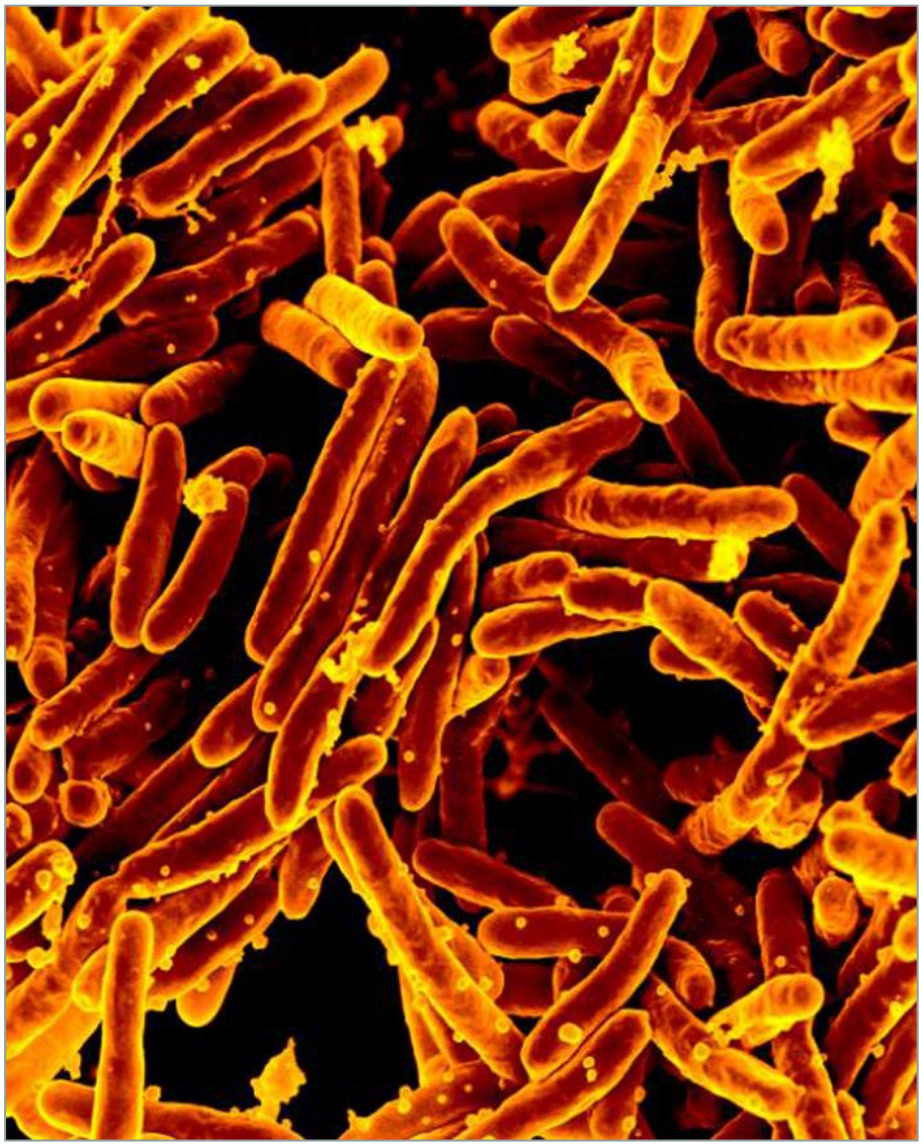

Tuberculosis in Colorado

2017

COLORADO
Department of Public Health & Environment

colorado.gov/cdphe/tb

Summary

In Colorado, 84 people were diagnosed with active tuberculosis (TB) disease in 2017, an increase of 31 percent from the 64 reported in 2016 (Figure 1 and Table 1). For regional comparison, Arizona recorded no change, Kansas decreased 26 percent, Nebraska decreased 29 percent, New Mexico decreased 5 percent, Oklahoma decreased 31 percent, Utah increased 45 percent, and Wyoming increased 100 percent) compared to 2016. The Colorado case rate increased to 1.5 per 100,000 persons (the highest rate since 2009) from 1.2 per 100,000 persons in 2016. The U.S. case rate was 2.8 per 100,000 persons according to the March 2017 TB report from the Centers for Disease Control and Prevention (CDC), a 2 percent decrease from 2016 (Figure 2). Although the number of cases in Colorado has fluctuated over the past ten years, TB cases have declined approximately 40 percent from 2001.

Sixteen (25 percent) of the state's 64 counties reported at least one person with active TB disease in 2017. There were 24 new patients reported in Denver, the most of any single Colorado county. Tri-County Health Department, comprised of Adams, Arapahoe, and Douglas counties, reported 26 patients with TB disease in 2017, and El Paso County reported 10. Sixty percent of Colorado's counties (39 of 64) have reported at least one new patient with active TB disease in the past 10 years (2008-2017) (Table 1). The geographic distribution of those patients is similar to 2016 with the exception of Boulder, Fremont, Park, Pitkin, Summit and Yuma Counties, which each reported at least one new case each after reporting none in 2016 (Table 1).

In 2017, TB burden in Colorado remained highest among racial and ethnic minorities (Figure 4), which is consistent with national observations. Though comprising only 31 percent of the state's population, 86 percent of new TB cases occurred in racial and ethnic minority populations, meaning minorities are the most at-risk demographic group for developing TB disease. The largest change among demographic groups was in the Asian population (25 people in 2017, up from 14 in 2016). Having a diabetes diagnosis is the strongest modifiable risk factor for developing active TB disease (20 percent of all patients in 2017). In addition, birth in one of the 30 countries with highest TB burden, as defined by the World Health Organization, remains a strong risk factor, comprising 32 percent of all patients in 2017 (Table 2 and Figure 11).

In 2017, TB was reported among people ranging in age from one to 93 years, with an average age of 48 years. The largest percentage (40 percent) occurred in the 25-44 year age group (up from 19 percent in 2016), and the smallest percentage (5 percent) was in the under-15-year age group (unchanged from 2016). Active TB in children is particularly concerning, as it indicates ongoing transmission in the community as well as evidence of missed opportunities for prevention (Figure 7).

In 2017, 56 percent of new TB patients were male, and 44 percent were female (Figure 8).

Drug susceptibility testing is recommended for all culture-positive TB cases in the U.S. In 2017, all 57 patients with culture-positive TB had drug susceptibility results. Seven (12 percent) of the 57 patients were resistant to one or more first-line drugs (isoniazid-INH, rifampin-RIF, pyrazinamide-PZA, ethambutol-EMB), and three (5 percent) were resistant to non-first-line drugs. None were multi-drug resistant (MDR) TB (defined as being resistant to at least INH and RIF), and there was no extensively drug resistant (XDR) TB identified in 2017 (Figure 13). There were no MDR or XDR-TB in 2016 either.

TB drug treatment is lengthy, so completion rates are pending for 2017. Of the 64 TB patients reported in 2016, the most recent year where final completion data are available, four patients were dead at diagnosis, and one died prior to

initiating treatment. Of the remaining 59, 47 (80 percent) completed treatment; one moved out of the U.S. (completion data not available), two were lost to follow-up, seven died during treatment, and two didn't complete treatment (Figure 15 and Figure 16). All new patients counted in 2017 have initiated treatment.

Except for the current year, TB disease incidence remained steady over the past five years in Colorado. The Colorado Department of Public Health and Environment, local public health agencies and other TB stakeholders and partners collaborated on a 10-year TB elimination plan to reduce the burden of TB in Colorado. This plan guides and informs programming to support people and populations at increased risk for developing TB disease as well as the providers who care for them. A key goal of the plan is to encourage people at risk to "know their TB status" while increasing public and private provider capacity to screen, test and treat for TB infection.

The only way to eliminate TB is to identify and treat people with TB infection who are at elevated risk of developing active disease. Timely evaluation of people identified as contacts to an infectious TB patient and of those who arrive in Colorado with a Class B TB designation means we can identify and treat additional cases of both active TB disease and TB infection. The Colorado Department of Public Health and Environment acknowledges that generations-long social, economic and environmental inequities result in adverse health outcomes. These inequities affect communities differently and have a greater influence on health outcomes than either individual choices or one's ability to access health care. Reducing health disparities through policies, practices and organizational systems can help improve opportunities for all Coloradans. The TB elimination plan is available on the TB Program website https://www.colorado.gov/pacific/cdphe/tb

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On the cover: A digitally colorized scanning electron microscopic image of a group of *Mycobacterium tuberculosis* bacteria, which cause tuberculosis (TB) in human beings. Photo from the Centers for Disease Control and Prevention.

Figures and tables

TB cases and rates

In 2017, 84 people were diagnosed and reported with active tuberculosis disease (TB) in Colorado. Although the number of cases has declined steadily since 2007, there was an increase in 2017. Time will tell if this was an anomaly or the start of an upward trend. The hope is that TB elimination efforts have increased awareness among providers resulting in more sick people being found and brought into care while deaths due to TB dropped accordingly. Overall, the number of cases and corresponding case rates are trending down in Colorado as the linear trend lines in Figures 1 and 2 illustrate.

Figure 1. Number of TB Cases and Trend Line: Colorado 1998-2017

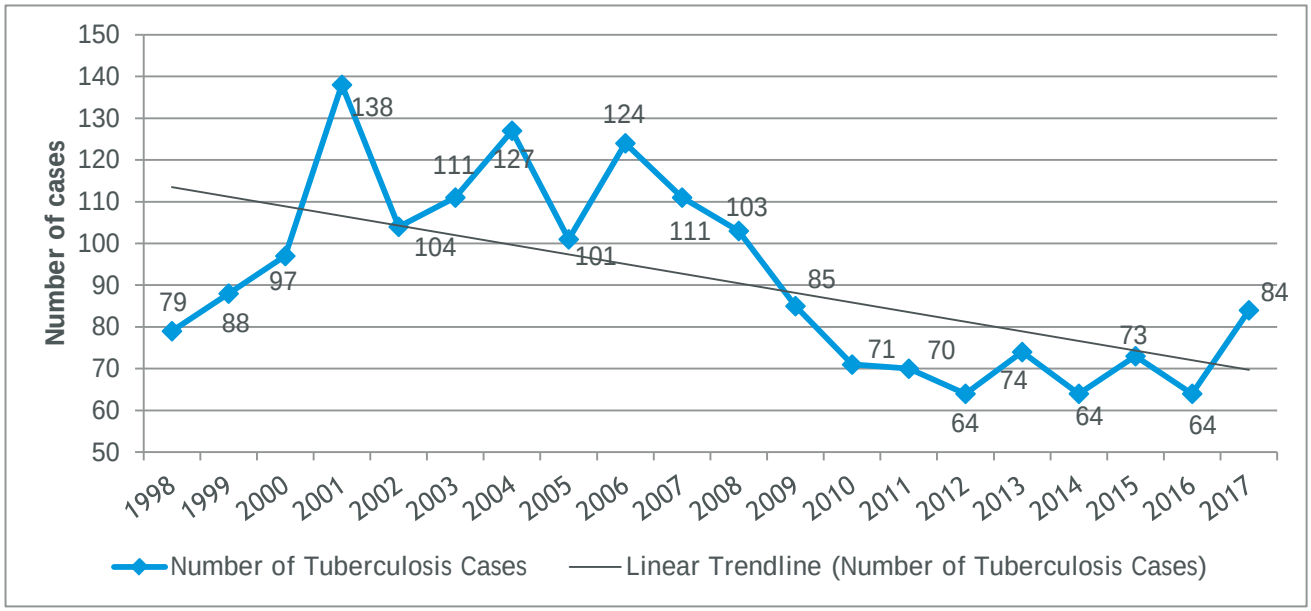
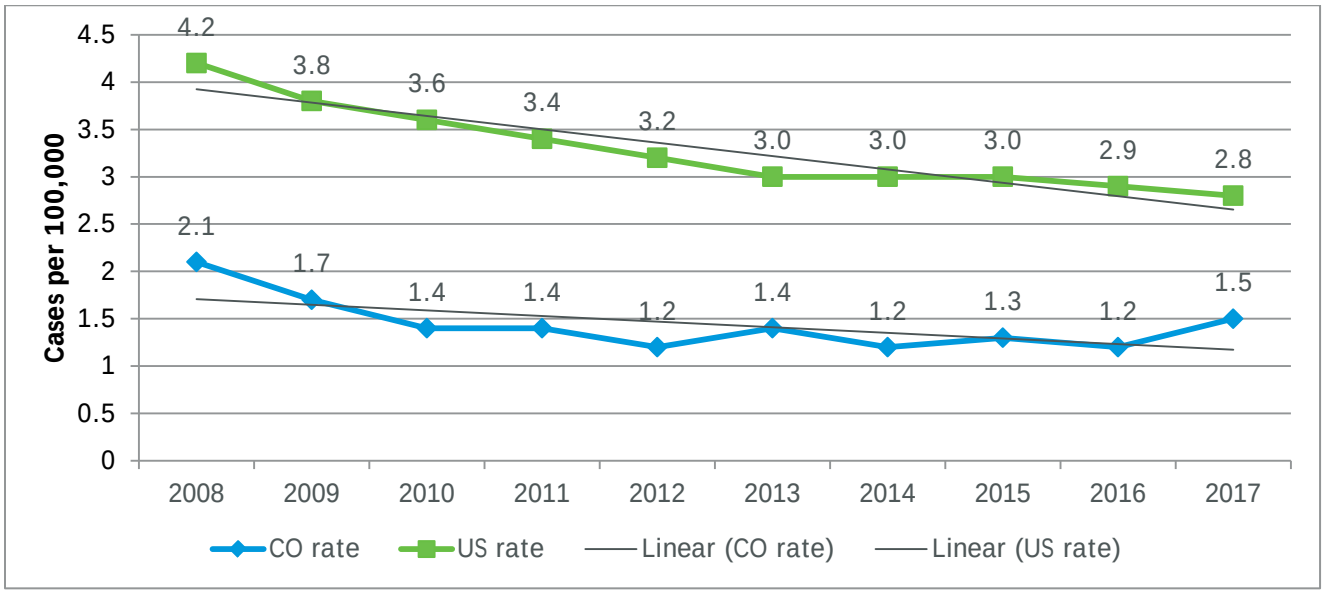


Figure 2. Case Rates per 100,000 Persons in the U.S. and Colorado 2008-2017



TB by county

Sixteen of Colorado's 64 counties reported a new person with active TB disease in 2017. Denver County reported the most with 24; followed by Arapahoe (21), El Paso (10), and Adams and Boulder counties (five each) **(Figure 3)**. Thirty-nine of Colorado's 64 counties have reported at least one new person with active TB in the past ten years **(Table 1).**

Figure 3.

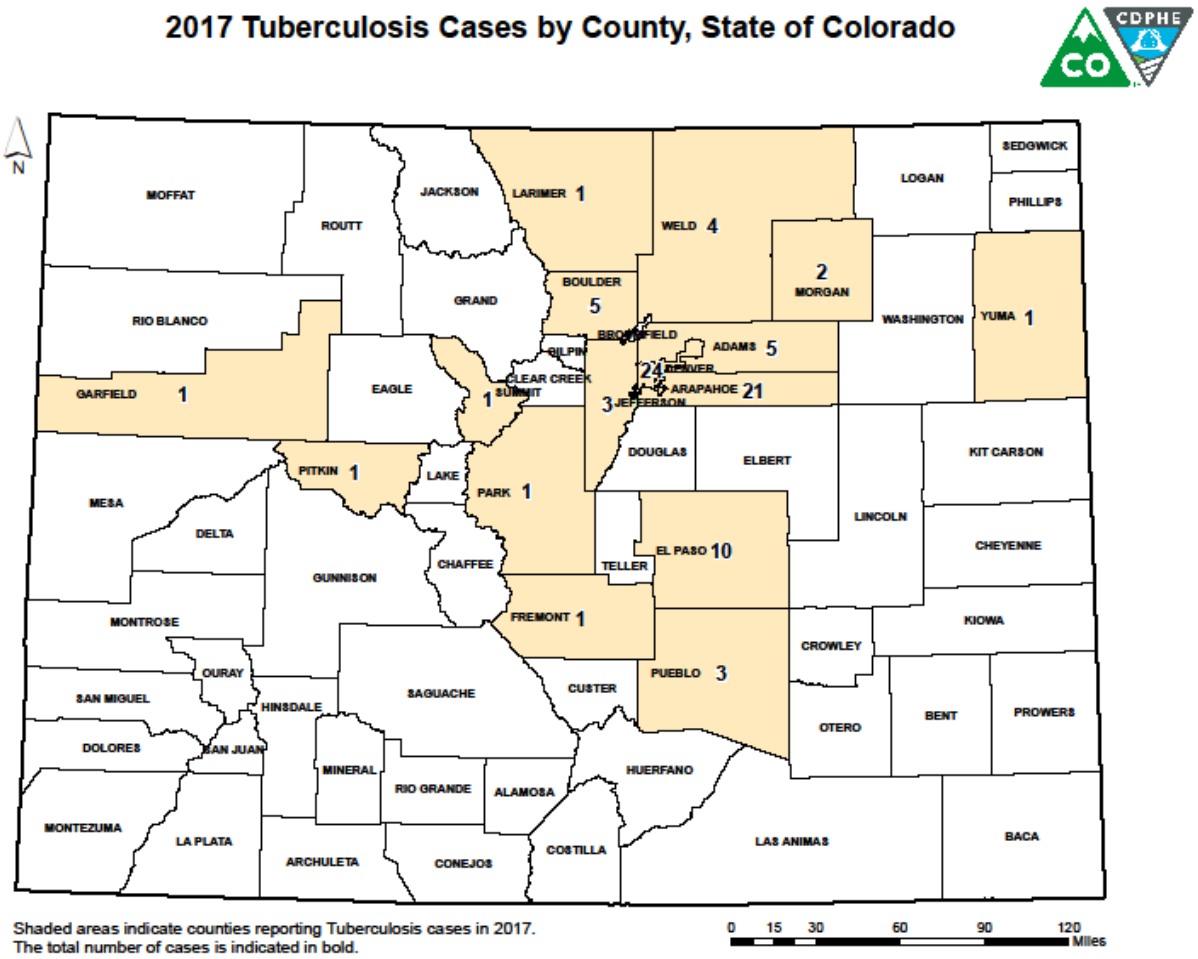


Table 1. TB in Colorado: Cases by County and Year of Report 2008-2017

County[a]	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017[b]	5-Year Case Rate 2013-2017[cd]
Adams	14	4	7	12	7	7	7	7	4	5	1.2
Arapahoe	14	11	17	5	11	14	14	14	17	21	2.6
Archuleta	0	0	0	0	0	1	0	0	0	0	1.6
Baca	0	0	0	0	0	1	0	0	0	0	5.5
Boulder	7	3	0	5	9	6	3	5	0	5	1.2
Broomfield	0	0	1	0	0	1	0	1	0	0	0.6
Clear Creek	0	1	0	0	0	0	0	0	0	0	0.0
Conejos	2	0	0	0	0	0	0	0	0	0	0.0
Delta	0	1	0	0	0	0	0	0	0	0	0.0
Denver	24	29	23	21	10	21	23	17	23	24	3.2
Douglas	3	4	1	2	1	2	1	8	1	0	0.8
Eagle	1	2	0	0	1	0	1	1	0	0	0.7
El Paso	10	7	8	7	5	8	1	3	3	10	0.7
Fremont	0	1	1	0	0	0	0	0	0	1	0.4
Garfield	1	2	0	0	0	0	1	2	2	1	2.0
Gunnison	0	2	0	0	0	0	0	0	0	0	0.0
Huerfano	0	0	1	0	0	0	0	0	0	0	0.0
Jefferson	12	8	0	8	3	2	4	3	3	3	0.5
Kit Carson	0	0	1	0	0	0	0	0	0	0	0.0
La Plata	0	0	0	0	1	0	0	0	0	0	0.0
Lake	1	0	0	0	0	0	0	0	0	0	0.0
Larimer	3	2	5	2	4	3	1	2	4	1	0.7
Las Animas	1	2	0	0	0	0	0	0	0	0	0.0
Logan	1	0	0	0	0	0	1	0	1	0	1.8
Mesa	0	1	0	1	1	2	0	1	1	0	0.5
Montrose	0	0	0	0	0	0	0	1	0	0	0.5
Morgan	1	1	0	2	1	0	1	0	1	2	2.8
Otero	1	0	0	0	0	0	0	0	0	0	0.0
Park	0	0	0	0	0	0	0	0	0	1	1.2
Pitkin	0	0	0	0	0	0	1	1	0	1	3.4
Prowers	0	0	0	0	0	2	0	0	0	0	3.3
Pueblo	3	1	2	1	1	2	2	3	2	3	1.5
Rio Grande	0	0	1	0	0	0	0	0	0	0	0.0
Saguache	1	0	0	0	0	1	0	2	0	0	9.4
San Miguel	0	0	0	0	0	0	0	0	1	0	2.5
Summit	0	0	1	0	1	0	0	0	0	1	0.7
Teller	0	1	0	0	1	0	0	1	0	0	0.8
Weld	3	2	2	4	7	0	3	1	1	4	0.6
Yuma	0	0	0	0	0	1	0	0	0	1	3.9
TOTAL	**103**	**85**	**71**	**70**	**64**	**74**	**64**	**73**	**64**	**84**	**1.3**

[a]Only counties reporting an active case of TB (2008-2017) are included.
[b] Highlighted counties reported at least one case of active TB in 2017.
[c]TB cases per 100,000 persons
[d] Population data for determining the case rates throughout this report are from the Colorado Division of Local Government, State Demography Office.

Table 2. Demographic Comparison of 2016 and 2017 Active TB Cases

	2016		2017	
	n	%	n	%
Age Group (years)				
<15	3	4.7	4	4.8
15-24	5	7.8	5	6.0
25-44	12	18.7	34	40.5
45-64	25	39.1	15	17.9
65+	19	29.7	26	31.0
TOTAL	**64**	**100**	**84**	**100**
Gender				
Male	34	53.1	47	56.0
Female	30	46.9	37	44.0
TOTAL	**64**	**100**	**84**	**100**
Race/Ethnicity				
White	9	14.1	12	14.3
Black or African American	16	25.0	20	23.8
Hispanic	25	39.1	24	28.6
American Indian or Alaska Native	0	0	1	1.2
Asian	14	21.9	25	29.8
Native Hawaiian or Other Pacific Islander	0	0	2	2.4
Multiple race/Unknown	0	0	0	0
TOTAL	**64**	**100**	**84**	**100**
Region				
Denver-metro[a]	48	75.0	58	69
Outside Denver-metro	16	25.0	26	31
TOTAL	**64**	**100**	**84**	**100**
HIV Status				
HIV Negative	57	89.1	80	95.2
HIV Positive	2	3.1	1	1.2
Testing done, results unknown	0	0	0	0
Refused testing	1	1.5	0	0
Not offered	4	6.3	3	3.6
TOTAL	**64**	**100**	**84**	**100**
Risk factors[b]				
Birth in one of the 30 highest TB-burden countries[c]	14	22.8	27	32.1
Homeless within past year	4	6.3	4	4.8
Diabetes	20	31.2	17	20.2
Resident of correctional facility at diagnosis	3	4.7	3	3.6
Resident of long-term care facility	0	0	0	0
Injected drug use within past year	2	3.1	1	1.2
Non-injected drug use within past year	3	4.7	6	7.1
Excess alcohol use within past year	6	9.4	7	8.3
Health care worker within past year	1	1.5	1	1.2

Note: percentages may not equal 100 due to rounding.
a. Denver metro includes: Adams, Arapahoe, Boulder, Broomfield, Denver, Douglas and Jefferson counties.
b. A case may have more than one risk factor indicated.
c. According to the World Health Organization's definition of 30 highest-burden countries http://www.who.int/tb/publications/global_report/en/ Annex 2. Country profiles

TB by race/ethnicity

The number of people reported with TB in Colorado for the last decade has been highest among racial and ethnic minorities. Though comprising only 31 percent of the state's population, 86 percent of new TB occurred in racial and ethnic minority populations **(Figure 4)**. At 4.3 cases per 100,000 persons the case rates in racial and ethnic minorities is 14 times that of the majority white population **(Figure 5)**.

Figure 4. TB Cases by Race/Ethnicity: Colorado, 2017

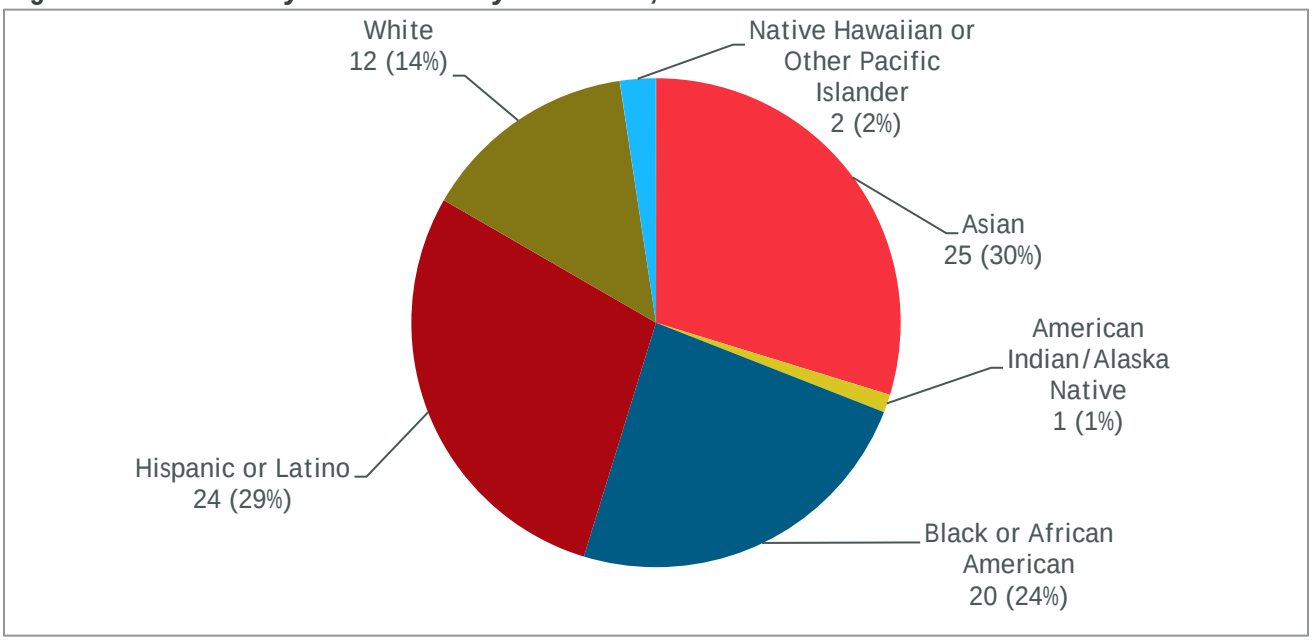
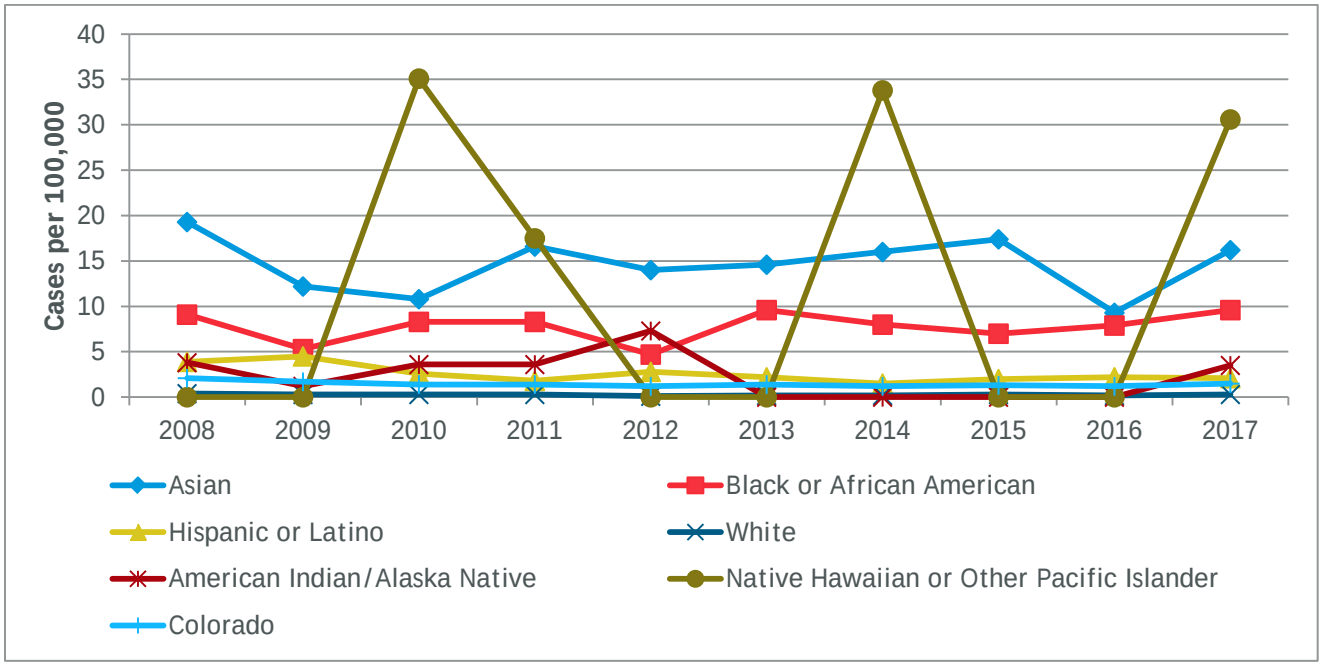


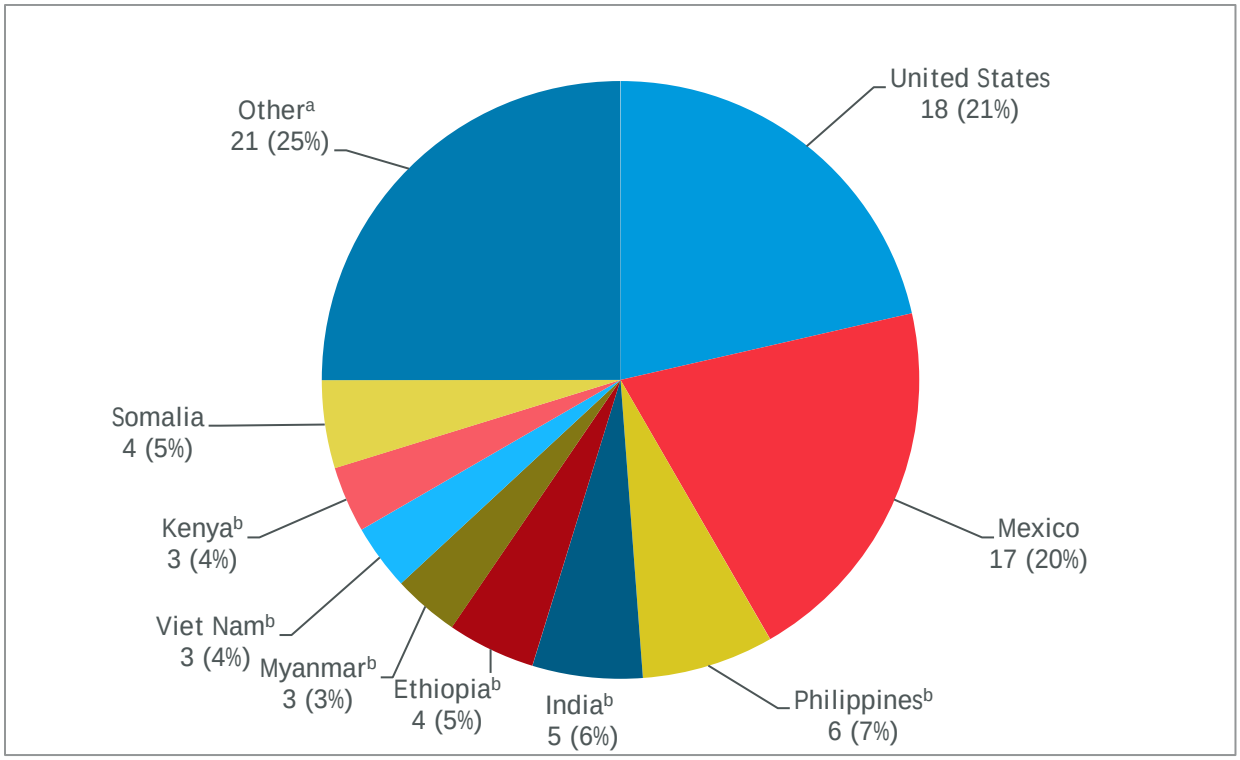
Figure 5. TB Case Rates by Race/Ethnicity: Colorado, 2008-2017



TB by country of birth

TB disease was diagnosed in people originating from 26 different countries. The largest cohort came from the United States, with 18 people, followed by Mexico with 17. Of people born outside of the United States, 27 (32 percent of all patients) came from one of the top 30 highest-burdened countries, which comprise 85-89 percent of all global active TB disease according to the World Health Organization (**Figure 6**).

Figure 6. TB Cases by Country of Birth: Colorado, 2017



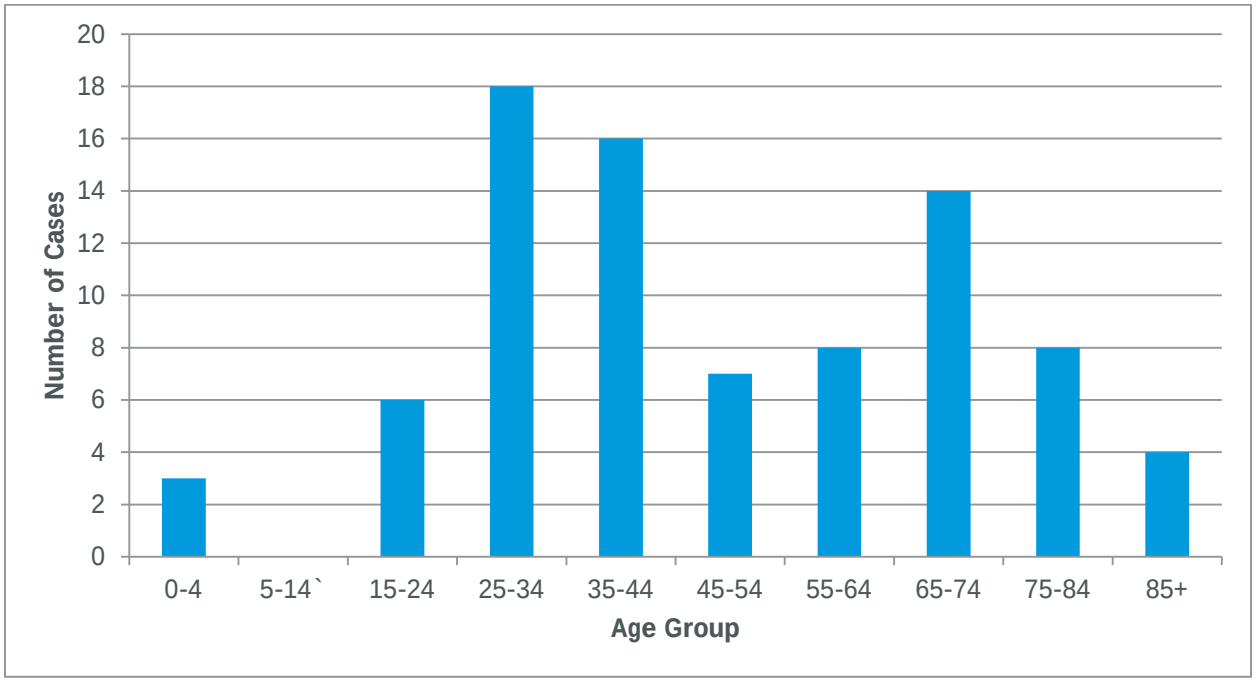
[a]Other countries: Afghanistan-2, Guatemala-2, Sudan-2, Taiwan-2, Bhutan-1, Bosnia-1, Chad-1, China[b]-1, Costa Rico-1, Guam-1, Guinea-1, South Korea-1, Liberia[b]-1, Malaysia-1, Micronesia-1, Nigeria[b]-1, Romania-1,

[b]Denotes one of the 30 highest TB burden countries according to the World Health Organization (http://www.who.int/tb/publications/global_report/en/Annex 2. Country profiles)

Tuberculosis by age group

In 2017, TB was reported among people ranging in age from one to 93 years. Forty-one percent of TB occurred among people 25-44 years old, followed by those aged 65+ years (31 percent) and those 45-64 years old (18 percent). Three new TB patients were children (<15 years of age). Active TB in children is particularly concerning, as it is a sign of recent transmission and missed opportunities for TB prevention. Of those three children, all were younger than five years. **(Figure 7).**

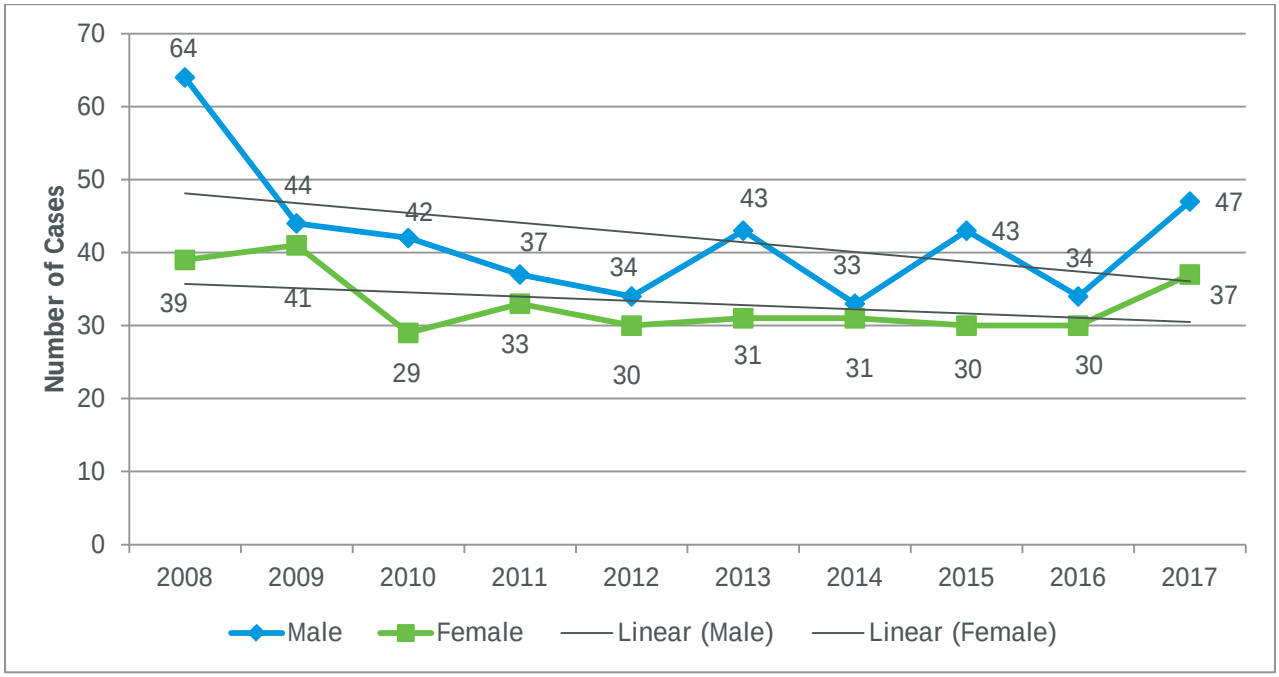
Figure 7. TB Cases by Age Group: Colorado 2017



Tuberculosis by gender

Tuberculosis tends to infect and lead to active TB disease in males more often than females. In 2017, 47 (56 percent) TB patients were male and 37 (44 percent) were female.

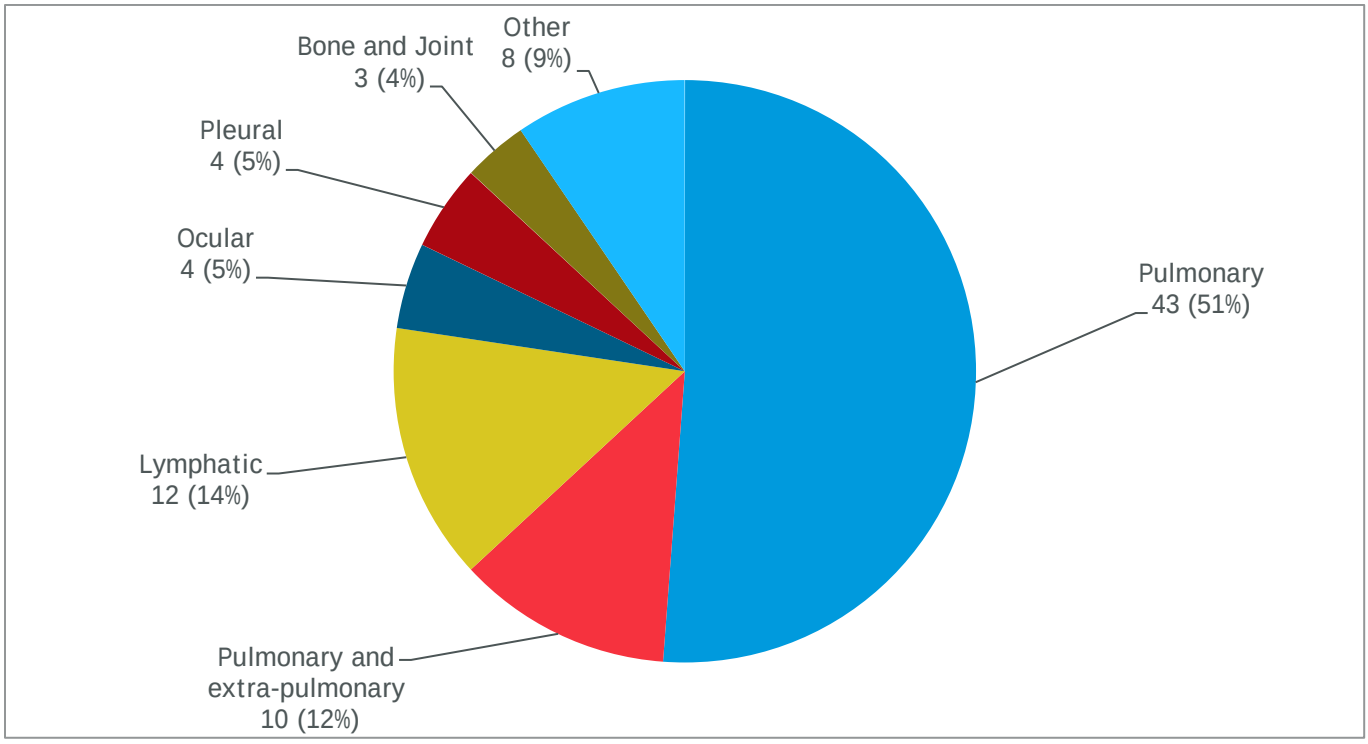
Figure 8. TB Cases by Gender: Colorado 2008-2017



Tuberculosis cases by major site of disease

Tuberculosis most often attacks the lungs (pulmonary TB) but may also affect any part of the body (extra-pulmonary TB). In 2017, 53 of the 84 (63 percent) patients were found to have pulmonary or both a pulmonary and extra-pulmonary site of disease. The next most common site of infection in 2017 was lymphatic TB, with 12 (14 percent) incidence. Sites classified as other included cutaneous-3, genitourinary-2, colon-1, meningeal-1 and pericardial-1 **(Figure 9)**.

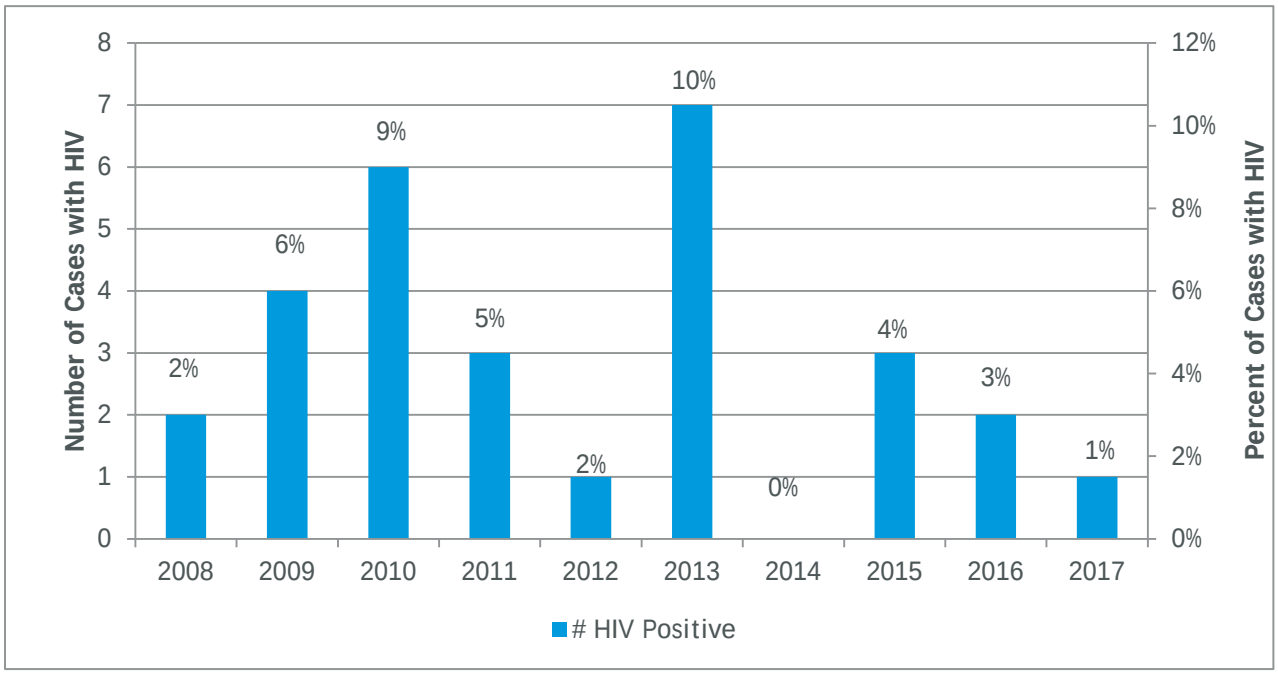
Figure 9. TB Cases by Major Site of Disease: Colorado 2017



HIV co-infection

Worldwide, one in four people with HIV who die of AIDS-defining conditions do so as a result of TB disease. HIV-infected people with TB infection are at higher risk of active TB because HIV weakens the immune system. Of the 84 people with TB in 2017, recent test results for HIV were available for 81 (96 percent of total). Of those 81, one (1.2 percent) was found to be co-infected with HIV. The three people who were not tested were not offered an HIV test (**Figure 10)**. Over the past 10 years, HIV/TB co-infection has fluctuated between seven cases in 2013 to zero cases in 2014. When analyzing small numbers, the annual percentages can fluctuate widely, and incidence rates, being unstable and imprecise, are likely to lack statistical significance.

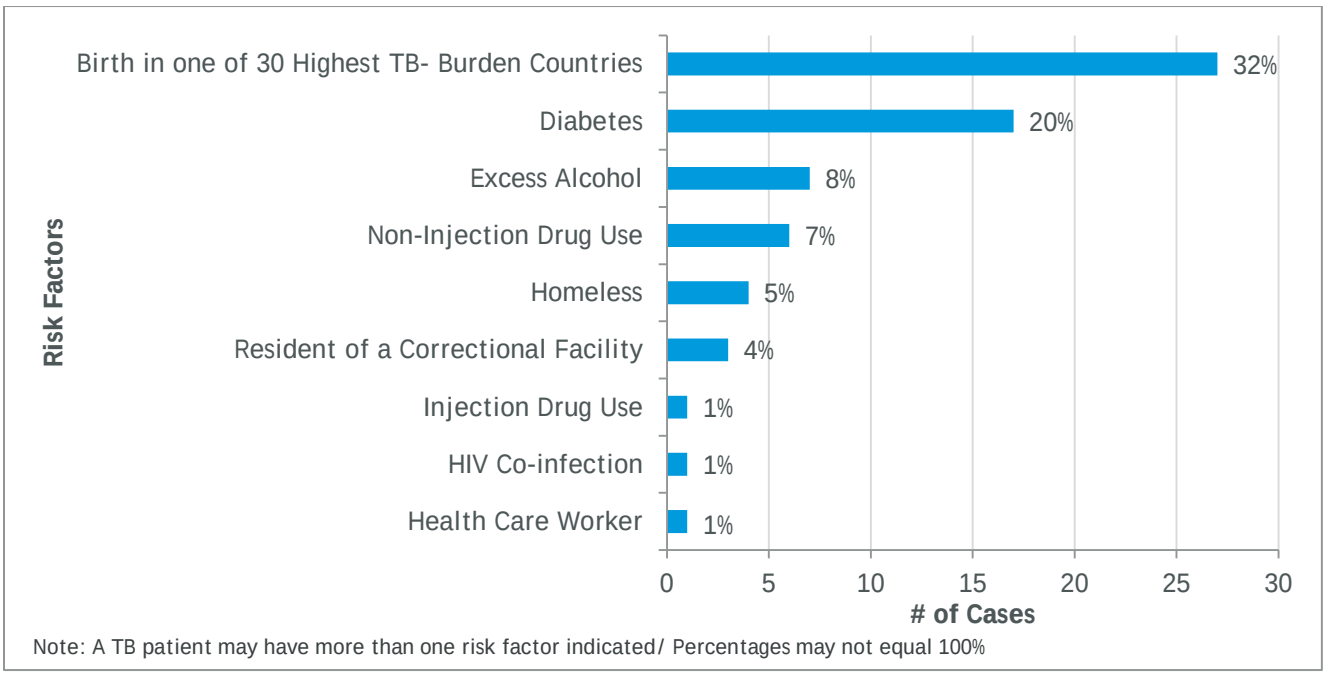
Figure 10. HIV-Positive TB Cases and Percentage of Annual Total: Colorado 2008-2017



Risk factors

In 2017, the most common risk factor for active TB was birth in one of the 30 highest TB-burden countries, followed by diabetes.

Figure 11. Risk Factors for TB: Colorado 2017

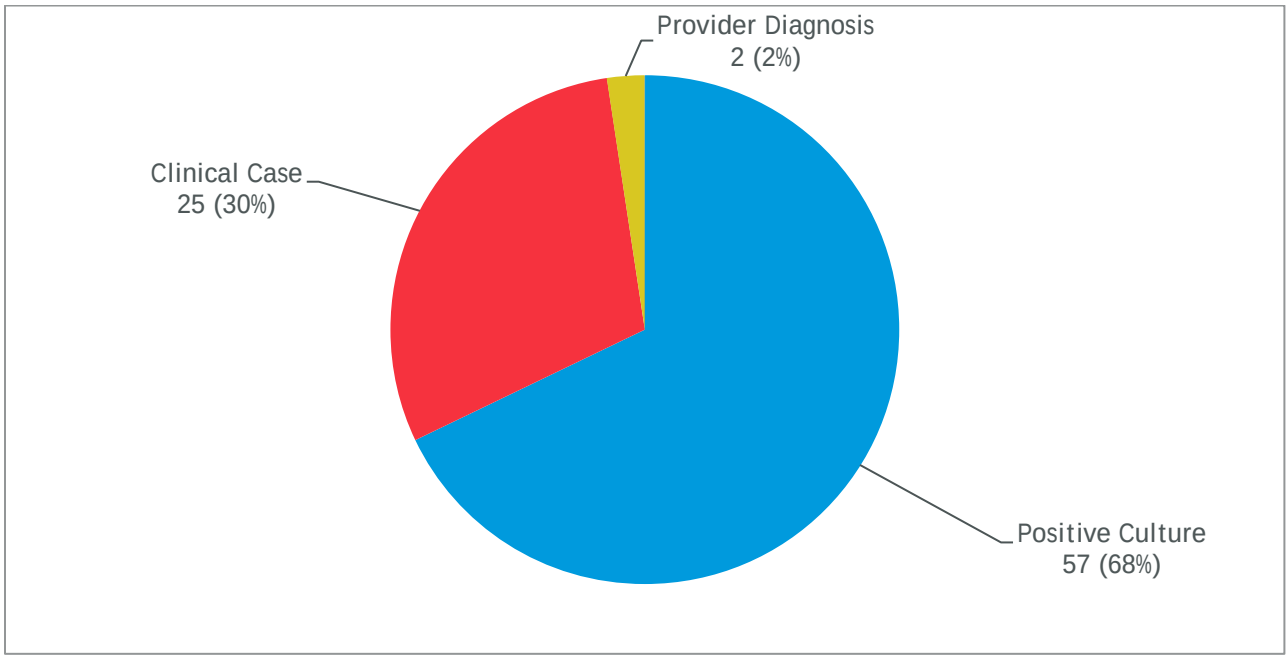


Note: A TB patient may have more than one risk factor indicated/ Percentages may not equal 100%

Tuberculosis case verification

Mycobacterium tuberculosis complex was culture-positive in 68 percent of the TB patients in 2017. Another 30 percent met the clinical case definition (positive tuberculin skin test or interferon gamma release assay with an abnormal chest radiograph), and 2 percent were verified by provider diagnosis.

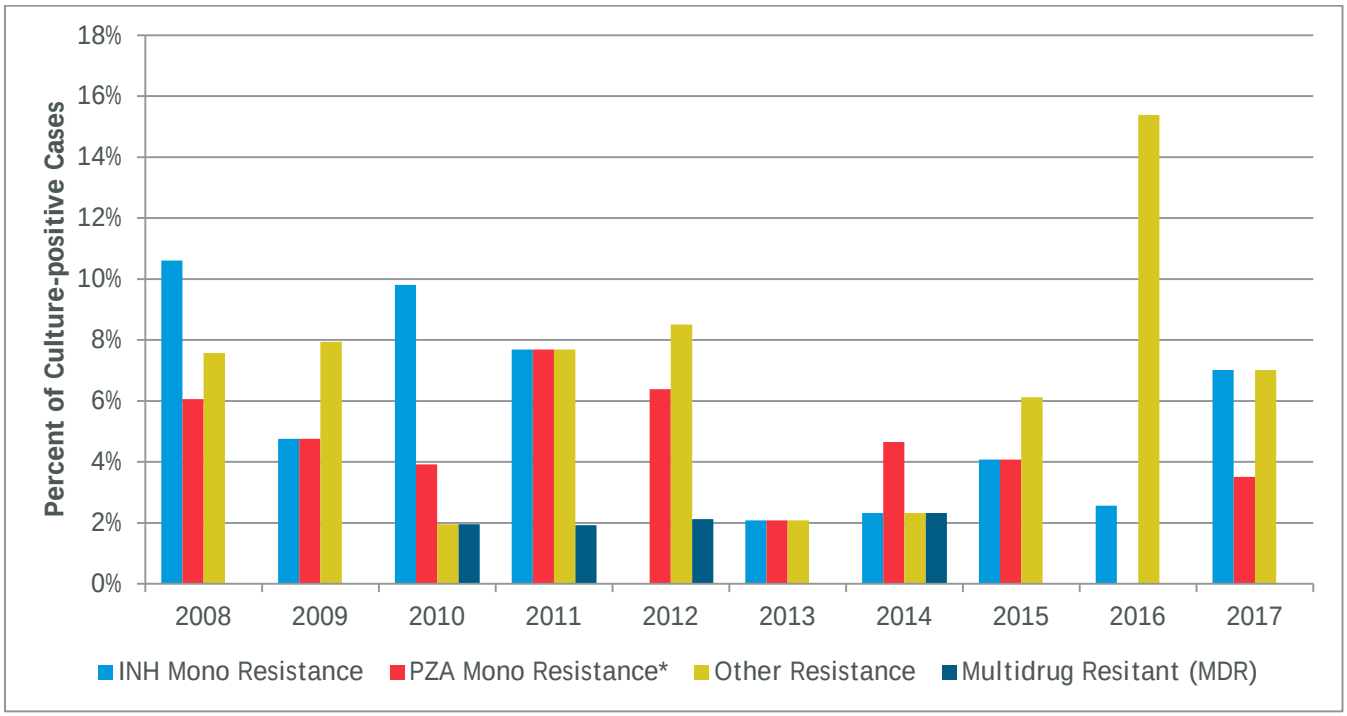
Figure 12. TB Cases by Verification Criteria: Colorado 2017



Drug resistance and tuberculosis

Of the 84 new TB patients reported in 2017, 57 (68 percent) had a positive culture and of those, ten were found to be resistant to one or more TB drugs. Seven (12 percent) were resistant to one or more of the four first-line TB drugs: isoniazid (INH), rifampin (RIF), pyrazinamide (PZA) and ethambutol (EMB). Of those seven patients, four had INH mono-resistance, two were resistant to PZA and one was resistant to INH and streptomycin. The other three patients were resistant to streptomycin (not considered a first-line TB drug and not currently used to treat TB). There was no multi-drug resistant (MDR: defined as being resistant to at least INH and RIF), or extensively-drug resistant TB (XDR-TB) identified in 2017 **(Figure 13)**.

Figure 13. TB Drug Resistance: Colorado 2008-2017

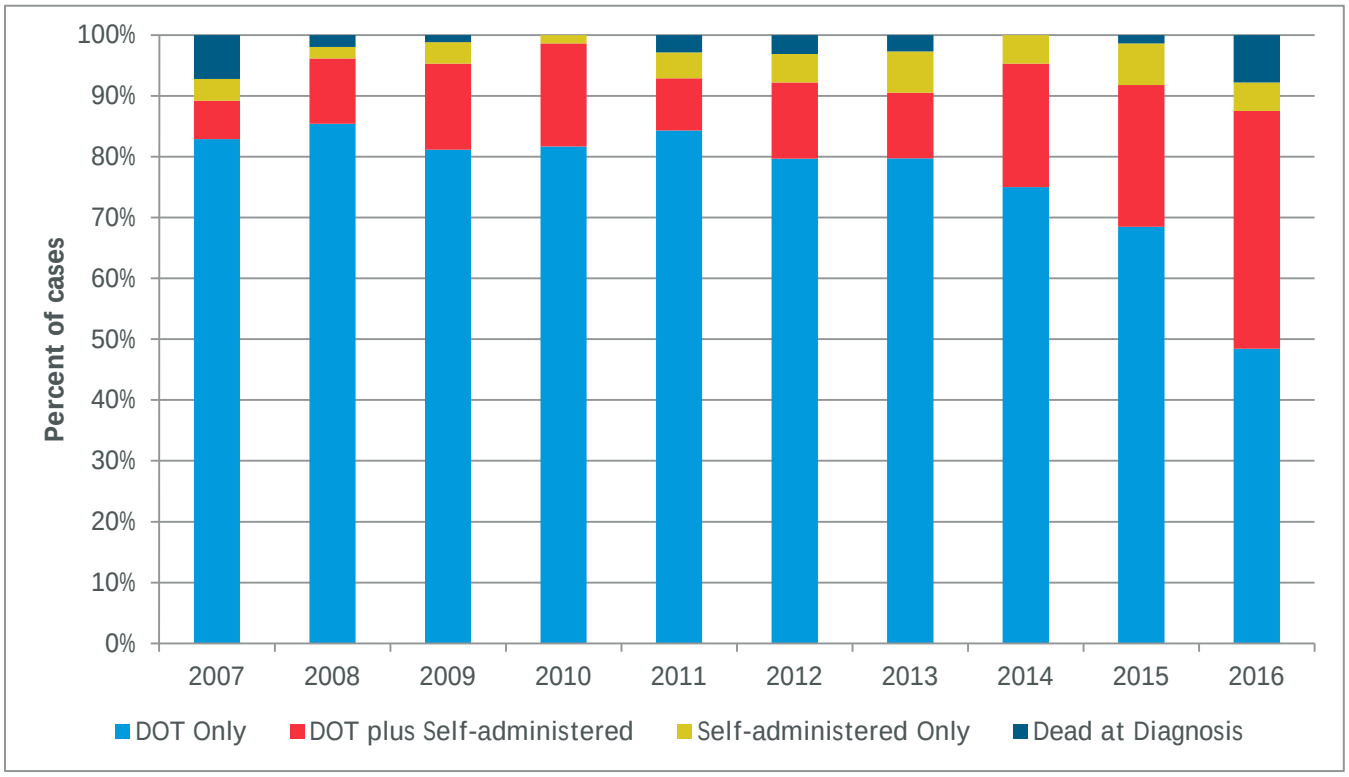


*Isolates with PZA resistance may indicate *Mycobacterium Bovis*, a form of tuberculosis, which causes tuberculosis in humans, cattle, and mammals. It is characteristically resistant to PZA.

Directly observed therapy

Directly observed therapy (DOT) is required for all patients with pulmonary TB in Colorado and means health care workers observe the patient taking every dose of his/her medications. During 2016 (the most recent year with complete data), 48 percent of patients received medications via DOT, 5 percent self-administered medications (non-infectious extra-pulmonary patients) and 39 percent received a combination of DOT and self-administered therapy. Five patients did not initiate treatment (4 patients were dead at diagnosis and another died prior to initiating treatment) **(Figure 14).**

Figure 14. Mode of TB Therapy: Colorado 2007-2016



Tuberculosis treatment outcomes

The standard treatment for active TB disease is six months using isoniazid, rifampin, ethambutol and pyrazinamide. Of the 64 patients in 2016, (the most recent year with complete data), four patient were dead at diagnosis and one died prior to initiating treatment. Of the remaining 59 eligible TB patients; 47 completed treatment; two were lost to follow-up; two did not complete a full course of treatment; seven died during treatment; and one moved outside the U.S. before treatment completion (completion data unavailable). The 2016 completion rate was lower than normal due to the two lost to follow-up and two others who chose not to continue treatment. All 2017 patients have initiated treatment.

Figure 15. TB Treatment Outcomes: Colorado 2016

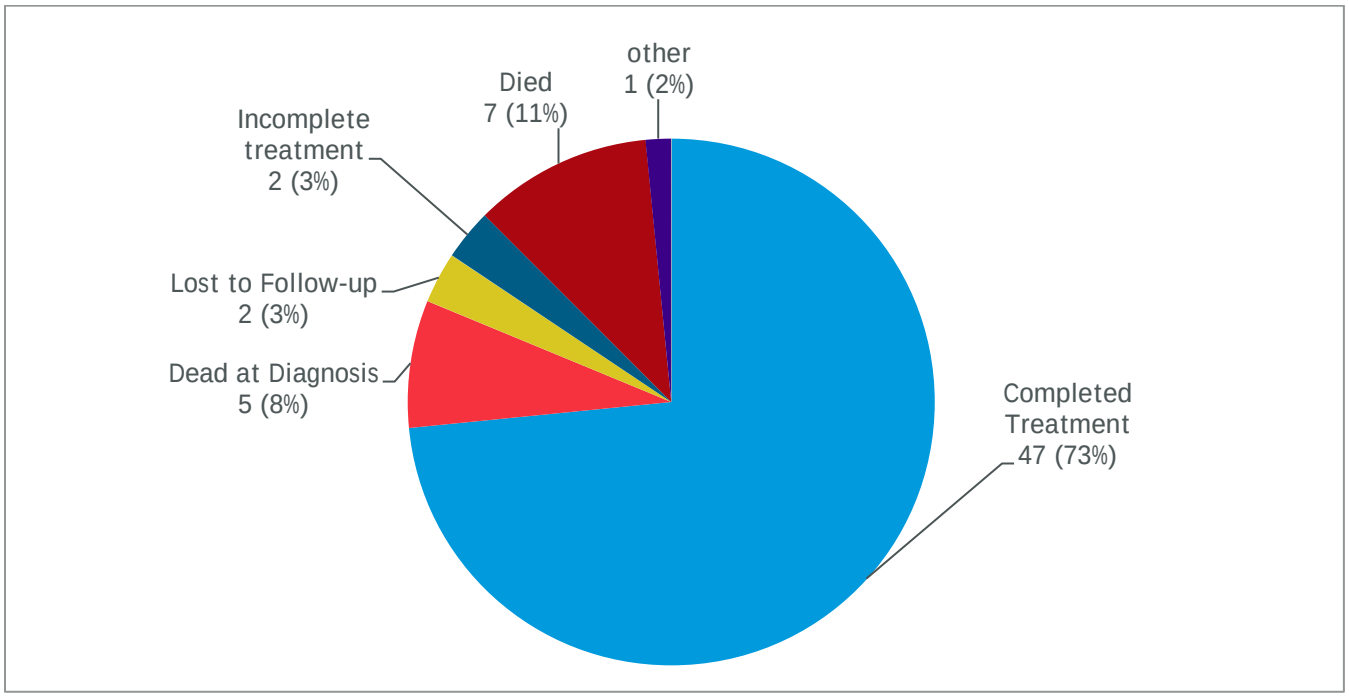
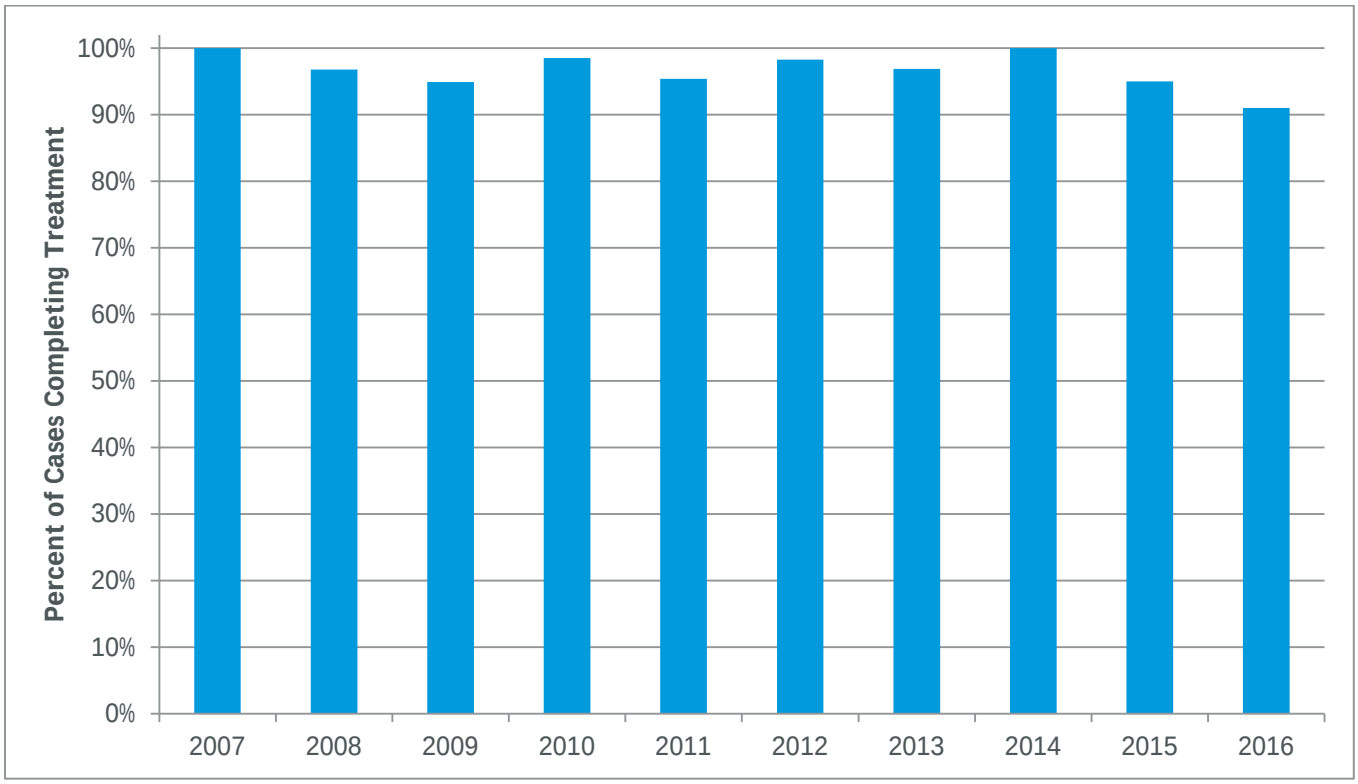


Figure 16. Completion of TB Treatment within One Year: Colorado 2007-2016



Note: Excludes cases with rifampin-resistant disease, cases with meningeal, bone and/or joint, or central nervous system disease, cases less than 15 years of age with disseminated tuberculosis disease, and cases that died less than one year after treatment initiation or moved out of the country.

Cascade of care for individuals at high risk for TB infection

The key strategy for eliminating TB is to identify and treat people with TB infection who are at high risk of developing active disease. Timely evaluation of people identified as contacts to an infectious TB patient and of those who arrive in Colorado with a Class B TB designation is vital to the success of this strategy. Class B TB is designated in immigrants and refugees who are traveling to the United States. They are evaluated for TB prior to arrival as required by U.S. immigration law and are assigned a classification according to the status of their disease. The Division of Global Migration and Quarantine notifies CDPHE's TB Program of all individuals who are known to be non-infectious but are in need of additional TB evaluation (referred to as Class B TB). By evaluating those at high risk for infection additional cases of both active TB disease and TB infection are identified and treated.

Figure 17. Cascade of Care for High Risk Individuals (Contacts and Class B TB): Colorado 2016

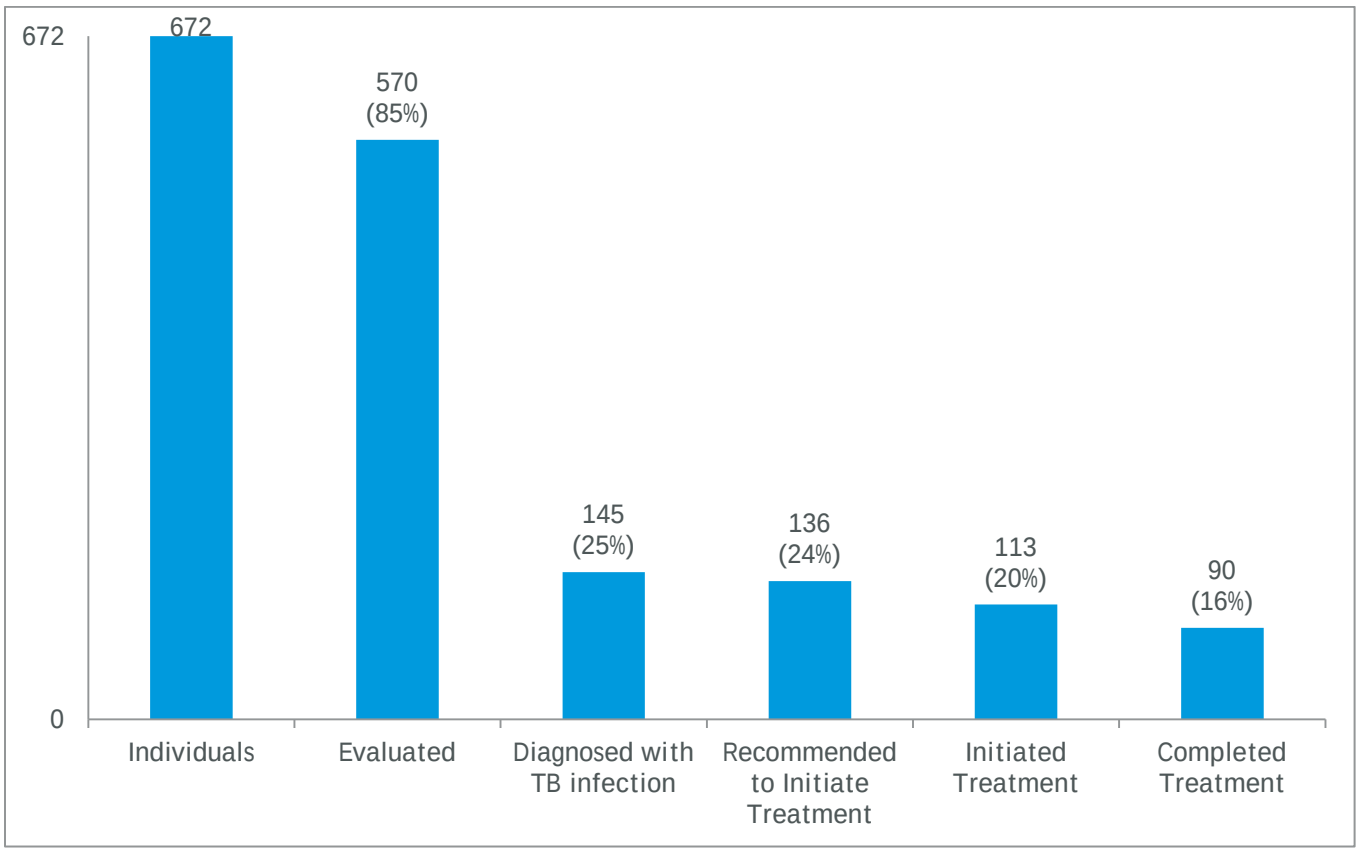


Table 3. Treatment Outcomes for High Risk Individuals (Contacts and Class B TB) Recommended to Initiate LTBI Treatment: Colorado 2016

Outcomes	No.	(%)
Total Diagnosed with TB Infection (LTBI)	145	(100%)
Completed Treatment	90	(62%)
Did Not Initiate Treatment	32	(22%)
Did Not Complete Treatment (Reasons below)		
Died	0	(0%)
Moved	4	(3%)
Developed Active TB	0	(0%)
Adverse Effect/s	6	(4%)
Patient Chose to Stop	0	(0%)
Lost to Follow-up	6	(4%)
Provider Decision to Stop	1	(1%)
Pending Outcome Documentation	6	(4%)

Conclusions and Next Steps

Active TB cases in Colorado increased in 2017 from 2016. The case rate in Colorado increased from 1.2 to 1.5 per 100,000 due to the 31 percent jump observed. This may be a one-time uptick or the first indication that increased TB vigilance among providers has resulted in a decrease in missed or delayed diagnoses. This also could be reflected in the drop from 2016 in those dead at diagnosis and those who died while on TB treatment. With the small numbers underlying these percentage changes, it is unclear if this one-year rate increase will develop into a more clearly defined upward trend after years of small fluctuations. Private providers and local public health agencies must continue to identify and screen those most at risk for TB infection and initiate treatment where appropriate in order to reduce the chance of developing TB disease. As the demographic breakdowns in this report attest, the key risk factors and the most at-risk groups for developing TB disease have been identified (see Figures 5 and 11). TB elimination plan activities initiated in 2017 include comprehensive over-the-phone interpretation for TB patients and those suspected of having TB, the rollout of video directly-observed treatment services (V-DOT), and expanded access to reliable, no cost (to patient or local public health agency) TB blood testing services. Next steps for 2018-2019 include the continued expansion of V-DOT services to local public health agencies statewide. Monthly enhanced TB case management (ECM) sessions to educate providers and increase capacity among those caring for TB patients will continue. These ECM sessions allow non-Denver-metro LPHAs and providers the opportunity to review current patients with subject matter experts from CDPHE and the Denver Metro

TB Clinic via a web-based, HIPAA-compliant platform. Other plans include developing site-specific screening and testing algorithms to succinctly explain the chronological steps necessary for private providers to care for their TB-infected patients without over-burdening local public health agencies with referrals, as past practice dictated.

It will be both a challenge and an opportunity to engage affected communities and populations in TB elimination activities. CDPHE's TB Training and Education Coordinator at CDPHE will oversee the planning, collaboration, and implementation of these activities. Community participation is essential to developing meaningful messaging that will resonate with their peers. TB stakeholders throughout Colorado look forward to working with new partners toward a shared vision of reduced TB morbidity and mortality among Coloradans. Reducing health disparities through policies, practices and organizational systems can help improve opportunities for all Coloradans.

Colorado's TB elimination plan is available on the TB Program website https://www.colorado.gov/pacific/cdphe/tb