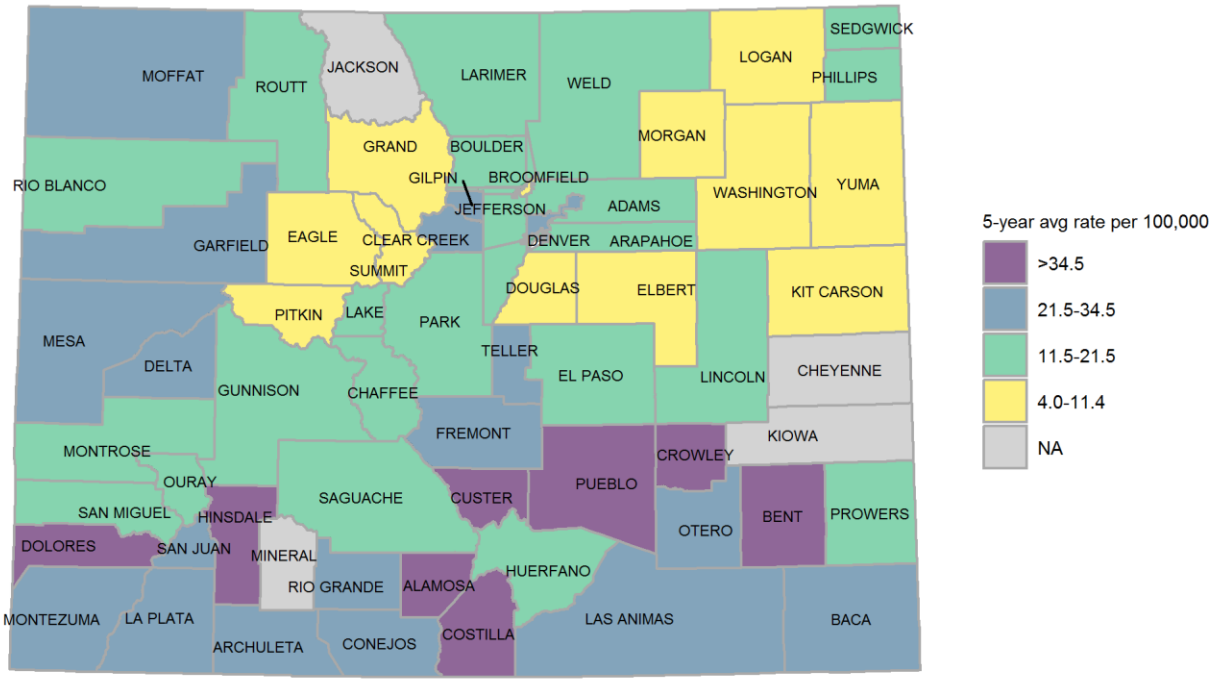


Figure 35. Average 5-year rates per 100,000 population of reported chronic viremic HCV cases by county, 2013-2017



Rates suppressed for counties with <2 cases between 2013-2017. High rates do not necessarily mean high case counts.

Risk factors

Data on risk factors for chronic HCV in Colorado are not routinely collected. However, the rising numbers of reported cases among individuals younger than 40 in tandem with the national opioid crisis suggests that many newly infected individuals acquired HCV through IDU. Another major risk factor for chronic HCV is having been born between 1945 and 1965.

Viral hepatitis co-infections

- In 2017, there were 23 reported cases of chronic viremic HCV and chronic HBV co-infection.
- There were 14 reported cases of co-infection with HIV and chronic HBV and 43 reported cases of co-infection with HIV and chronic viremic HCV in 2017.
- Between 2008 and 2017, there were 175 reported cases of co-infection with HIV and chronic HBV and 527 reported cases of coinfection with HIV and chronic viremic HCV.

HBV and HCV co-infections

The table below provides numbers of individuals with multiple diagnoses reported in CEDRS. Coinfection with HBV and HCV is associated with faster progression of disease as well as higher rates of hepatocellular carcinoma (HCC) development (33). Managing patients who are living with both HBV and HCV presents unique challenges. In some cases, treatment with DAAs for HCV may result in reactivation of previously suppressed HBV (33). There were 195 cases of HBV/HCV RNA coinfection from 2008 to 2017. Of these cases, 34 were diagnosed with HBV before HCV, 93 were diagnosed with HCV before HBV, and 105 were diagnosed during the same calendar year.

Table 8. People with multiple diagnoses in CEDRS (HBV and HCV)		
Diagnoses reported to CEDRS	**2008-2017**	**2017**
Acute HCV/chronic viremic HCV	87	10
Acute HBV/chronic HBV	42	7
Acute HBV/acute HCV	2	1
Acute HCV/chronic HBV	2	1
Chronic viremic HCV/chronic HBV	195	23

HBV and HCV co-infections with HIV

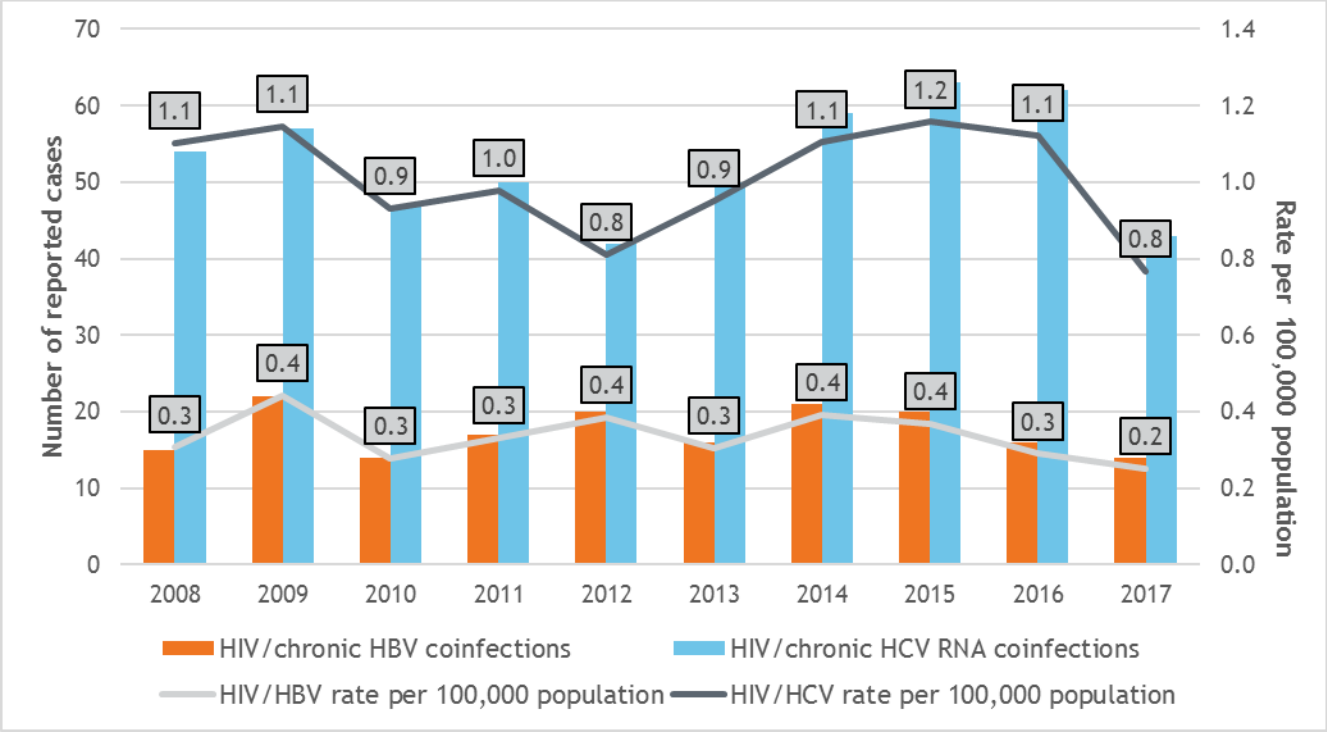
The CDC estimates that approximately 25 percent of PLWH are also living with HCV (34). Diagnosing and treating HCV among PLWH is critical to providing the highest level of care to this population. Studies show that coinfection with HBV and/or HCV among PLWH may be associated with increased mortality compared with HIV alone (35,36). Additionally, PLWH who are also living with HBV and/or HCV progress faster to fibrosis, cirrhosis, HCC, and end-stage liver disease than people not living with HIV (36).

Reported HBV and HCV cases from CEDRS were linked to the HIV cases reported into the enhanced HIV/AIDS Reporting System (eHARS). Between 2008 and 2017, there were 175 PLWH who had also been diagnosed with confirmed or probable chronic HBV. Of those PLWH who were also diagnosed with chronic HBV, 135 were already living with HIV and subsequently diagnosed with HBV, while six were diagnosed first with HBV and subsequently diagnosed with HIV. Since 2008, 34 individuals were diagnosed with HBV and HIV in the same year, two of whom were diagnosed with both viruses in 2017.

Table 9. HIV and chronic HBV		
Diagnoses reported to CEDRS	**2008-2017**	**2017**
HIV with subsequent HBV	135	12

HBV with subsequent HIV	6	0
HIV/HBV in same year	34	2
Total HIV/HBV	175	14

Figure 36. Chronic HBV and HCV coinfections with HIV, 2008-2017



Rates may be unstable due to small case counts and should be interpreted with caution.

Between 2008 and 2017, there were 527 PLWH who had a positive HCV RNA test. Of those PLWH who tested positive for HCV RNA, 431 were already living with HIV and subsequently diagnosed with chronic viremic HCV, while 27 were diagnosed first with HCV and subsequently diagnosed with HIV. Since 2008, 69 individuals were diagnosed with HCV and HIV in the same year, 7 of whom were diagnosed in 2017. Numbers and rates per 100,000 population of reported co-infections are shown in Figure 36.

In 2017, there were three cases each of acute HCV and acute HBV among PLWH.

Since 2008, there have been 13 individuals diagnosed with HIV, chronic HBV, and chronic HCV RNA.

Table 10. HIV and chronic HCV RNA		
Diagnoses reported to CEDRS	**2008-2017**	**2017**

HIV with subsequent HCV	431	36
HCV with subsequent HIV	27	0
HIV/HCV in same year	69	7
Total HIV/chronic viremic HCV	527	43

Liver cancer among reported HBV and HCV cases

- There were 123 cases of liver cancer among reported HBV cases and 1,309 cases among reported HCV cases from 2008-2017.
- There were 354 deaths among reported chronic HBV cases and 35 deaths among reported acute HBV cases from 2008 to 2017.
- There were 2,342 deaths among reported chronic viremic HCV cases and 32 deaths among reported acute HCV cases from 2008 to 2017.

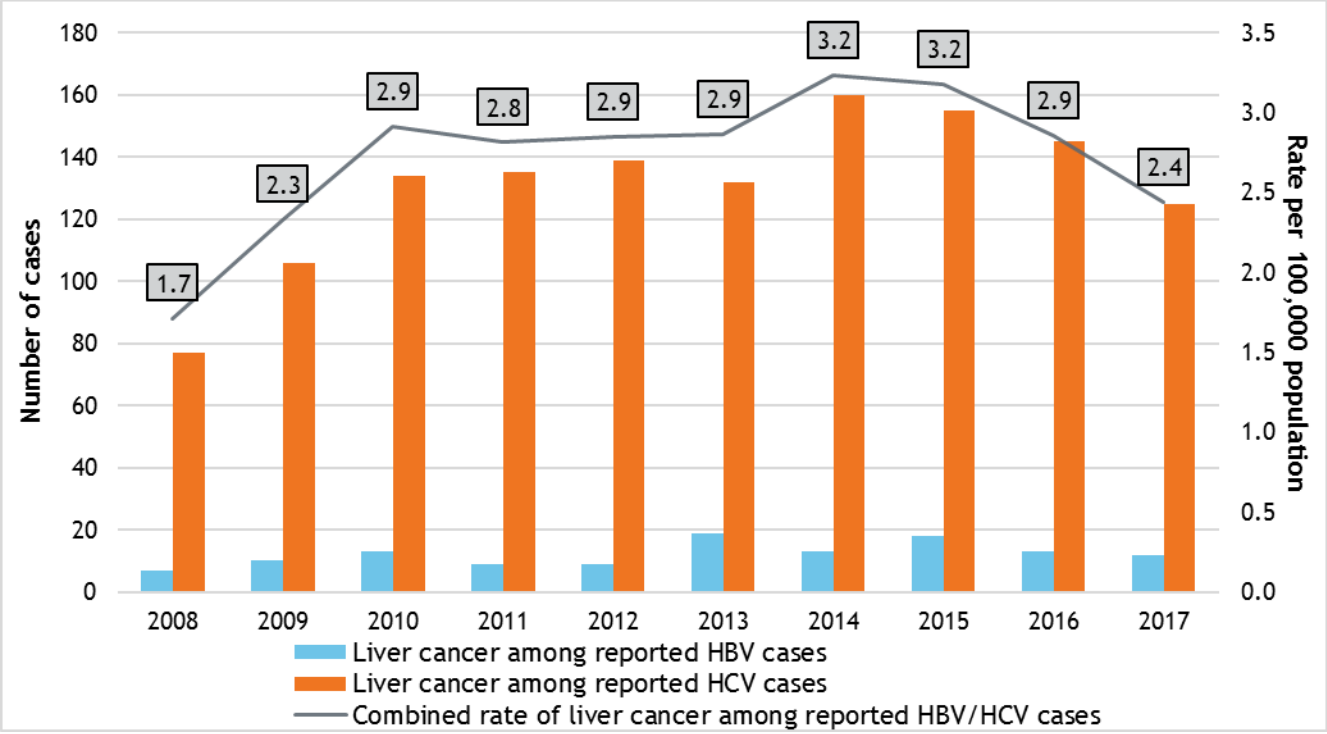
Liver cancer data

Liver cancer is the fourth most common cause of death from cancer worldwide (37). Rates of new liver cancer cases went up from 6.6 to 9.1 per 100,000 population (27 percent increase) in the U.S. from 2003-2015 and deaths increased from 5 to 6.6 (24 percent increase) in this same period (38). The five-year survival rate for liver cancer and intrahepatic bile duct cancer was 17.7 percent in the U.S from 2008-2014 (39). HBV and HCV cause an estimated 61 percent of HCC in the U.S.

The lifetime risk of developing HCC among people with HBsAg positivity is 15-20 times greater than the risk among people without HBsAg (40). A study conducted in 2012 revealed that among patients with HCC in the U.S., 50 to 60 percent were living with HCV and 10 to 15 percent were living with HBV (40).

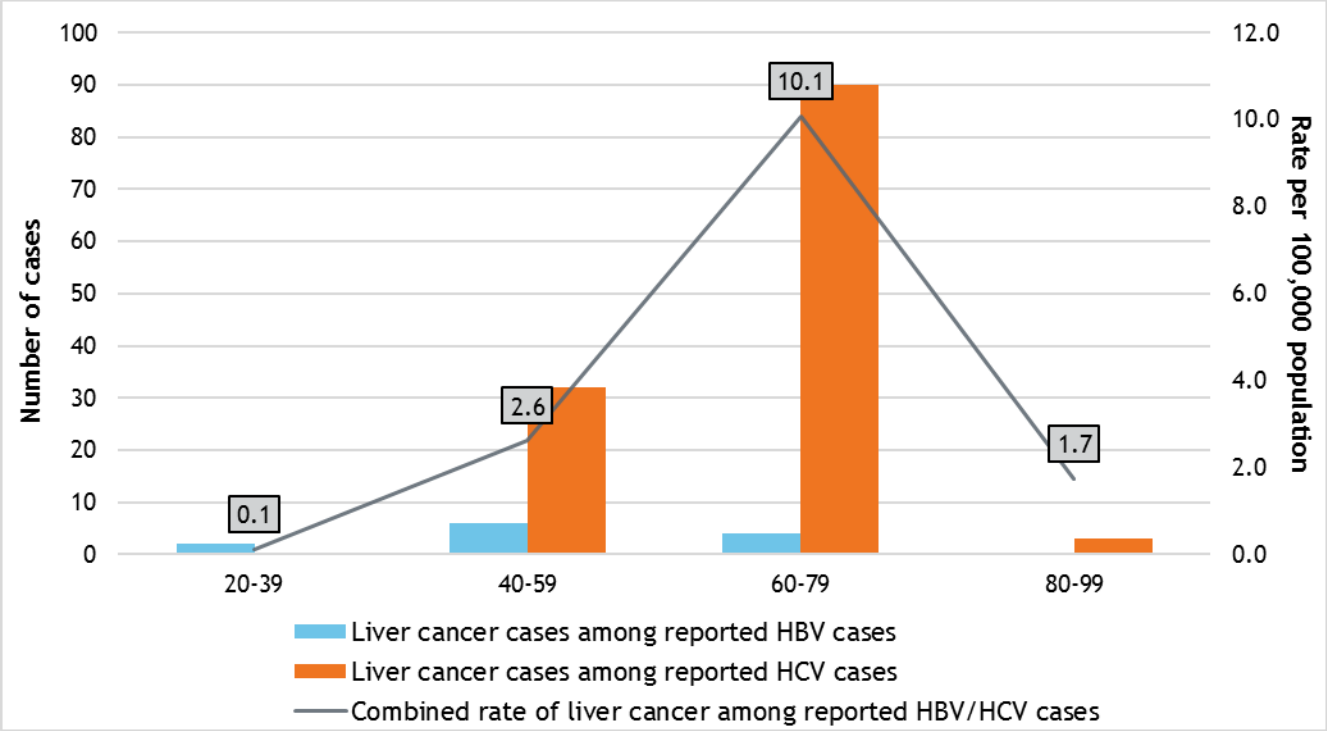
CDPHE matched cases of acute and chronic HCV and HBV that were reported into CEDRS through 2017 to the CCCR. Since 2008, 102 people living with HBV were subsequently diagnosed with liver cancer. From 2008 to 2017, 1238 people living with HCV were subsequently diagnosed with liver cancer. The number of liver cancer cases in people reported to be living with HBV and/or HCV and the rates per 100,000 population are shown in Figure 37.

Figure 37. Liver cancer among reported HBV and HCV cases, 2008-2017



The number of new liver cancer diagnoses have remained low for young people aged 30 to 49 living with HCV, as illustrated in Figure 38. Those aged 60-69 in 2017 accounted for 63 percent of new liver cancer diagnoses. These people were born between 1948 and 1957 making them a part of the Baby Boomer generation that is disproportionately affected by HCV. The rising numbers of diagnoses of liver cancer amongst the Baby Boomers could be due to liver damage after living with HCV.

Figure 38. Liver cancer among reported HBV and HCV cases by age group, 2017



Rates may be unstable due to small case counts and should be interpreted with caution.

Men with HCV have a higher burden of liver cancer than women with HCV. Of the new liver cancer diagnoses in 2017, men made up 80 percent. From 2008 to 2017, men accounted for 82 percent of new liver cancer diagnoses among reported cases of HBV and/or HCV.

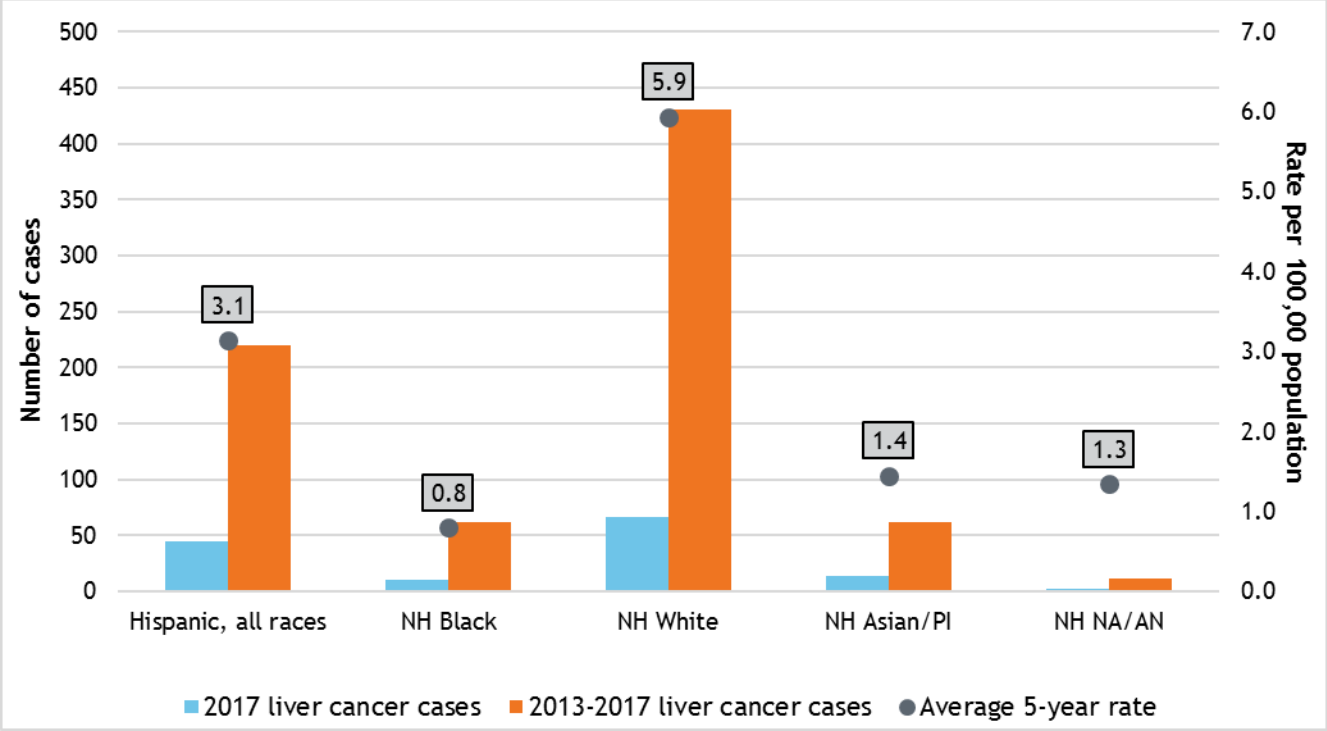
Table 11. Liver cancer diagnoses among reported HCV and/or HBV cases by gender

Year	Liver cancer cases among reported HCV cases		Liver cancer cases among reported HBV cases		Liver cancer cases among reported HBV and/or HCV cases		Liver cancer rate per 100,000 among reported HBV and/or HCV cases	
	Men	Women	Men	Women	Men	Women	Men	Women
2008	66	11	6	1	72	12	2.9	0.5
2009	83	23	7	3	90	26	3.6	1.0
2010	114	20	10	3	124	23	4.9	0.9
2011	108	27	8	1	116	28	4.5	1.1
2012	109	30	6	3	115	33	4.4	1.3

2013	112	20	17	2	129	22	4.9	0.8
2014	134	26	11	2	145	28	5.4	1.0
2015	127	28	15	3	142	31	5.2	1.1
2016	121	24	13	0	134	24	4.8	0.9
2017	99	26	11	1	110	27	3.9	1.0

NH whites with HCV account for the majority of new liver cancer diagnoses. Among people reported to be living with HBV and/or HCV, the five-year average rate of liver cancer diagnoses between 2013 and 2017 was highest among NH whites at 5.9 per 100,000 population, followed by Hispanics (all races) at 3.1 per 100,000 population (Figure 39). NH Asians account for more than half of the population of people living with chronic HBV. The liver cancer rate among NH NA/AN living with HBV or HCV, while high, should be interpreted with caution, since there were fewer than 20 cases of liver cancer in this population identified between 2013 and 2017.

Figure 39. Number and rate of liver cancer diagnoses among reported HBV and HCV cases, 2013-2017

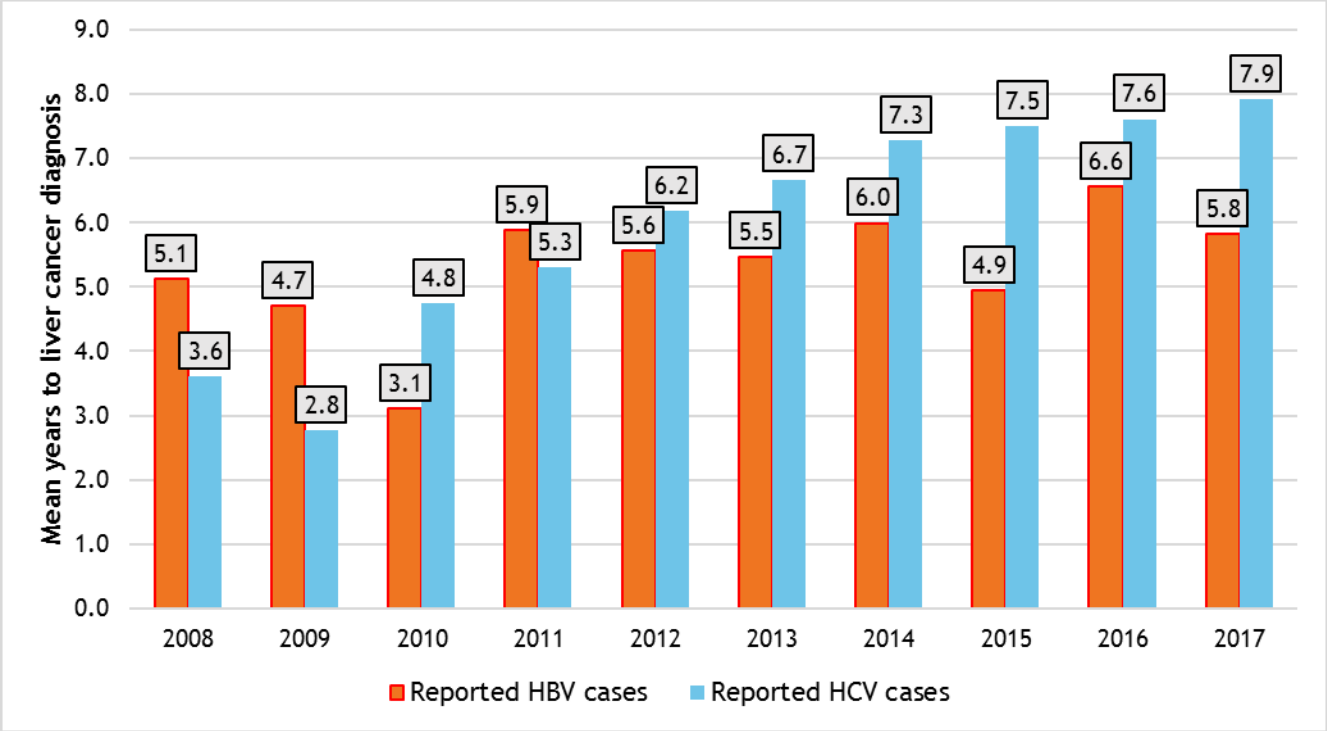


Rates may be unstable due to small case counts and should be interpreted with caution.

Since 2008, the time between HCV diagnosis and a liver cancer diagnosis has increased from an average of 3.6 years between diagnoses to an average of nearly eight years in 2017 (shown in Figure 40). This trend is also seen

in HBV diagnosis and liver cancer diagnosis. These trends in both HCV and HBV could indicate earlier diagnoses and/or better access to care after a diagnosis with HCV or HBV.

Figure 40. Mean years to liver cancer diagnosis after reported diagnosis with HBV or HCV, 2008-2017



Mortality among reported HBV and HCV cases

The national rate of HBV-related deaths as the underlying cause in 2016, the most recent year of available data, was 0.45 per 100,000 population in 2016 (26). HBV accounts for almost 2,000 annual deaths in the United States (17). HCV-associated mortality surpassed the 60 other nationally notifiable conditions combined in 2012 (41). Nationally, the HCV-related mortality rate declined to 4.9 deaths per 100,000 population in 2015 and declined even further to 4.5 deaths per 100,000 in 2016 (29), due to advances in treatment. HCV accounts for almost 20,000 annual deaths in the United States (26).

In Colorado, there were 354 deaths among the 5,408 cumulatively reported chronic HBV cases from 2008 to 2017. There were 35 deaths out of the 323 acute HBV cases reported from 2008 to 2017. Two of the deaths included in the chronic and acute counts had been reported as having acute and later chronic HBV.

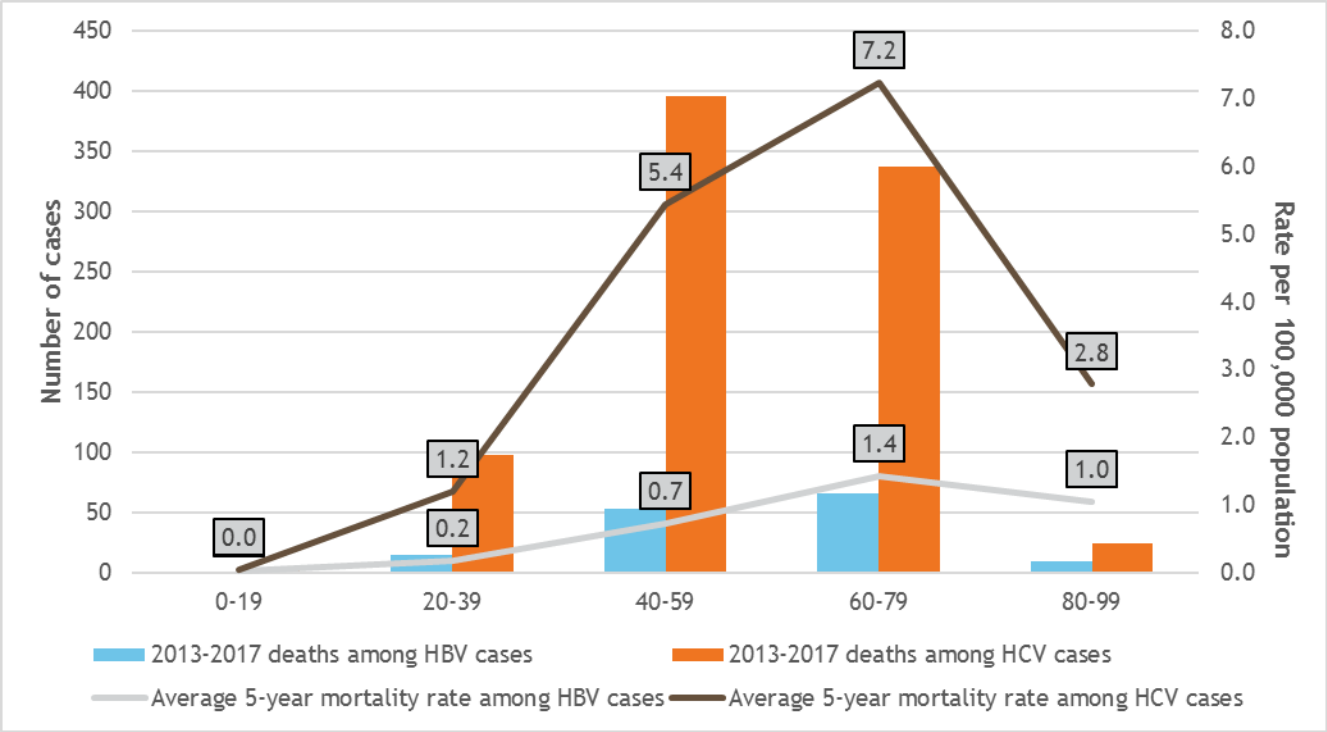
Of the 354 deaths among chronic cases, approximately 27 percent were estimated to be related to liver disease. Of the 35 deaths among acute cases, 34 percent were estimated to be related to liver disease. For chronic HBV cases, the mean age of death was 57.4 for people with liver-related causes of death and 59.3 for people without liver-related causes of death.

Of the 11 individuals living with HBV who died in 2017, five were diagnosed with HBV at the time of death or less than one month before their death. Among the reported cases of chronic HBV in 2016, there were 24 deaths, 33 percent of whom were diagnosed less than one month before death or at the time of death. Between 2000 and 2015, the average time between chronic HBV diagnosis and death was 3.7 years. HBV and HCV are known as "silent killers" since those infected can live without symptoms or knowledge of their infection for many years. The high proportion of deaths within one month of diagnosis (including posthumous diagnoses) underscores the need for more testing for the virus statewide.

Among chronic viremic HCV cases from 2008 to 2017, there were 2,342 deaths among the 23,989 cumulatively reported cases. There were 32 deaths out of the 343 acute HCV cases reported from 2008 to 2017. Six of the deaths included in the chronic and acute counts had been reported as both acute and chronic HCV. Of the 2,342 deaths among chronic viremic HCV cases, approximately 34 percent were estimated to be related to liver disease. Of the 32 deaths among acute cases, 41 percent were estimated to be related to liver disease.

Of the 19 deaths among acute HCV cases that were not liver-related, the mean age of death was 39.3, and at least 42 percent were known to be related to drug intoxication, according to causes of death. Figure 41 shows the number of deaths between 2013 and 2017 among people living with HBV and HCV and the 5-year average mortality rates in these groups.

Figure 41. Deaths among reported HBV and HCV cases by age group, 2013-2017



Rates may be unstable due to small case counts and should be interpreted with caution.

Addressing viral hepatitis in Colorado

- IDU is the primary cause of new HCV cases in Colorado and nationally.
- People who are incarcerated have a greater prevalence of viral hepatitis than the general population.
- Health care exposures to HBV and HCV have declined dramatically since screening of donated blood products began in the 1980s; however, these types of exposures can still occur and can cause disease outbreaks.
- Eliminating HBV and HCV is feasible if key mitigating factors are considered. These include:
    - Strengthening surveillance activities for acute and chronic viral hepatitis.
    - Expanding testing and immunizations with a focus on priority populations.
    - Increasing disease control and prevention efforts related to IDU.
    - Reaching marginalized populations.
    - Implementing widespread jail and prison testing, linkage to care, and treatment services.
    - Improving access to curative, direct-acting antiviral medications for HCV.

Populations of importance

PWID

In 2017, IDU was the primary risk factor associated with reported acute HCV cases in Colorado and nationally (10).

CDC, in collaboration with state and local health departments, initiated the National HIV Behavioral Surveillance (NHBS) grant to monitor risk behaviors among three risk populations: MSM, IDU and heterosexual adults. NHBS has been conducted in Denver among PWID populations in 2006, 2009, 2012, and 2015. PWID are recruited via respondent-driven sampling, in which health department staff members select a small number of initial participants, or "seeds," who complete the survey and then recruit peers to participate until a target of 500 eligible people are recruited.

The NHBS survey data from Denver has found high usage of a non-sterile needle or syringe in the last 12 months, fluctuating from 73 percent in 2006, to 80 percent in 2009, to 64.5 percent in 2012, and to 70 percent in 2015. HCV testing is recommended at least annually for people who currently inject drugs. In 2015, 83.5 percent of study participants reported ever been tested for HCV compared to 87.8 percent in 2012. About half of survey participants reported having ever been told they had HCV by a health care professional: 51.3 percent in 2006; 49.8 percent in 2009; 46.9 percent in 2012, and 51.2 percent in 2015. In year 2009 only, participants were

offered a standard HCV antibody test. Of the 430 participants in 2009, 395 provided a blood specimen to test for HCV antibody and 73.2 percent were HCV antibody positive.

Estimating the number of PWID is of public health interest, but is challenging. One commonly used estimate of national prevalence is from a published article, which predicted that 2.6 percent (95% CI: 1.8-3.3) of the U.S. population aged 13 years and older (both men and women) have injected drugs at some point in their lifetime and 0.3 percent (95% CI: 0.19-0.41) have injected in the past year (42). These estimates were derived from the review of multiple national population studies. In Colorado, there were 4,709,723 people 13 years and older in 2017 (14). Applying the published estimates to the Colorado population, there would be approximately 14,130 individuals who injected in the past year.

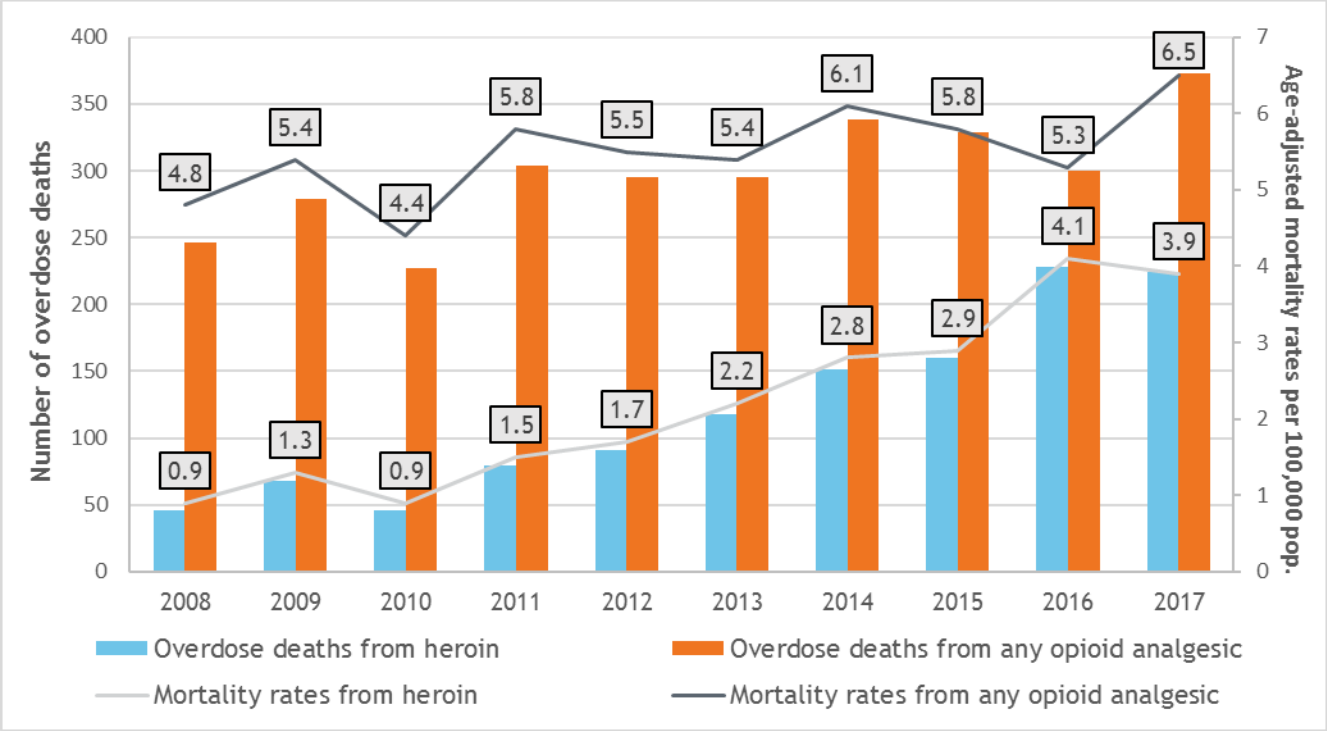
It can be challenging to link PWID who test positive for HCV to care. PWID may not have insurance or stable housing and may feel stigmatized by the health care system and not pursue follow-up care. Under Colorado law and local regulation, syringe services programs (SSPs) have been authorized in seven counties that have 11 sites within the state. These programs provide risk-reduction counseling services, HCV testing, safe disposal of used needles and syringes, and clean needles, syringes, cookers, cottons, and water. The programs are growing, and some sites are unable to keep up with the demand for clean needles and safe disposal of injection equipment.

Drug overdoses are not all injection-related, but most heroin users inject. Overdose deaths are frequently used as a marker of increased IDU activity. Annual data on overdose deaths, including opioid analgesics and other drugs, can be found at https://www.colorado.gov/pacific/cdphe/vital-statistics-program.

As illustrated in Figure 42, mortality rates from heroin overdose in Colorado increased each year from 2010 until 2016, when the rate among all ages was 4.1 per 100,000 population. The largest increase in mortality rates from heroin overdose was between 2015 (2.9 per 100,000 population) to 2016. Heroin overdose rates fell slightly in 2017 to 4.0 per 100,000 population. The number of heroin-related overdose deaths in Colorado increased by 387 percent from 2008 to 2017.

Mortality rates from any opioid analgesic had an inverse relationship with mortality rates from heroin, and the rate per 100,000 population in 2017 was the highest it has ever been at 6.5. The number of overdose deaths from any opioid analgesic increased by 52 percent from 2008 to 2017.

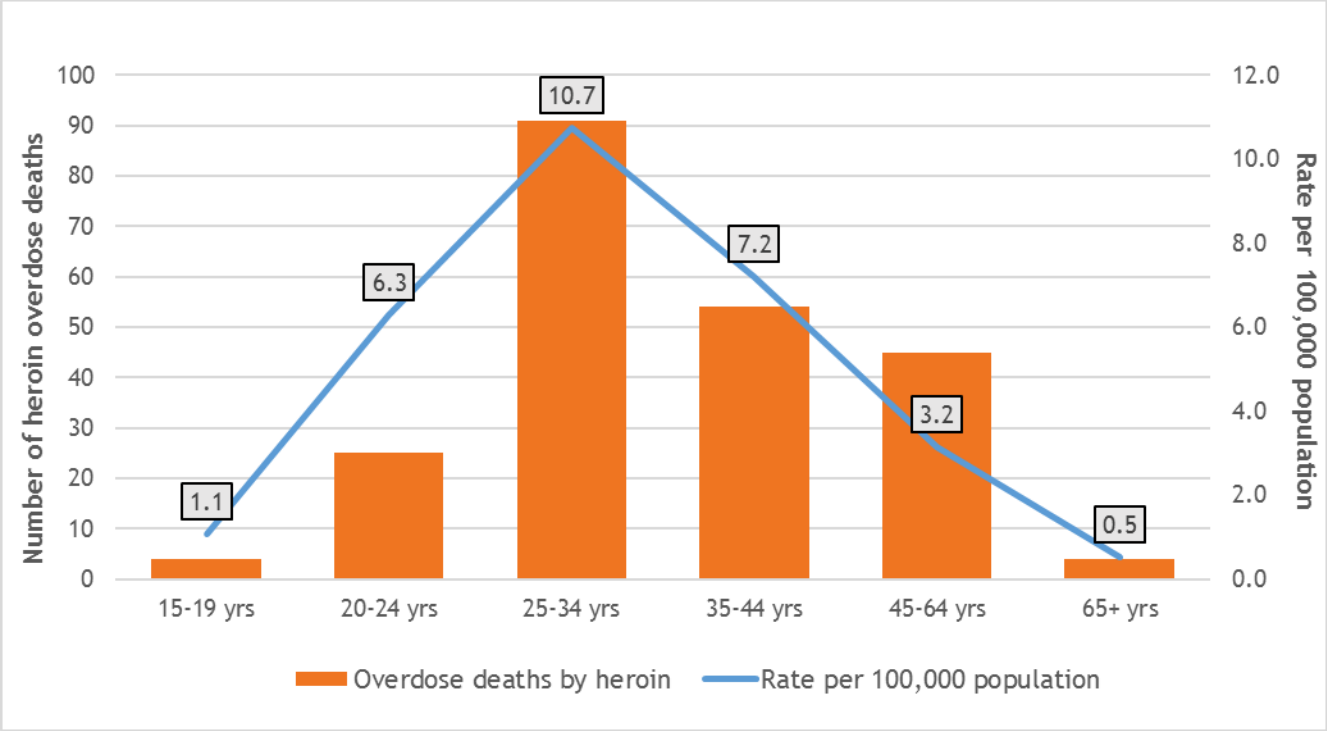
Figure 42. Number and rates per 100,000 population of mortality from opioids, 2008-2017



Data Source: CDPHE Vital Statistics Branch, 2018

As shown in Figure 43, overdose rates by heroin were highest in 2017 among 25-34 year olds at 10.7 per 100,000 population. Individuals between the ages of 35 and 44 had the second highest overdose death rates at 7.2 per 100,000 population.

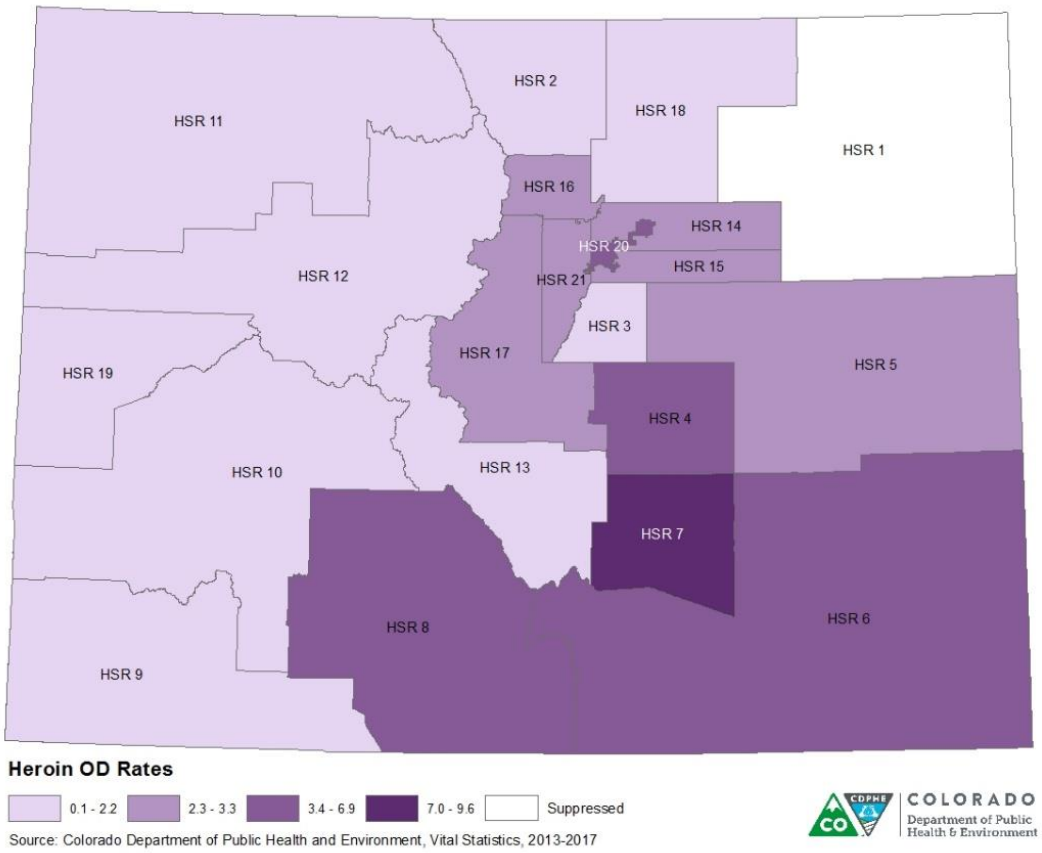
Figure 43. Rate of heroin overdose deaths by age per 100,000 population, 2017



Rates may be unstable due to small case counts and should be interpreted with caution.
Data Source: CDPHE Vital Statistics Branch, 2018

The highest heroin overdose death rates appear in the southeast corner of Colorado as well as in urban areas such as Denver and its surrounding metropolitan area. Figure 44 illustrates this trend based on pre-determined Health Statistics Regions. Health Statistics Regions are determined by population size and allow for the suppression of sensitive data in counties with small populations.

Figure 44. Age-adjusted heroin-related overdose death rates by health statistics region, 2013-2017



People who are incarcerated

The most recent NHANES study cites an HCV antibody prevalence of 16.1 percent and HCV RNA prevalence of 10.7 percent among incarcerated individuals from 2013 to 2016 (27). In previous studies, the antibody prevalence in Colorado was estimated to be 19.7 percent (43). As mentioned above, 16.3 percent of all reported chronic viremic HCV cases in 2017 in Colorado were reported from prisons. The burden of HCV on incarcerated individuals in Colorado is high. Since 2013, there have been 2,338 chronic viremic HCV cases reported to CDPHE from prisons. There was an estimated year-end prison population of 20,101 in Colorado (44). Assuming 2,200 of the 2,338 chronic viremic HCV individuals are still incarcerated (45), this would indicate that at least 10.9 percent of incarcerated individuals in Colorado are living with chronic, unresolved HCV, which is consistent with the national estimate (27).

The Colorado Department of Corrections (CDOC) offers HCV testing to inmates upon intake into a prison. Individuals diagnosed with HCV are evaluated for treatment, and the CDOC applies a clinical designation for prioritizing offenders for treatment.

Pregnant people

Infants who acquire HBV at birth or within their first year have a 90 percent chance of carrying HBV for life. HBV screening of people who are pregnant is a standard of care and should occur with each and every pregnancy regardless of self-reported status of infection or vaccination. It is recommended that people who are pregnant and who test positive for HBsAg should have a subsequent HBV DNA to measure the virus. According to the CDC, pregnant people who have an HBV DNA >20,000, or a positive HBeAg, should be referred for postpartum care. Pregnant people who have an HBV DNA >200,000 should be referred to a specialist for evaluation to start treatment in their third trimester. Knowing a pregnant person's HBV status prior to delivery is essential to the infant getting the correct prophylaxis after birth.

Health care exposures to hepatitis B and C

The risk of acquiring HBV and HCV from blood or blood products has dramatically declined in the U.S. since the screening of blood, plasma and organ tissue was implemented. Screening of blood products for HBV began in 1969 and became mandatory in 1972, while screening for HCV became available in 1992. If infection control practices (ICP) and standard precautions are followed consistently, medical and dental procedures do not pose a risk for spreading bloodborne pathogens. However, lapses in ICP do occur and can cause a risk of HIV, HBV and/or HCV transmission. This can result in large public notifications involving many potentially exposed patients and screening for these pathogens. CDC identified 24 HBV related outbreaks and 38 HCV related outbreaks in U.S. health care settings from 2008-2017 (46). This included 179 outbreak-associated HBV cases and more than 295 outbreak-associated HCV cases. Nearly 11,000 people at risk for HBV and more than 1 million people at risk for HCV were notified to be screened for infection. CDC notes that it is likely that only a fraction of outbreaks are detected and reported, and these numbers greatly underestimate the actual burden.

One of these HCV outbreaks was in 2009 in Colorado, in a hospital-based surgery service. In this investigation, a health care worker who was positive for HCV diverted drugs and used the same syringe and needles as patients. Almost 6,000 people were notified to be screened for HCV at two different facilities. Testing resulted in 18 cases of HCV that were genetically linked and an additional eight cases that were epidemiologically linked to the health care worker (47).

CDPHE continues to actively engage Colorado hospitals and other health care, home health, and emergency health care service providers to assure adherence to national and state regulations, and implementation and maintenance of infection-control practices. This includes appropriate sterilization and/or disinfection of medical and dental devices and the single use and appropriate disposal of needles, syringes and other sharp instruments. It also includes appropriate storage and handling of medications and ongoing professional and public education.

CDPHE investigates unsafe injection practices in any health care setting, and previous investigations have included unsafe practices related to pediatric immunizations, acupuncture, paramedic services, dental offices, nursing homes, medical offices, outpatient surgery centers, assisted living facilities, research facilities, and

hospitals. Unsafe practices are often identified by the public, health care providers, staff surveyors in the Health Facilities and Emergency Medical Services Division at CDPHE, and/or through public health disease surveillance.

Strategies

Both public health and clinical strategies are needed to stop the spread of viral hepatitis and limit the impact on people who are infected. Public health must work with communities and health care providers to identify new cases and stop transmission. Hepatitis A and B have safe and effective vaccines; screening, education, and treatment are the primary tools available to prevent new HCV infections, in the context of identified cross-cutting barriers that include sporadic and under-funded surveillance systems (20).

Screening

Health care providers and public health communities, identify people who are living with viral hepatitis through screening tests for HCV antibody and HBV surface antigen. According to the CDC, most people with HBV and HCV are unaware of their status. Additional screening of people at risk will help identify previously undiagnosed cases.

Education

Hepatitis education for both professional health care workers and the public is important. There is a need for more health care providers who can serve people living with chronic HBV and HCV. Colorado is helping meet this need through Project ECHO (Extension for Community Health care Outcomes). Project ECHO provides video training of specialized medical knowledge to expand treatment capacity. Project ECHO Colorado began HCV training in 2016 with the goal of preparing primary care physicians to both manage their patients' HCV infections and to cure patients using newer therapies.

Public awareness of hepatitis is a public and private effort. Public funds are being used to raise awareness among high-risk groups and promote HCV testing. Drug makers are in an increasingly competitive market and have undertaken large marketing campaigns to connect patients with treatment.

Treatment

People with chronic HBV and chronic HCV need additional medical management and evaluation for treatment. These patients also need counseling and education related to their diagnosis. The current health care system has been slow to address the needs of people living with chronic hepatitis. The U.S. Action Plan for Prevention, Care, and Treatment of Viral Hepatitis calls for improving linkage to care. Providing treatment for viral hepatitis can prevent complications of the disease including fibrosis, cirrhosis and HCC. While there are effective treatments now available to cure HCV, treatment will only suppress the virus in HBV. However, viral suppression among people living with HBV can decrease the likelihood of transmission.

HBIG is available for infants and people exposed to HBV that can help prevent infection in addition to the three-dose vaccine series and post-vaccine serologic testing. There are several antiviral medications for people with chronic HBV to manage their infection, including medications that are approved for use in the third trimester of pregnancy. Infants at risk for perinatal transmission should be given both HBV vaccine and HBIG within 12 hours of birth. Other people exposed to the virus should be given post-exposure prophylaxis within 24 hours. This is usually the HBV vaccine, but depending on the type of exposure, can also include HBIG in addition to the vaccine for added protection. Previously vaccinated people who have had an exposure to HBV are recommended to receive a booster dose of HBV vaccine dependent on the type of exposure (48).

The treatment landscape for HCV has changed dramatically over the last five years. Ten different DAAs have become available since their initial release in 2014 with two new drugs being approved by the FDA every year up to 2017. Before 2014, treatment for HCV was interferon-based, administered through weekly injections. The efficacy was low; interferon treatments alone had an SVR rate of 20 percent. While combining interferon treatments with ribavirin, an antiviral used to treat many diseases since the 1970s, increased SVR rates to 54-63 percent, side effects were so severe that 20 percent of patients were forced to discontinue treatment.

Now, the SVR rate of the ten DAAs on the market is over 95 percent, side effects are mild, and treatments are all oral. Four of the treatments are pan-genotypic, meaning they are effective in treating all genotypes of HCV. While prices currently remain high, further competition between drug manufacturers could drive prices lower. There are currently five manufacturers producing DAA, some of which have plans to produce generics of their own drugs at a lower price. However, because of the novelty of DAAs, all of them are still protected by patents until the late 2020s, making true generics made by third parties unavailable for production until then.

The cost and demand for treatment has the potential to overwhelm many health care systems. HCV disproportionately affects individuals who are likely to receive health coverage from public payers including Medicaid, Medicare, the Veterans Administration and the state and federal prison systems. A 2015 U.S. Senate report concluded that HCV drug spending in 2014 exceeded twelve billion dollars, or more than a third of the amount spent that year on new pharmaceutical treatments for all diseases. Due to high treatment costs and the number of people infected with HCV, insurers have historically placed restrictions on eligibility criteria for treatment.

To effectively reduce morbidity and mortality related to viral hepatitis in Colorado, CDPHE recommends expanding public education, increasing screening and confirmatory testing (specifically for HCV), expanding professional education (including HCV treatment in primary care settings), and providing HCV treatment to more Coloradans. In addition, for HBV, ensure screening for people who are pregnant and people born in endemic countries. HAV and/or HBV vaccines should be offered to all populations and should be part of routine care for people living with HCV or HBV.

References

1. Stanaway JD, Flaxman AD, Naghavi M, Fitzmaurice C, Vos T, Abubakar I, et al. The global burden of viral hepatitis from 1990 to 2013: findings from the Global Burden of Disease Study 2013. Lancet [Internet]. 2016 Sep 10;388(10049):1081–8. Available from: https://doi.org/10.1016/S0140-6736(16)30579-7

2. Centers for Disease Control and Prevention. Hepatitis C Questions and Answers for the Public [Internet]. 2018. Available from: https://www.cdc.gov/hepatitis/hcv/cfaq.htm

3. The Generation Gap in American Politics [Internet]. 2018. Available from: http://www.people-press.org/2018/03/01/the-generation-gap-in-american-politics/

4. Centers for Disease Control and Prevention. People Born 1945-1965 (Baby Boomers) [Internet]. 2018. Available from: https://www.cdc.gov/hepatitis/populations/1945-1965.htm

5. Denniston MM, Jiles RB, Drobeniuc J, Klevens RM, Ward JW, McQuillan GM, et al. Chronic hepatitis C virus infection in the United States, National Health and Nutrition Examination Survey 2003 to 2010. Vol. 160, Ann Intern.Med. 2014. p. 293–300.

6. Safer JD, Coleman E, Feldman J, Garofalo R, Hembree W, Radix A, et al. Barriers to healthcare for transgender individuals. Curr Opin Endocrinol Diabetes Obes [Internet]. 2016 Apr 1;23(2):168–71. Available from: https://www.ncbi.nlm.nih.gov/pubmed/26910276

7. Shover CL, DeVost MA, Beymer MR, Gorbach PM, Flynn RP, Bolan RK. Using Sexual Orientation and Gender Identity to Monitor Disparities in HIV, Sexually Transmitted Infections, and Viral Hepatitis. Am J Public Health [Internet]. 2018/11/. 2018 Nov;108(S4):S277–83. Available from: https://www.ncbi.nlm.nih.gov/pubmed/30383431

8. Wasserman C, Ossiander E. Department of Health Agency Standards for Reporting Data with Small Numbers [Internet]. 2018. Available from: https://www.doh.wa.gov/Portals/1/Documents/1500/SmallNumbers.pdf

9. Centers for Disease Control and Prevention. Hepatitis B Questions and Answers for the Public [Internet]. [cited 2018 Oct 5]. Available from: https://www.cdc.gov/hepatitis/hbv/bfaq.htm

10. Centers for Disease Control and Prevention. Surveillance for Viral Hepatitis – United States, 2016 [Internet]. 2018 [cited 2018 Jun 6]. Available from: https://www.cdc.gov/hepatitis/statistics/2016surveillance/pdfs/2016HepSurveillanceRpt.pdf

11. Polaris Observatory Collaborators. Global prevalence, treatment, and prevention of hepatitis B virus infection in 2016: a modelling study. Lancet Gastroenterol Hepatol. 2018 Jun;3(6):383–403.

12. Colorado Department of Local Affairs. Population Totals for Colorado and Sub-State Regions [Internet]. Available from: https://demography.dola.colorado.gov/population/population-totals-colorado-substate/#population-totals-for-colorado-and-sub-state-regions

13. Chen Jr MS, Dang J. Hepatitis B among Asian Americans: Prevalence, progress, and prospects for control. World J Gastroenterol [Internet]. 2015 Nov 14;21(42):11924–30. Available from: http://www.ncbi.nlm.nih.gov/pmc/articles/PMC4641114/

14. Colorado Department of Local Affairs. Population data [Internet]. Available from: https://demography.dola.colorado.gov/population/

15. U.S. Department of Health and Human Services. Hepatitis B Basic Information [Internet]. 2017. Available from: https://www.hhs.gov/hepatitis/learn-about-viral-hepatitis/hepatitis-b-basics/index.html

16. Forde KA. Ethnic Disparities in Chronic Hepatitis B Infection: African Americans and Hispanic Americans. Curr Hepatol reports [Internet]. 2017 Jun 22;16(2):105–12. Available from: http://www.ncbi.nlm.nih.gov/pmc/articles/PMC5754030/

17. Centers for Disease Control and Prevention. Statistics and Surveillance [Internet]. Available from: https://www.cdc.gov/hepatitis/statistics/index.htm

18. Roberts H, Kruszon-Moran D, Ly KN, Hughes E, Iqbal K, Jiles RB, et al. Prevalence of chronic hepatitis B virus (HBV) infection in U.S. households: National Health and Nutrition Examination Survey (NHANES), 1988-2012. Hepatology [Internet]. 2015 Aug 6;63(2):388–97. Available from: https://doi.org/10.1002/hep.28109

19. Rosenberg ES, Hall EW, Sullivan PS, Sanchez TH, Workowski KA, Ward JW, et al. Estimation of State-Level Prevalence of Hepatitis C Virus Infection, US States and District of Columbia, 2010. Clin Infect Dis [Internet]. 2017/04/26. 2017 Jun 1;64(11):1573–81. Available from: https://www.ncbi.nlm.nih.gov/pubmed/28449115

20. Buckley G, Strom B. Eliminating the Public Health Problem of Hepatitis B and C in the United States: Phase One Report [Internet]. The National Academies Press. Washington, D.C.; 2016. Available from: https://www.ncbi.nlm.nih.gov/pubmed/27336113

21. Ditah I, Ditah F, Devaki P, Ewelukwa O, Ditah C, Njei B, et al. The changing epidemiology of hepatitis C virus infection in the United States: National health and nutrition examination survey 2001 through 2010. J Hepatol [Internet]. 2014;60(4):691–8. Available from: http://dx.doi.org/10.1016/j.jhep.2013.11.014

22. Yeung C-Y, Lee H-C, Chan W-T, Jiang C-B, Chang S-W, Chuang C-K. Vertical transmission of hepatitis C virus: Current knowledge and perspectives. World J Hepatol [Internet]. 2014/09/27. 2014 Sep 27;6(9):643–51. Available from: https://www.ncbi.nlm.nih.gov/pubmed/25276280

23. Polis CB, Shah SN, Johnson KE, Gupta A. Impact of maternal HIV coinfection on the vertical transmission of hepatitis C virus: a meta-analysis. Clin Infect Dis. 2007 Apr;44(8):1123–31.

24. Kish T, Aziz A, Sorio M. Hepatitis C in a New Era: A Review of Current Therapies. P T [Internet]. 2017 May;42(5):316–29. Available from: https://www.ncbi.nlm.nih.gov/pubmed/28479841

25. Colorado Prevalence and Incidence of Hepatitis C Virus Infection: A Modeling Study (2018 update). Denver, CO; 2018.

26. Centers for Disease Control and Prevention. Surveillance for Viral Hepatitis – United States [Internet]. 2016. Available from: https://www.cdc.gov/hepatitis/hcv/statisticshcv.htm%0A

27. Hofmeister MG, Rosenthal EM, Barker LK, Rosenberg ES, Barranco MA, Hall EW, et al. Estimating Prevalence of Hepatitis C Virus Infection in the United States, 2013-2016. Hepatology [Internet]. 2018;0(0):2013–6. Available from: http://doi.wiley.com/10.1002/hep.30297

28. Hart A, Coyle JR. Measuring the Impact of the 2016 Case Definition Change on Acute and Chronic HCV Surveillance Numbers. In: 2018 CSTE Annual Conference [Internet]. Available from: https://cste.confex.com/cste/2018/videogateway.cgi/id/4320?recordingid=4320

29. Centers for Disease Control and Prevention. Viral Hepatitis Surveillance - United States 2016 [Internet]. Atlanta; 2017. Available from: https://www.cdc.gov/hepatitis/statistics/2016surveillance/pdfs/2016HepSurveillanceRpt.pdf

30. Schranz AJ, Barrett J, Hurt CB, Malvestutto C, Miller WC, Miller WC. Challenges Facing a Rural Opioid Epidemic : Treatment and Prevention of HIV and Hepatitis C. Curr HIV/AIDS Rep. 2018;15:245–54.

31. Centers for Disease Control and Prevention. Hepatitis C, Chronic: 2016 Case Definition [Internet]. Available from: https://wwwn.cdc.gov/nndss/conditions/hepatitis-c-chronic/case-

definition/2016/

32. Colorado Health Institute. Screening for Hepatitis C Climbs in Colorado [Internet]. 2018. Available from: https://www.coloradohealthinstitute.org/sites/default/files/file_attachments/Hepatitis C Screening in Colorado.pdf

33. Mavilia MG, Wu GY. HBV-HCV Coinfection: Viral Interactions, Management, and Viral Reactivation. J Clin Transl Hepatol [Internet]. 2018/07/06. 2018 Sep 28;6(3):296–305. Available from: https://www.ncbi.nlm.nih.gov/pubmed/30271742

34. Centers for Disease Control and Prevention. HIV/AIDS and Viral Hepatitis [Internet]. Available from: https://www.cdc.gov/hepatitis/populations/hiv.htm

35. Gunter J, Callens S, De Wit S, Goffard J-C, Moutschen M, Darcis G, et al. Prevalence of non-infectious comorbidities in the HIV-positive population in Belgium: a multicenter, retrospective study. Acta Clin Belg [Internet]. 2018 Jan 2;73(1):50–3. Available from: https://doi.org/10.1080/17843286.2017.1339965

36. Thornton AC, Jose S, Bhagani S, Chadwick D, Dunn D, Gilson R, et al. Hepatitis B, hepatitis C, and mortality among HIV-positive individuals. AIDS [Internet]. 2017/11/09. 2017 Nov 28;31(18):2525–32. Available from: https://www.ncbi.nlm.nih.gov/pubmed/28926400

37. International Agency for Research on Cancer. Liver Cancer Fact Sheet [Internet]. 2018. Available from: http://gco.iarc.fr/today/data/factsheets/cancers/11-Liver-fact-sheet.pdf

38. American Cancer Society. Colorado At A Glance [Internet]. 2018. Available from: https://cancerstatisticscenter.cancer.org/#!/state/Colorado

39. National Institutes of Health. Cancer Stat Facts: Liver and Intrahepatic Bile Duct Cancer [Internet]. Available from: https://seer.cancer.gov/statfacts/html/livibd.html

40. El-Serag HB. Epidemiology of viral hepatitis and hepatocellular carcinoma. Vol. 142, Gastroenterology. p. 1264–73.

41. Ly KN, Hughes EM, Jiles RB, Holmberg SD. Rising mortality associated with Hepatitis C virus in the United States, 2003-2013. Clin Infect Dis. 2016;62(10):1287–8.

42. Lansky A, Finlayson T, Johnson C, Holtzman D, Wejnert C, Mitsch A, et al. Estimating the number of persons who inject drugs in the United States by meta-analysis to calculate national rates of HIV and hepatitis C virus infections. PLoS One. 2014;9(5).

43. Spaulding AC, Anderson EJ, Khan MA, Taborda-Vidarte CA, Phillips JA. HIV and HCV in U.S. prisons and jails: the correctional facility as a bellwether over time for the community's infections. AIDS Rev. 2017;19(3):134–47.

44. Harrison L. Adult and Juvenile Correctional Populations Forecasts [Internet]. 2018. Available from: https://cdpsdocs.state.co.us/ors/data/PPP/2018_PPP.pdf

45. ACLU and Colorado Department of Corrections Reach Historic Settlement to treat all Colorado Prisoners with Hepatitis C. ACLU [Internet]. 2018 Sep; Available from: https://www.aclu.org/news/aclu-and-colorado-department-corrections-reach-historic-settlement-treat-all-colorado-prisoners

46. Centers for Disease Control and Prevention. Healthcare-Associated Hepatitis B and C Outbreaks (≥ 2 cases) Reported to the Centers for Disease Control and Prevention (CDC) 2008-2017 [Internet]. 2018. Available from: https://www.cdc.gov/hepatitis/outbreaks/healthcarehepoutbreaktable.htm

47. Warner AE, Schaefer MK, Patel PR, Drobeniuc J, Xia G, Lin Y, et al. Outbreak of hepatitis C virus

infection associated with narcotics diversion by an hepatitis C virus-infected surgical technician. Am J Infect Control [Internet]. 2014/11/20. 2015 Jan;43(1):53–8. Available from: https://www.ncbi.nlm.nih.gov/pubmed/25442395

48. Centers for Disease Control and Prevention. Postexposure Prophylaxis to Prevent Hepatitis B Virus Infection. Morb Mortal Wkly Rep. 2006;55(RR16):30–1.