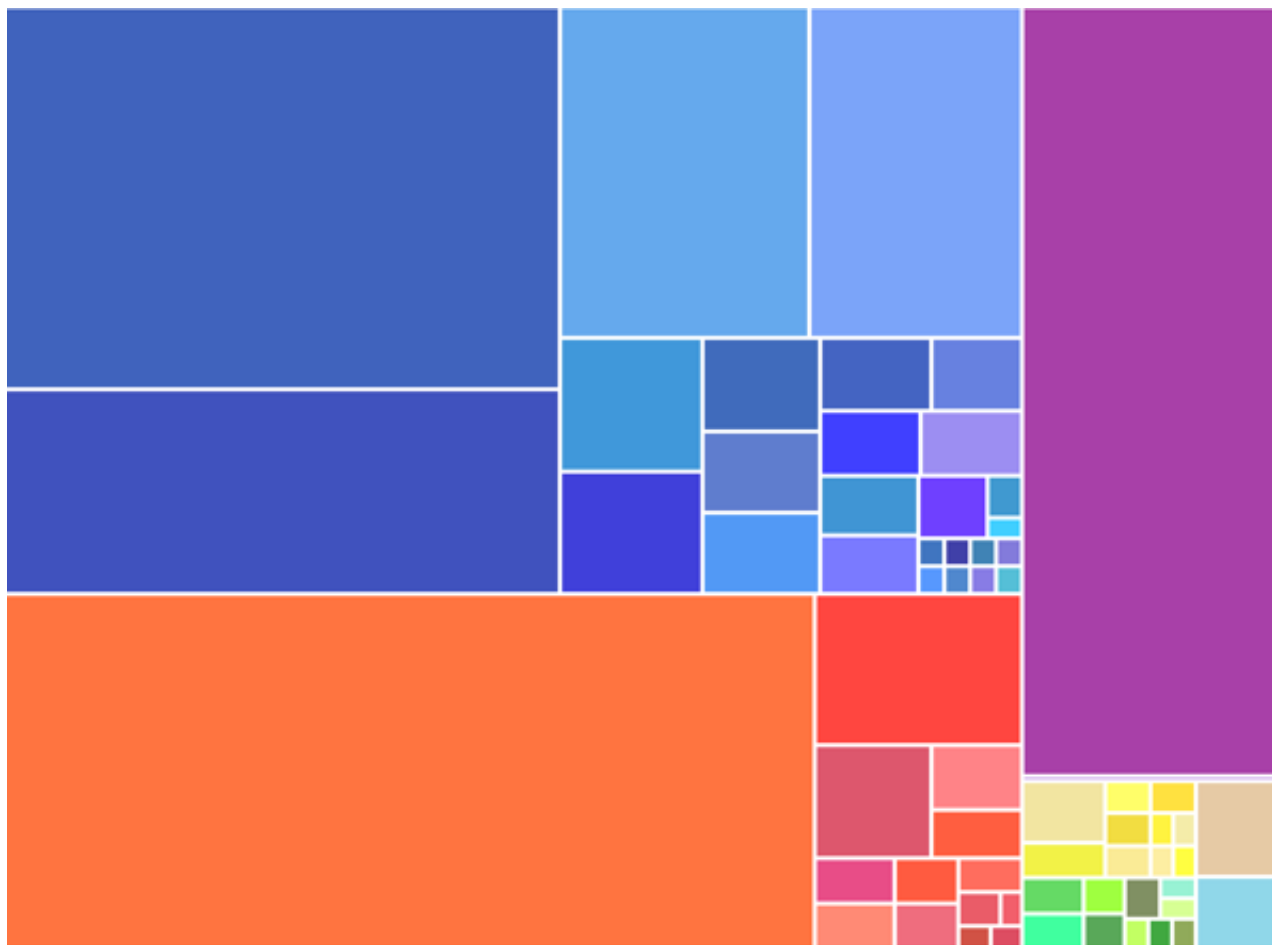


Report on Tuberculosis in California, 2021



Gavin Newsom, Governor
State of California
Mark A. Ghaly, MD, MPH, Secretary
California Health and Human Services Agency
Tomás J. Aragón, MD, Dr. PH, Director and State Public Health Officer
California Department of Public Health



Report on Tuberculosis in California, 2021

Gavin Newsom
Governor
State of California

California Department of Public Health
Center for Infectious Diseases
Division of Communicable Disease Control
Tuberculosis Control Branch
850 Marina Bay Parkway
Richmond, CA 94804-6403
(510) 620-3000

November 2022



Report on Tuberculosis in California, 2021
California Department of Public Health
Center for Infectious Diseases
Division of Communicable Disease Control
Tuberculosis Control Branch

November 2022

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This report and related Excel data tables can be found at the [CDPH TB Disease Data page](https://www.cdph.ca.gov/tbdata) (<https://www.cdph.ca.gov/tbdata>)

Tuberculosis Control BranchJennifer Flood, MD, MPH, Chief

Surveillance and Epidemiology Section Pennan Barry, MD, MPH, Chief
Adam Readhead, PhD, MPH

Tuberculosis RegistryVarsha Hampole, MPH, Chief
Emily Han, MPH
Maria Carter, MPH
Rebecca Wang

Division of Communicable Disease ControlSeema Jain, MD, Chief

For more information, contact the Tuberculosis Control Branch at the following address and phone number:

850 Marina Bay Parkway
Building P, 2nd Floor
Richmond, CA 94804-6403
Phone: (510) 620-3000

Cover figure: The cover displays number of 2021 cases by country of birth with each square representing one country



TOMÁS ARAGÓN, MD, Dr. PH
Director and State Public Health Officer

State of California—Health and Human Services Agency
California Department of Public Health



GAVIN NEWSOM
Governor

December 31, 2022

Dear Colleagues,

I am pleased to present the 2021 Report on Tuberculosis in California. Last year, California reported 1,752 new TB cases, a three percent increase compared with 1,704 cases in 2020, but a 17% decline since 2019. This overall decrease likely reflects the continuing effects of the COVID-19 pandemic. Although there are several potential ways that the pandemic could have affected TB case reporting, the decline since 2019 triggers concern that TB cases may have gone undiagnosed and unreported. I expect further increases in TB cases as pandemic conditions recede.

Many aspects of TB in California remained unchanged. The case rate remained nearly twice the national rate; 4.5 cases per 100,000 population compared with 2.4 nationally. Disparities by country of birth and between racial and ethnic groups continue to persist. Overall, 84% of TB cases occurred among those born outside the United States. The TB rates among people of Asian, Black, and Hispanic race or ethnicity born outside the United States were 52, 38, and 23 times greater, respectively, than among White people born in the United States. Children continue to be sickened by TB and they have an increased risk of the most severe forms of TB including disseminated TB and TB involving the central nervous system. An alarming proportion of people ill with TB continue to die. In 2019, the most recent year for which complete death data is available, 11.5% of people diagnosed with TB died, a proportion not seen since 1993. Nearly one-fifth of those who died did not survive long enough to be started on treatment. Tragically, at least 4 adolescents died before starting TB treatment in 2021.

This report also contains some hints at hopeful news. The number of cases among children under the age of 5 years remains low with 24 cases in 2020 compared with 82 cases ten years ago. The number and proportion of cases that were multidrug-resistant (MDR) remained low ($n=12$, 0.7% of cases) in 2021. The vast majority (87%) of TB in California continues to be attributable primarily to progression of longstanding TB infection and thus is preventable by testing for and treating latent TB infection to prevent progression to active TB disease. Preventing TB in communities at risk for TB will promote health equity and prevent Californians from dying or being sickened by TB.

Despite the significant challenges associated with responding to the COVID-19 pandemic while fighting TB in 2021, we look forward to continuing to work together with our partners to control TB and toward our ultimate goal of a TB-free California.



With many thanks for all that you do,

Jennifer Flood, M.D., M.P.H., Chief,
Tuberculosis Control Branch
Division of Communicable Disease Control
Center for Infectious Diseases
California Department of Public Health

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Introduction

Tuberculosis (TB) case reports are submitted to the California Department of Public Health (CDPH), TB Control Branch (TBCB), by 61 local health jurisdictions (58 counties, and the cities of Berkeley, Long Beach, and Pasadena). In 1993, the Centers for Disease Control and Prevention (CDC), in conjunction with state and local health departments, began using the Report of Verified Case of Tuberculosis (RVCT) to collect information on each case of TB. The RVCT includes demographic and clinical characteristics of TB cases, as well as information on drug resistance, risk factors for TB, and treatment outcomes. In 2009, CDC released an expanded RVCT that collects additional information to address the changing epidemiology of TB in terms of risk factors, new drug treatments, and enhanced laboratory capacity for diagnostic tests. California implemented this revised RVCT January 1, 2010. This version has been used for case data collection through 2021. Another revision of the RVCT will be used in future reports starting with 2022 case data collection. The latest update includes molecular drug susceptibility test results, an important laboratory tool to monitor drug resistance, as well as supplemental data collection on Multi-Drug Resistant (MDR) TB, and other elements critical to understanding the TB epidemic.

CDPH Division of Communicable Disease Control has been using an internet-based surveillance system for reportable diseases including TB since January 2010. This system, California Reportable Disease Information Exchange (CalREDIE), allows all jurisdictions in California to submit TB case reports and access their local data on-line in a timely manner.

Acknowledgment

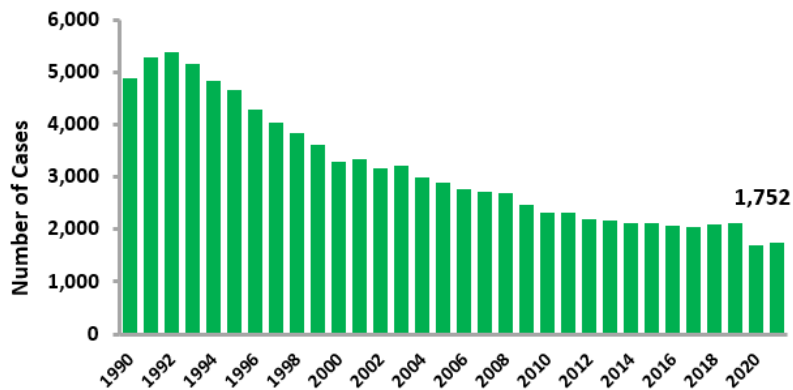
TBCB would like to thank surveillance and reporting staff in all local reporting jurisdictions. Without their hard work we would not have data for this publication. We also acknowledge the support of our partners at CDC's Division of Tuberculosis Elimination.

TB in California: 2021 Summary

Tuberculosis (TB) disease is an illness caused by the bacteria *Mycobacterium tuberculosis*. TB usually affects the lungs and spreads through the air when a person sick with TB coughs. Not everyone infected with the bacteria becomes sick. People that have been infected but are not sick have latent tuberculosis infection (LTBI). People with LTBI can become sick with TB disease in the future if they are not treated.

California continues to have a high rate of TB

Reported TB Cases: California, 1990–2021



- In 2021, California reported **1,752** new TB cases, a three percent increase compared with 1,704 in 2020.
- California's annual TB incidence was **4.5** cases per 100,000 persons; nearly double the national incidence rate of 2.4
- The overall decrease in TB cases since 2019 is likely at least partially due to the COVID-19 pandemic. Possible reasons include fewer cases in persons born outside the U.S. because

of decreased international travel and immigration during the pandemic, fewer patients seeking care or receiving a diagnosis of TB, and decreased transmission of TB due to masking and other COVID restrictions. CDPH expects further increases in TB cases as pandemic conditions recede.

- Medical and societal costs of TB reached **\$203 million** in California in 2021.
- TB was reported in 42 of California's 61 (69%) local health jurisdictions; 15 (25%) jurisdictions reported 1-4 cases.
- The vast majority of TB cases (87%) were attributable to progression of LTBI to active TB while an estimated 3% of cases were in persons who arrived in California with active TB disease from outside the United States, and another 10% resulted from recent transmission.
- In 2021, 24 cases (1.4%) were reported in children under 5 years of age; all of whom were born in the United States. Among these, 79% occurred in Hispanic children. Central nervous system (CNS) TB, a serious complication of TB, occurred in 17% of these children.
- In 2021, there were 4 new TB outbreaks and 16 ongoing outbreaks in 8 jurisdictions, each involving at least 4 persons.
- During 2017-2019, 670 persons (11% of TB cases) died with TB. Of those, 20% died before receiving TB treatment.
- In 2019, the most recent year for which complete data is available, 11.5% of people diagnosed with TB died, a proportion not seen since 1993.
- Among persons reported with TB in 2019 who started anti-TB treatment, 85% completed treatment.
- **>2 million** Californians (6% of the population) have LTBI. Without treatment LTBI can progress to active TB.

TB and COVID-19

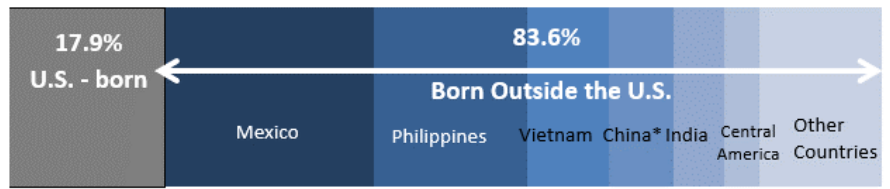
- Among 2210 persons with TB disease during September 2019-December 2020, 225 (10%) also had COVID-19 infection identified in 2020. TB and COVID-19 occurred in close succession (within 120 days) among 91 cases.
- Among the 91 people with TB/COVID-19, 60% were Hispanic and 45% resided in low health equity census tracts, highlighting health disparities in both COVID-19 and TB. People with TB and COVID-19 had higher mortality than those with either disease alone.

TB in California: 2021 Summary

TB in People Born Outside the United States

- The TB rate among persons born outside the U.S. (13.6 per 100,000) was **12 times** higher than the rate among U.S.-born persons (1.1 per 100,000).
- Half** of TB cases in non-U.S.-born persons occurred more than 20 years after arrival in the U.S.
- Among the most common countries of birth for people with TB in California, people born in Philippines (35.6 per 100,000) and Vietnam (30.5 per 100,000) had the highest rate of TB.

Proportion of TB Cases by National Origin, California, 2021



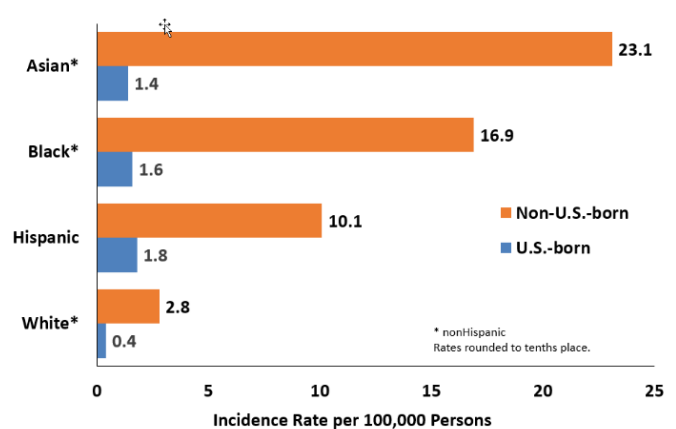
*People's Republic of China includes Hong Kong and Macau

Severe Racial and Ethnic Disparities

- The rates among people born outside the U.S. that are Asian* and Black* were **52 and 38 times higher** respectively than White* people born in the U.S. The rate among non-U.S.-born Hispanic people was 23 times that of U.S.-born White* people.
- Rates in each non-U.S.-born racial and ethnic group were higher than among U.S.-born persons in the same group.
- Nearly half (49%) of California's TB cases occurred in Asian* persons, and 41% of cases occurred in Hispanic persons.

* non-Hispanic

TB Rates by Place of Birth and Race and Ethnicity, California 2021



* non-Hispanic
Rates rounded to tenths place.

Comorbidities

- 40%** of adult TB cases had diabetes mellitus, end stage renal disease, HIV infection, or another condition that can increase the risk of progression from latent to active TB disease.
- The most common comorbidity was diabetes mellitus (30% of adult cases).
- HIV infection increases the risk of progression from LTBI to active TB disease, as well as for death with TB.
- In 2021, 88% of patients with TB were tested for HIV. Of those tested, 60 (**3.9%**) were HIV-positive, a decline from 101 (5.4%) in 2011, the first year these data were reported in California on the TB case report form.

Diagnosis and Management of TB

- The results of nucleic acid amplification (NAA) tests, used to identify *Mycobacterium tuberculosis*, can be available within hours after specimen collection, resulting in earlier detection and treatment of TB cases.
- NAA tests were used in 75% of cases reported in 2021.
- In 2021, pulmonary disease was diagnosed in 82% of TB cases, indicating a risk of transmission to others; of those, 16% also had TB in another site. Eighteen percent of TB patients had only extrapulmonary disease.
- Of pulmonary TB cases with an abnormal chest x-ray, cavitation was seen in 21%, indicating more advanced disease.
- TB was diagnosed by laboratory findings in 86% of cases; 14% of cases were clinically confirmed.

TB in California: 2021 Summary

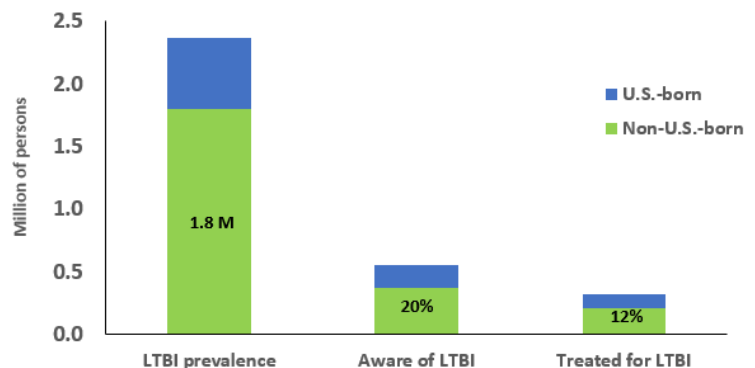
Multidrug-Resistant TB

- Multidrug-resistant (MDR) TB is TB resistant to the two most potent first line drugs, isoniazid and rifampin. Extensively drug-resistant (XDR) TB is MDR TB additionally resistant to two classes of drugs, fluoroquinolones and injectables.
- Patients with MDR and XDR TB generally have poorer outcomes.
- In 2021, there were 12 (0.7%) MDR TB cases in California, compared to 35 (1.5%) reported in 2011.
- Despite a worldwide increase in MDR TB, the proportion of TB cases in California that are MDR has remained constant (1-2%) since drug susceptibility data began being systematically collected in 1993.
- Since 1993, the start of routine tracking of drug resistance, 25 XDR TB cases have been reported in California. During 2017-2021, three XDR cases were reported.

TB can be prevented with LTBI treatment

- More than 2 million Californians have LTBI. Approximately 1.8 million were born outside the U.S., of whom only 20% are aware of their LTBI and only 12% have been treated.
- Because an estimated 87% of cases occur because of progression from LTBI, treating LTBI will prevent many TB cases in California.
- CDPH released a practical guidebook focused on TB prevention for medical providers and health system leaders who want to prevent TB in their patients - "[Preventing Tuberculosis in Your Clinical Setting: A Practical Guidebook](#)".
- The U.S. Preventive Services Task Force recommends testing and treating for LTBI ([USPSTF LTBI Screening](#)).
- [Risk assessment tools](#) are available for use by medical providers to identify persons at risk for LTBI for testing and treatment.
- New guidelines recommending shorter treatment for LTBI are now available for California ([CTCA LTBI Guidelines](#)) and the U.S. ([CDC LTBI Guidelines](#)).

Estimated TB infection, prevalence, awareness and treatment, California, 2021



Estimated using National Health and Nutrition Examination Survey, 2011-2012 applied to the California population.

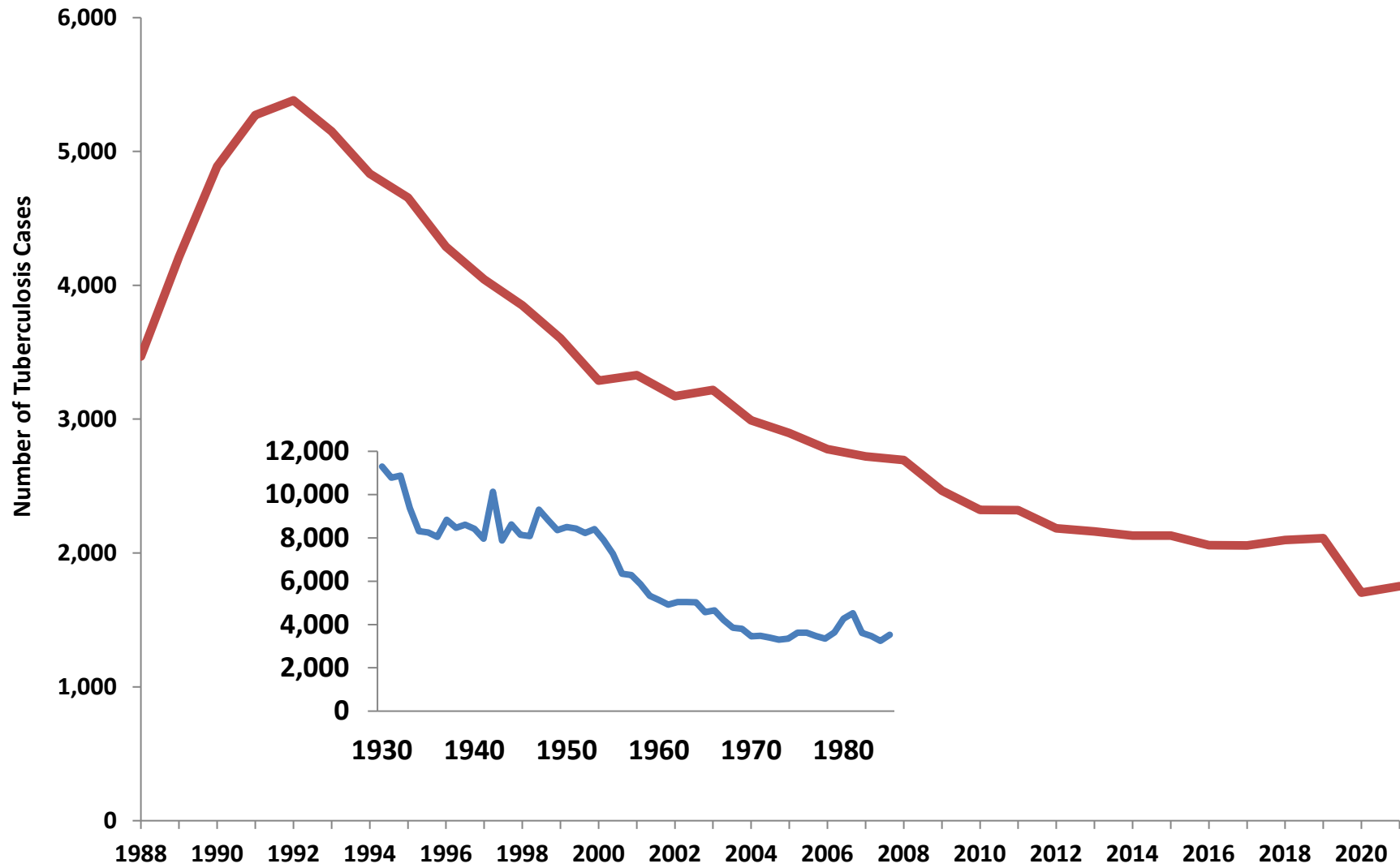
A Plan to Eliminate TB

CDPH, in collaboration with the California TB Elimination Advisory Committee and the California TB Controllers Association, recently released the second 5-year plan for making progress toward eliminating TB from California. The plan is supported by diverse stakeholders across the state. The plan calls for making TB prevention a routine part of medical care by finding and testing Californians who are at risk for TB, optimizing treatment for LTBI, monitoring and evaluating LTBI testing and treatment, and ensuring that patients, clinicians, and public health programs have the tools and resources they need to prevent TB.

More information about tuberculosis:

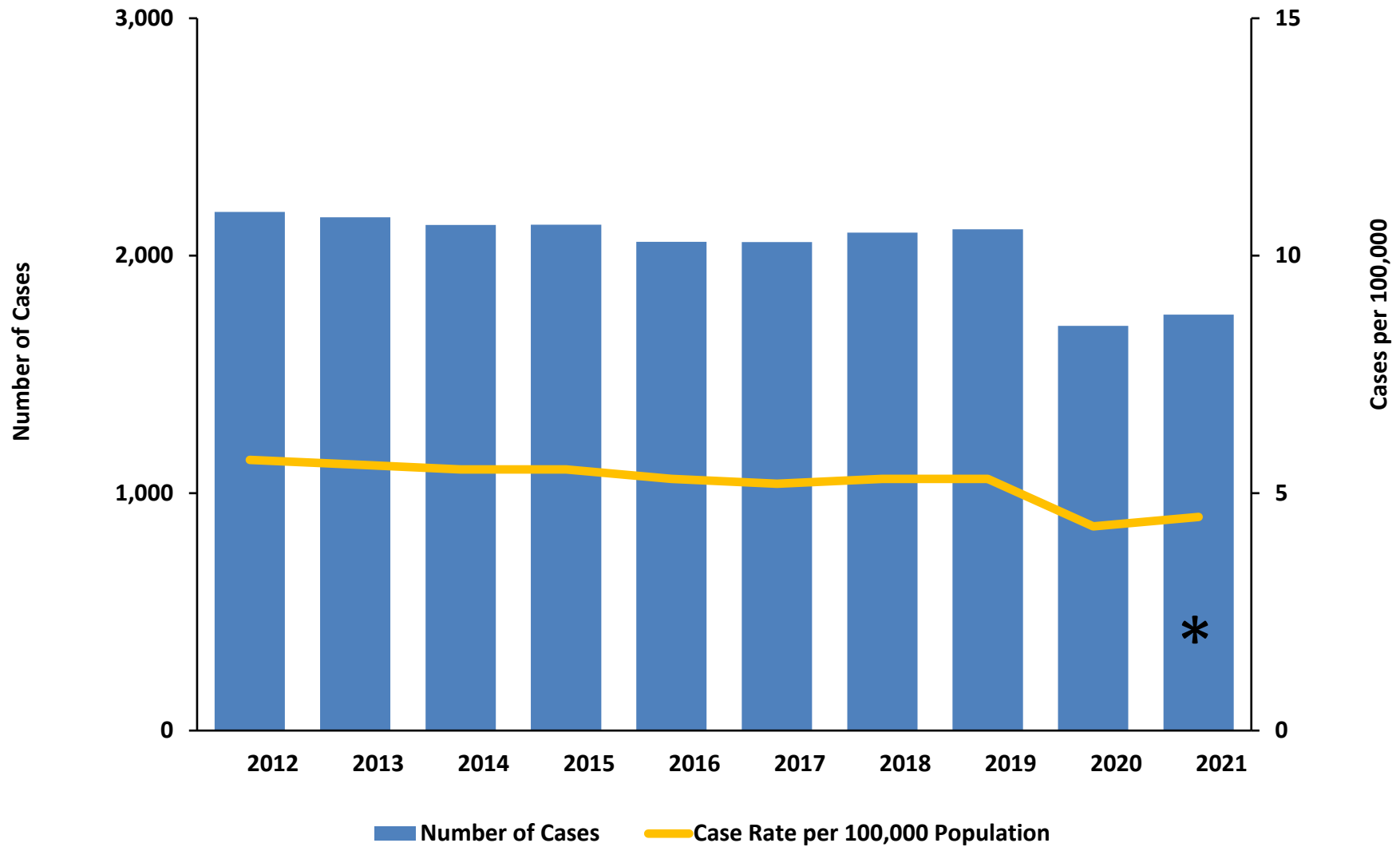
- Find more TB data, including performance trends on national and state TB objectives on [the CDPH TB Data page](#)
- Read more about the plan to eliminate TB from California at [the CDPH Tuberculosis Control Branch site](#)
- Learn more about the TB Free California initiative on the [CDPH TB Free page](#)

Figure 1. Number of Tuberculosis Cases: California, 1930-2021



California Department of Public Health, Tuberculosis Control Branch

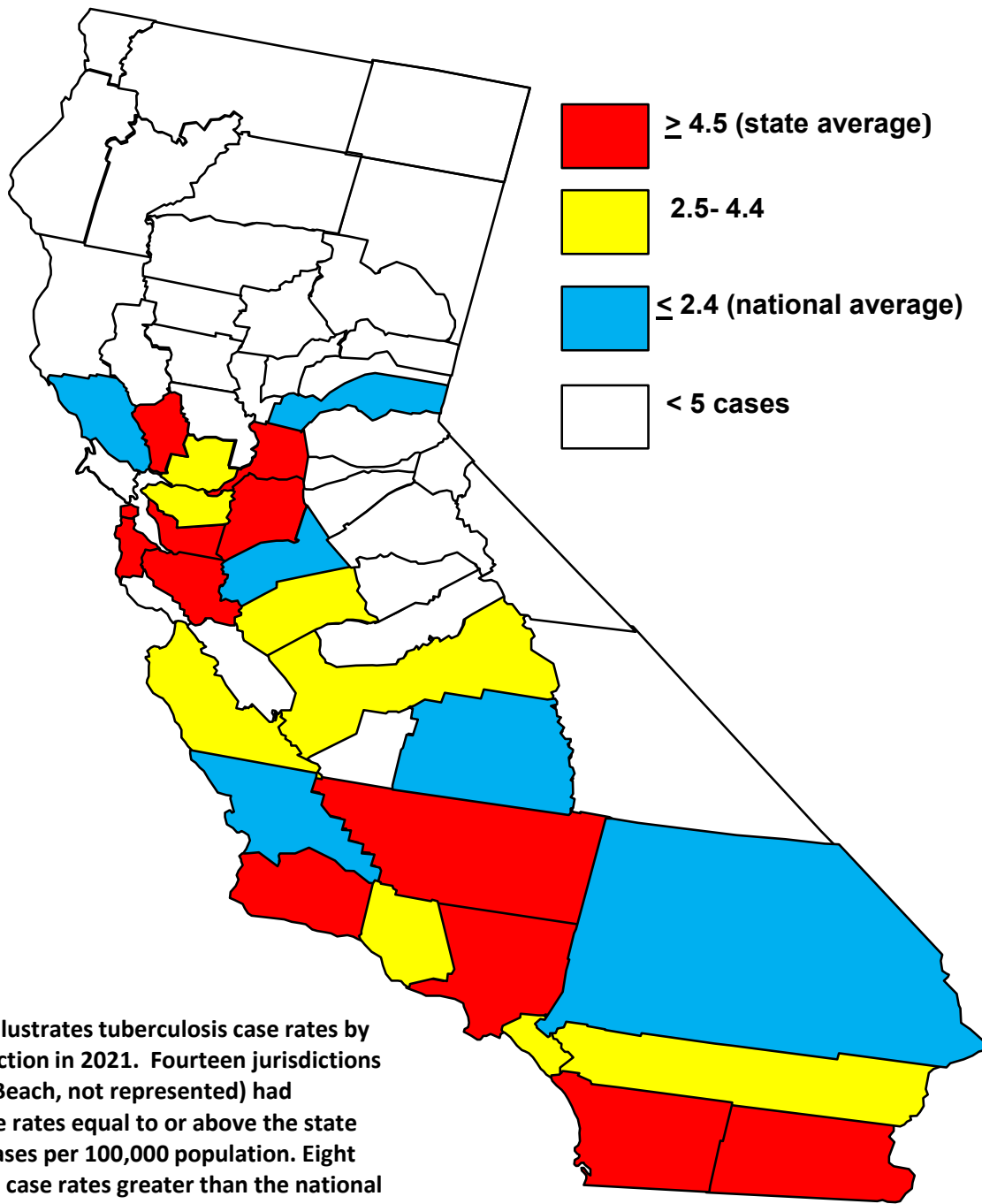
Figure 2. Number of Tuberculosis Cases and Case Rates: California: 2012-2021



* National Case Rate (2.4 per 100,000)

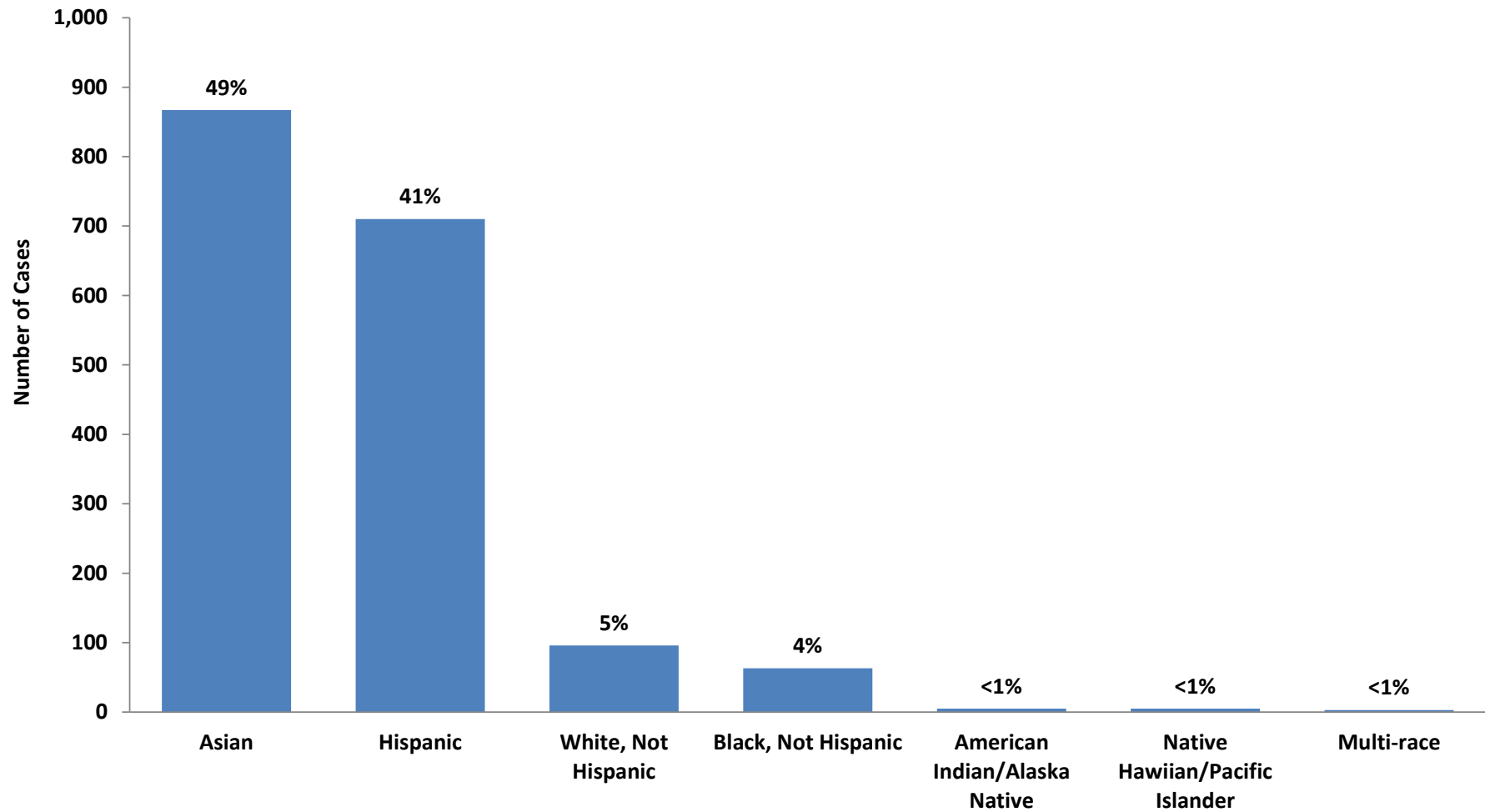
California Department of Public Health, Tuberculosis Control Branch

Figure 3. Tuberculosis Case Rates in California, 2021



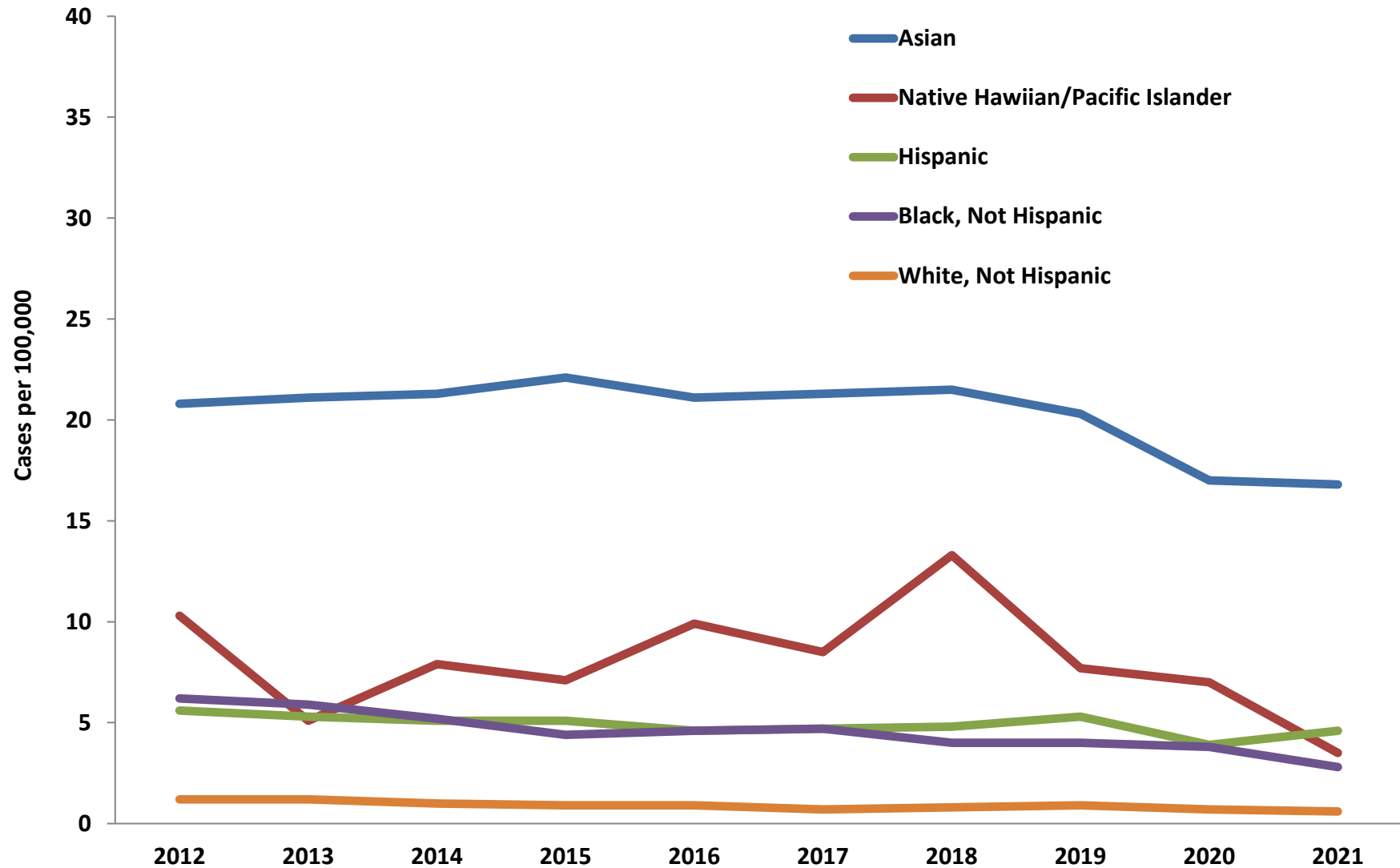
Note: The map illustrates tuberculosis case rates by reporting jurisdiction in 2021. Fourteen jurisdictions (including Long Beach, not represented) had tuberculosis case rates equal to or above the state average of 4.5 cases per 100,000 population. Eight jurisdictions had case rates greater than the national rate and less than the state rate (2.5 to 4.4 cases per 100,000 population). Six jurisdictions had case rates less than or equal the national rate (2.4 cases per 100,000 population). Case rates were not calculated for 34 jurisdictions (including Berkeley and Pasadena, not represented) because there were fewer than five cases in these areas.

Figure 4. Tuberculosis Cases by Race/Ethnicity: California, 2021



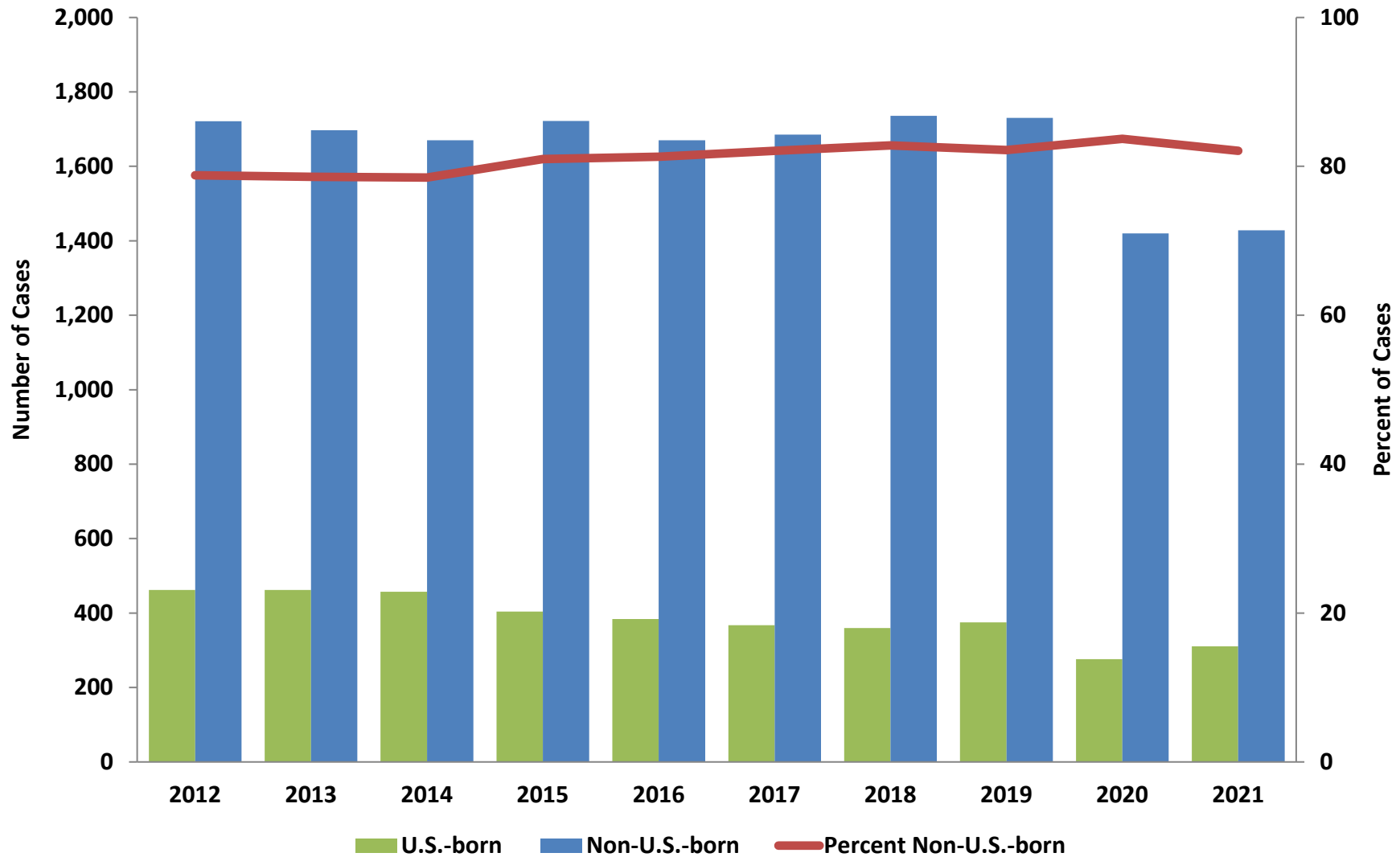
California Department of Public Health, Tuberculosis Control Branch

Figure 5. Tuberculosis Case Rates by Race/Ethnicity: California, 2012-2021



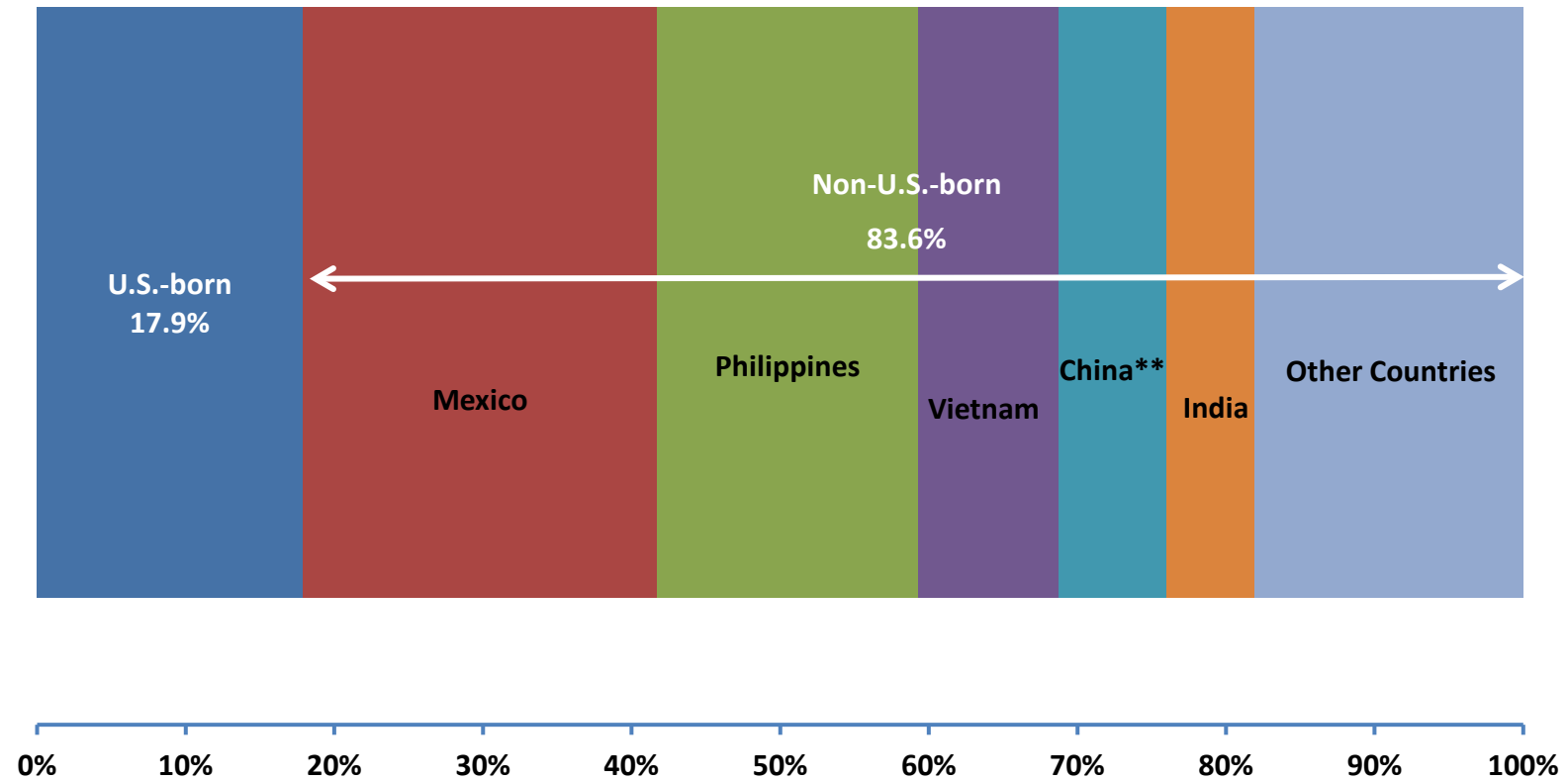
Rates for American Indian/Alaska Native and multi-race TB cases not shown due to small numbers of cases.
California Department of Public Health, Tuberculosis Control Branch

Figure 6. Tuberculosis Cases in Non-U.S.-born and U.S.-born Persons: California, 2012-2021



*Excludes cases where U.S.-born status is unknown
California Department of Public Health, Tuberculosis Control Branch

Figure 7. Tuberculosis Cases by Country of Origin:* California, 2021

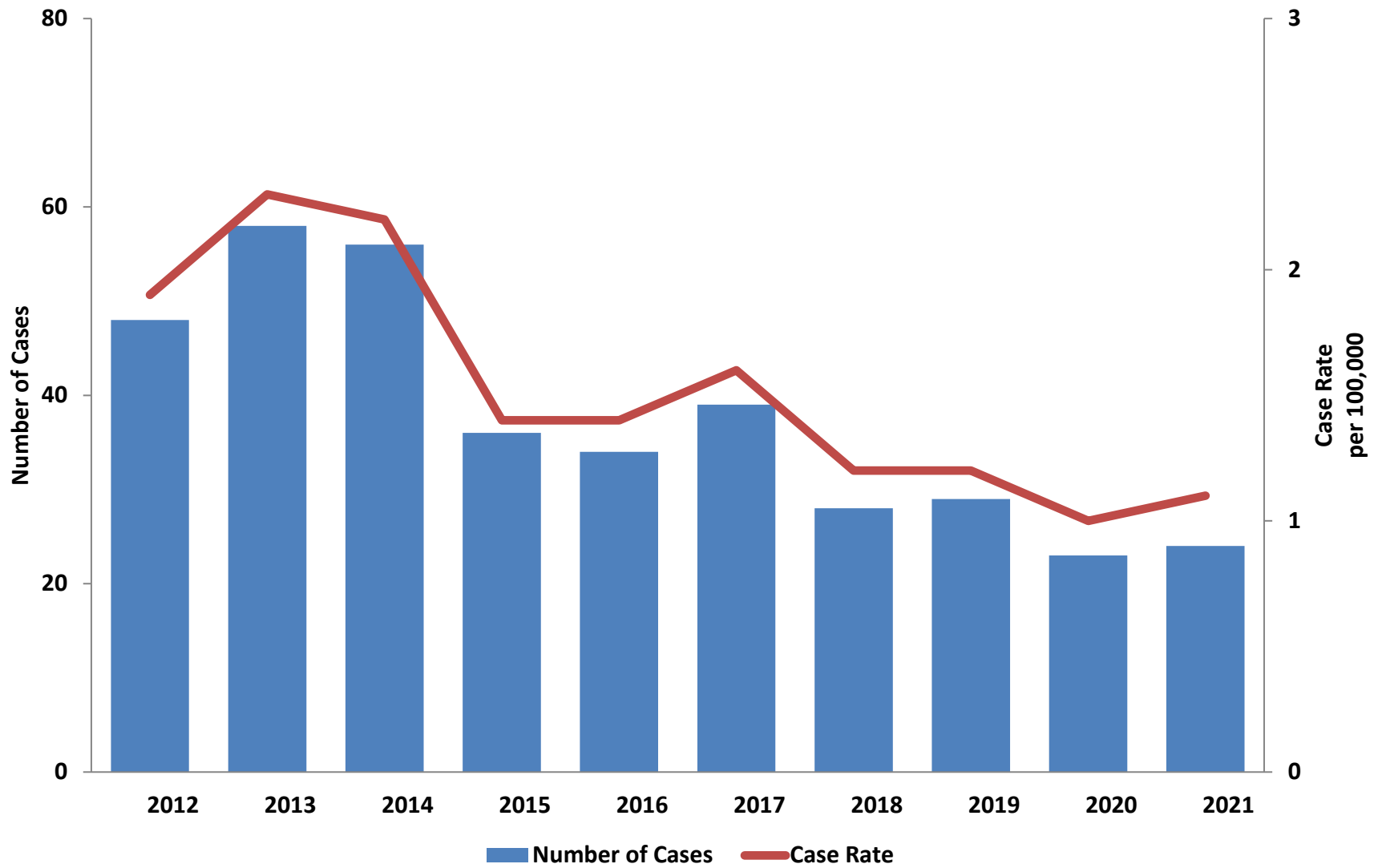


* Excludes cases for whom country of origin is unknown

** People's Republic of China includes Hong Kong and Macau

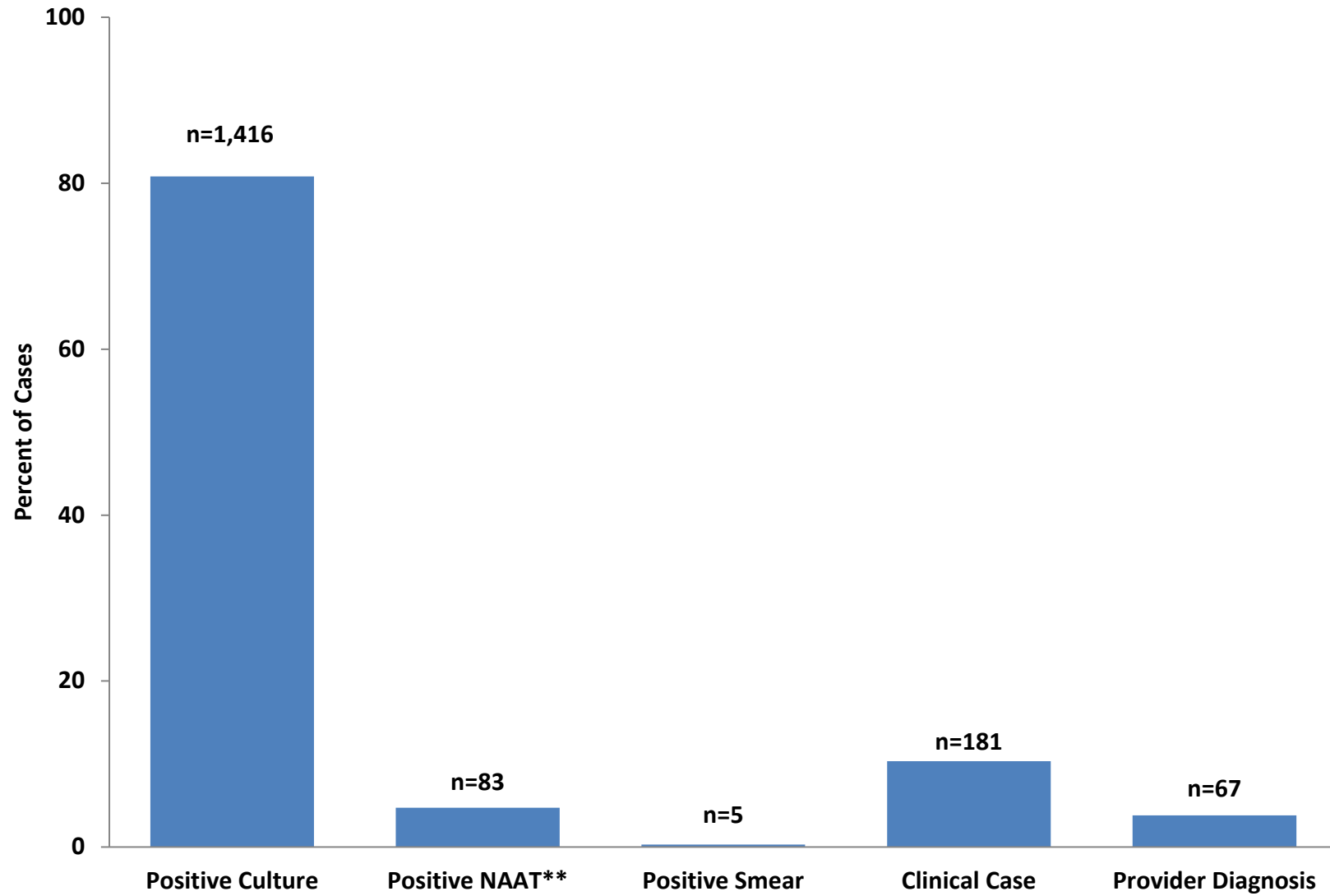
California Department of Public Health, Tuberculosis Control Branch

Figure 8. Tuberculosis Cases in Persons 0-4 Years of Age: California, 2012-2021



California Department of Public Health, Tuberculosis Control Branch

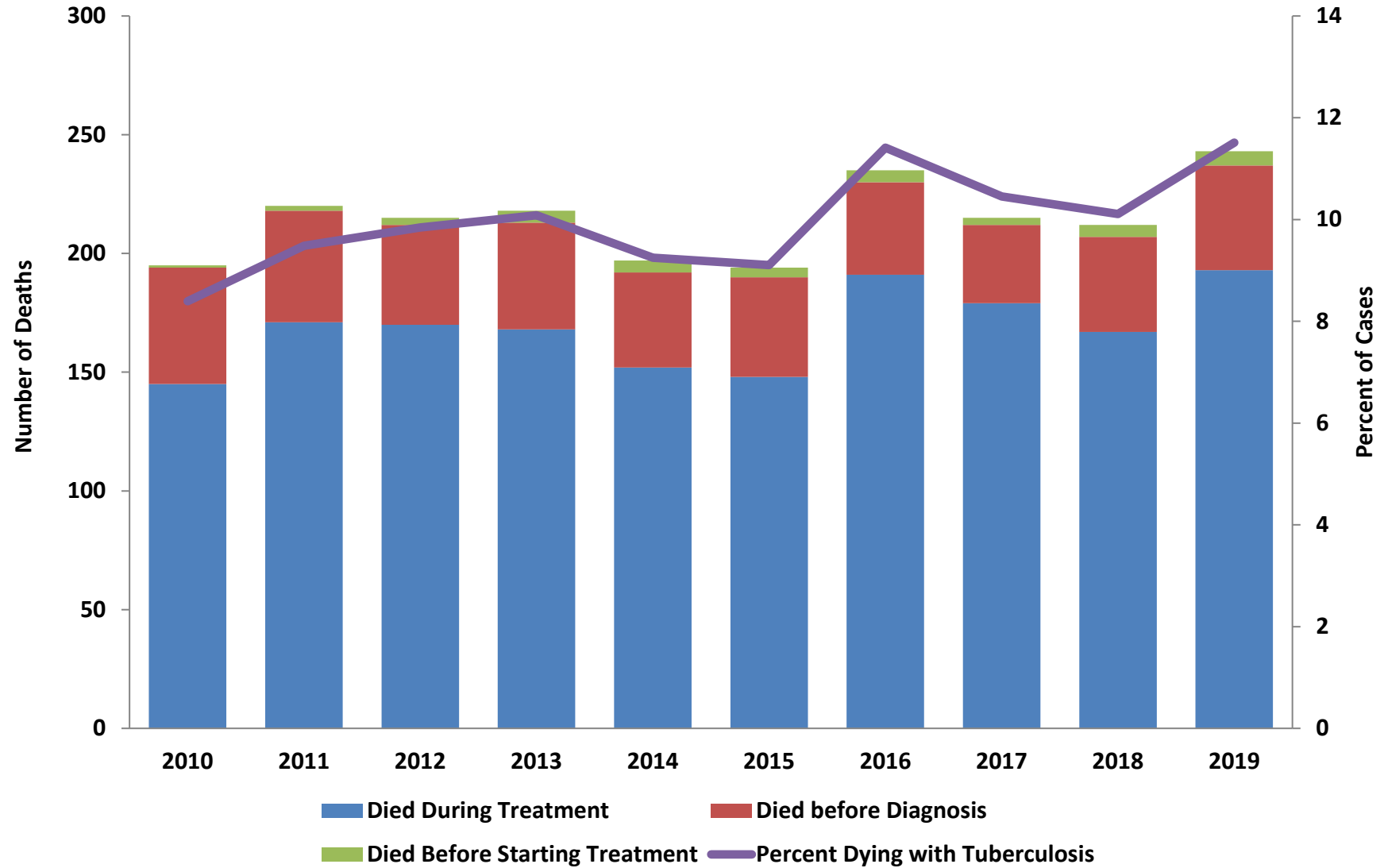
Figure 9. Tuberculosis Cases by Verification Criteria*: California, 2021



* See Technical Notes for description of verification criteria.

**NAAT = Nucleic Acid Amplification Test

Figure 10. Deaths in Persons with Tuberculosis: California, 2010-2019



California Department of Public Health, Tuberculosis Control Branch

Figure 11. Tuberculosis Cases by HIV/AIDS Diagnosis: California, 2013-2021

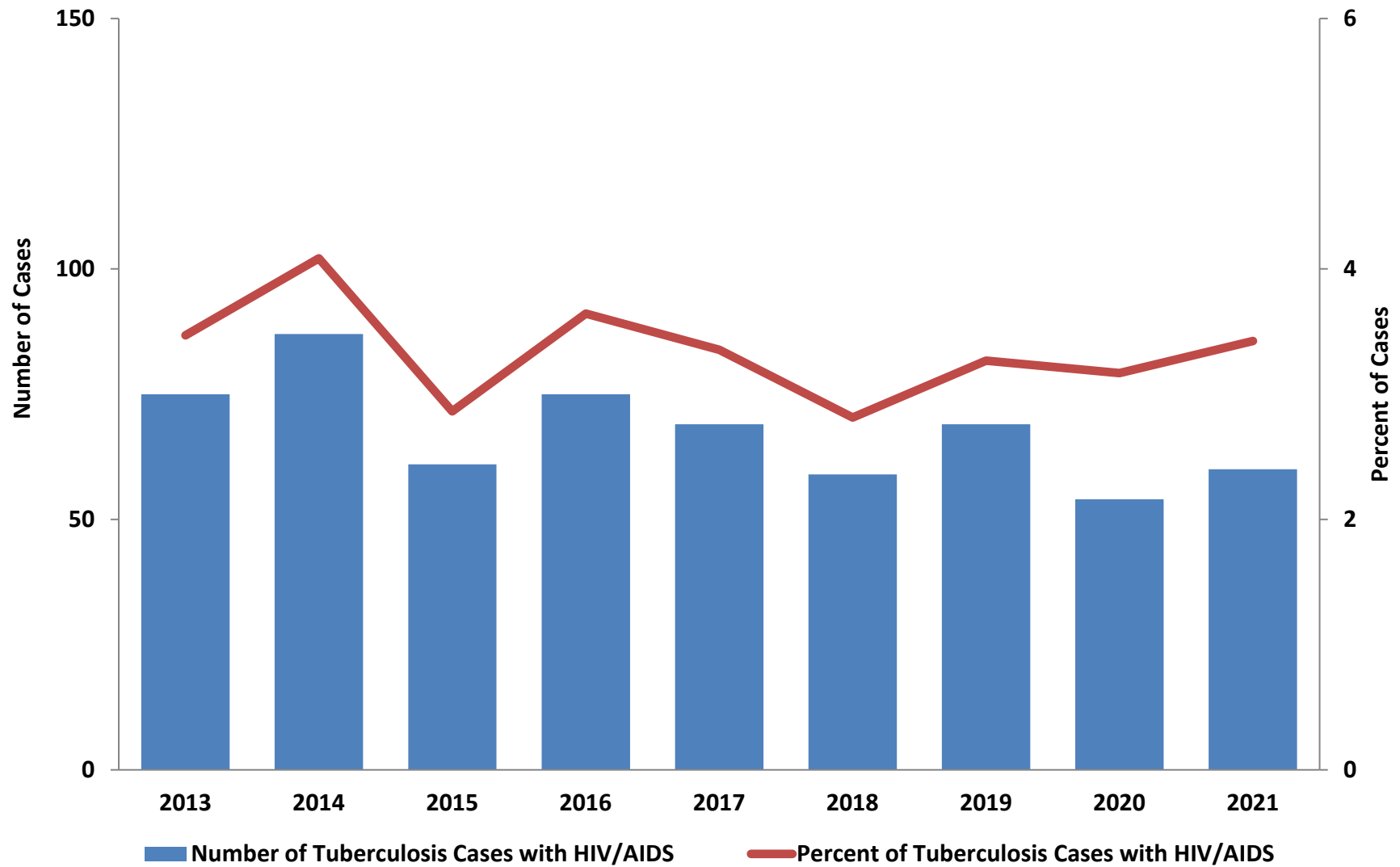
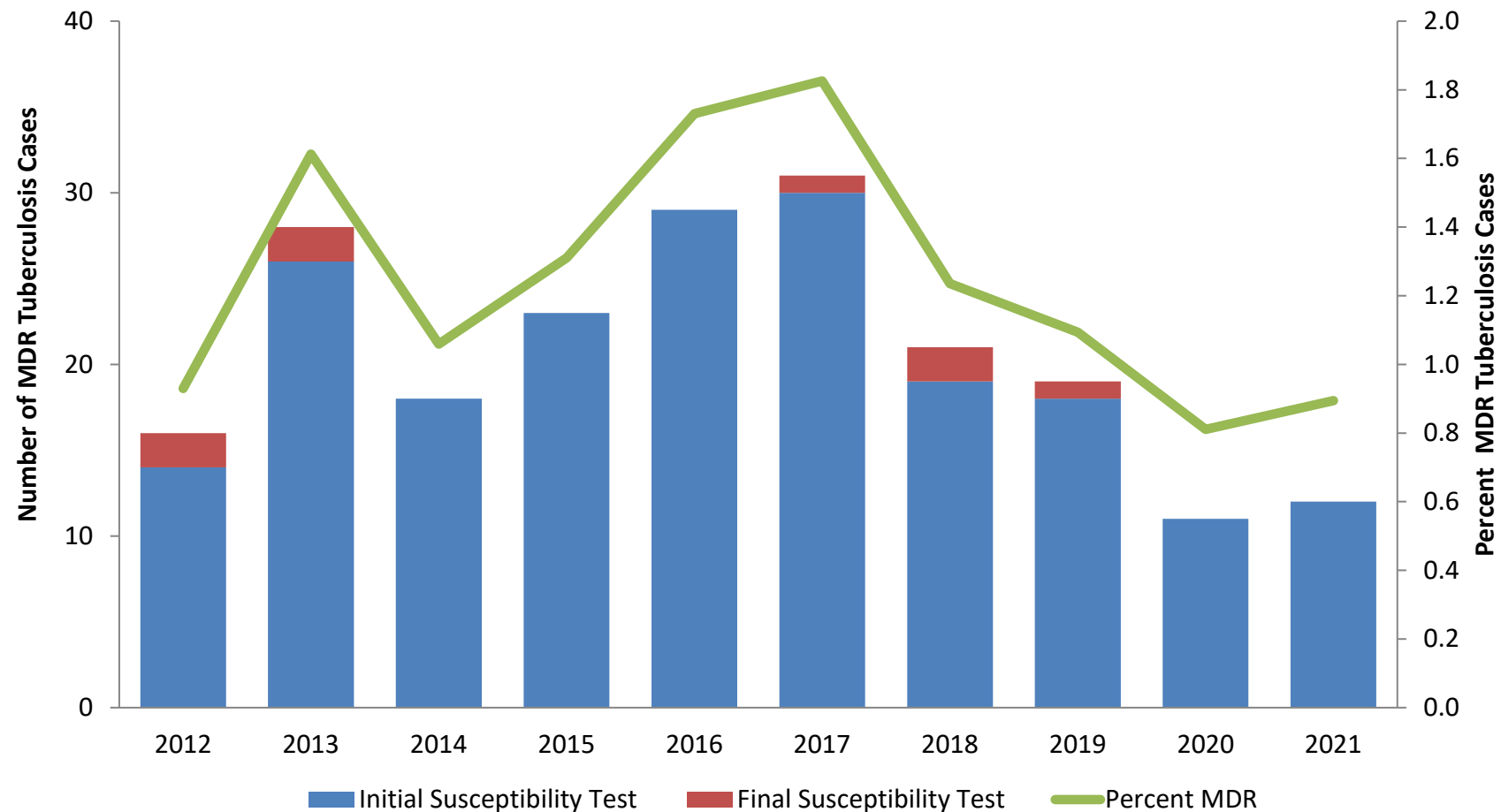


Figure 12. Tuberculosis Cases with Multidrug Resistance (MDR) on Initial or Final Drug Susceptibility Testing*: California, 2012-2021**



* Cases with resistance to at least isoniazid and rifampin on the Initial Drug Susceptibility Report

(Follow-up 1) or on the Case Completion Report (Follow-up 2)

** Number of MDR cases may increase as additional drug susceptibility test results are received for 2021.

*** Percent MDR cases based on those with MDR testing done

California Department of Public Health, Tuberculosis Control Branch

**Figure 13. Tuberculosis Cases with Initial Multidrug Resistance (MDR)*:
California, 2017-2021**

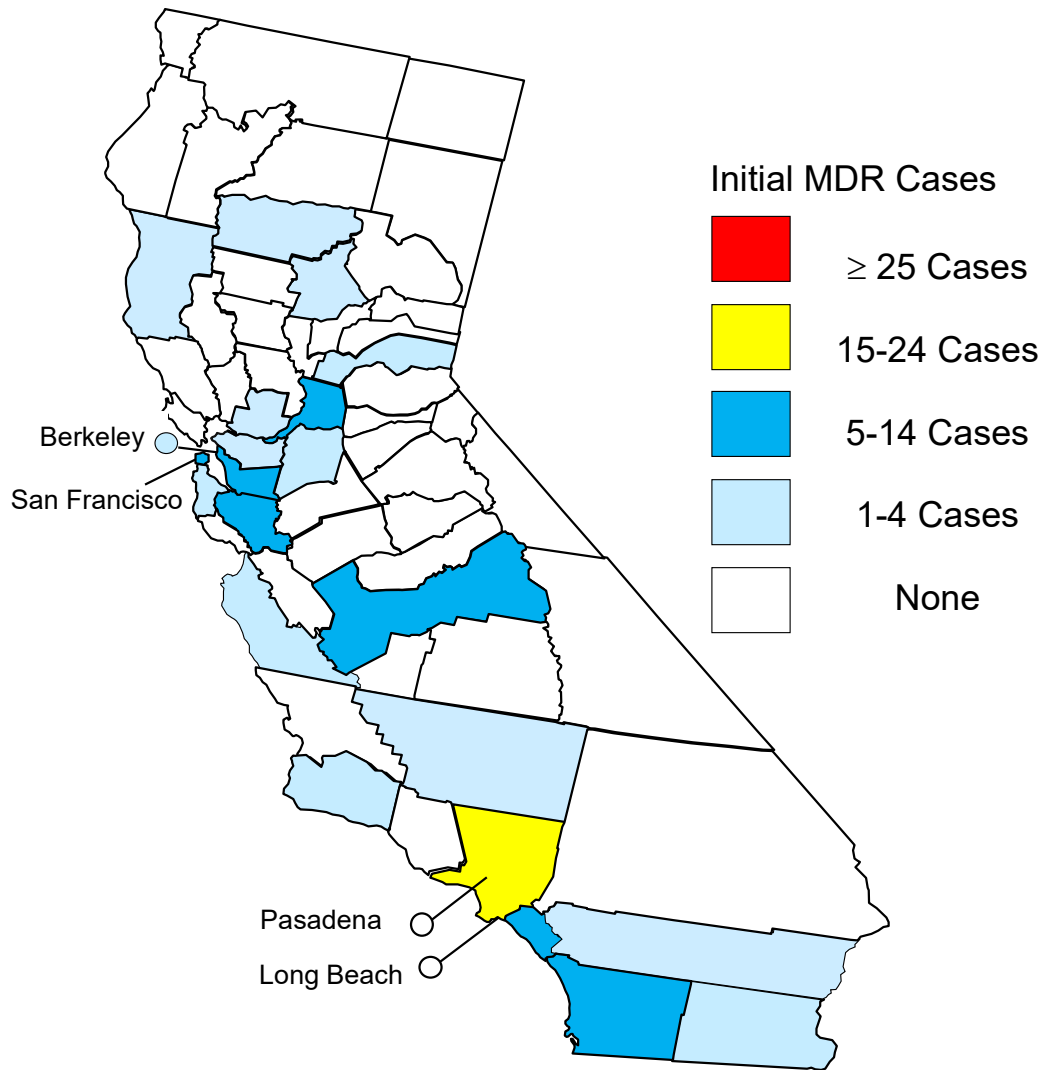
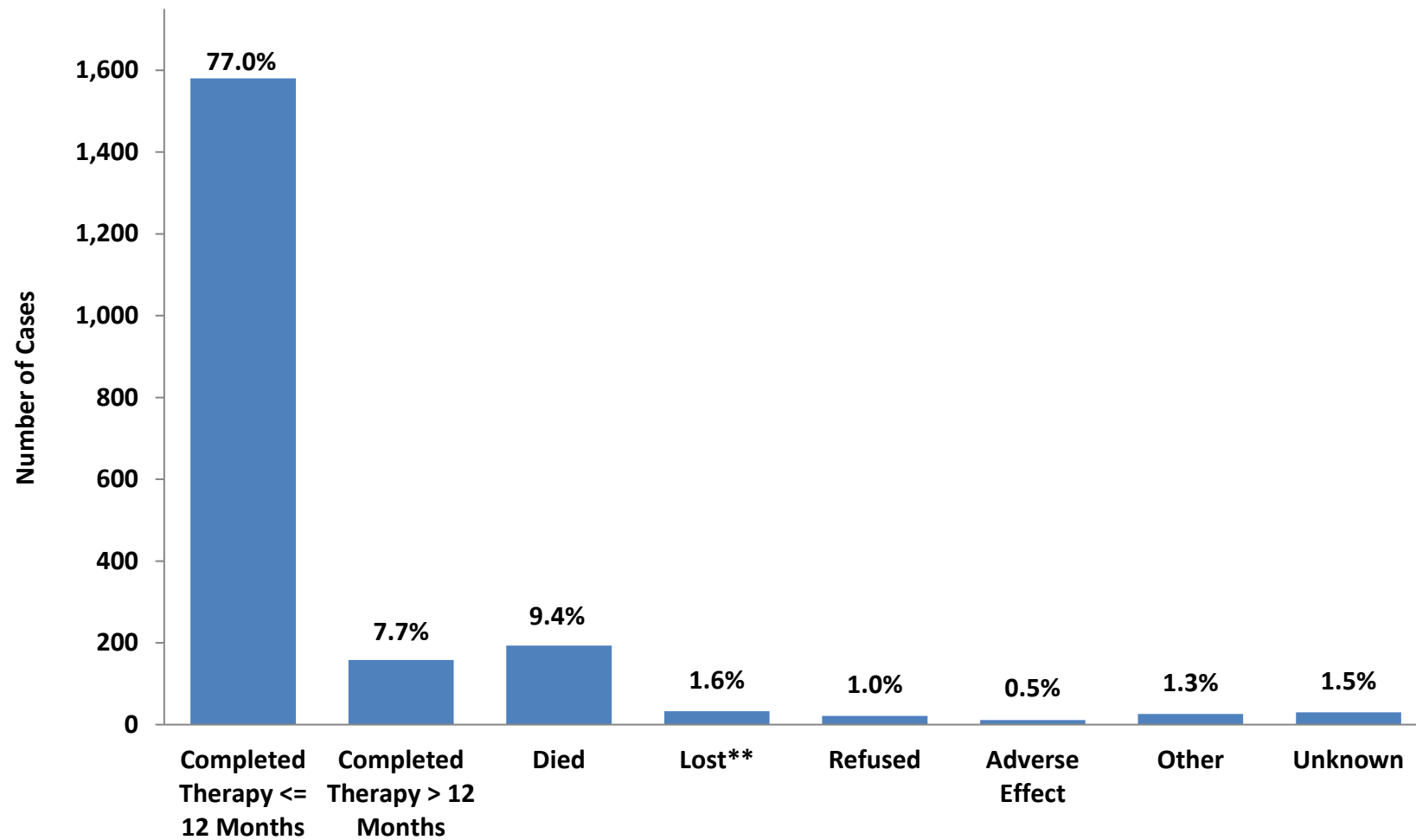


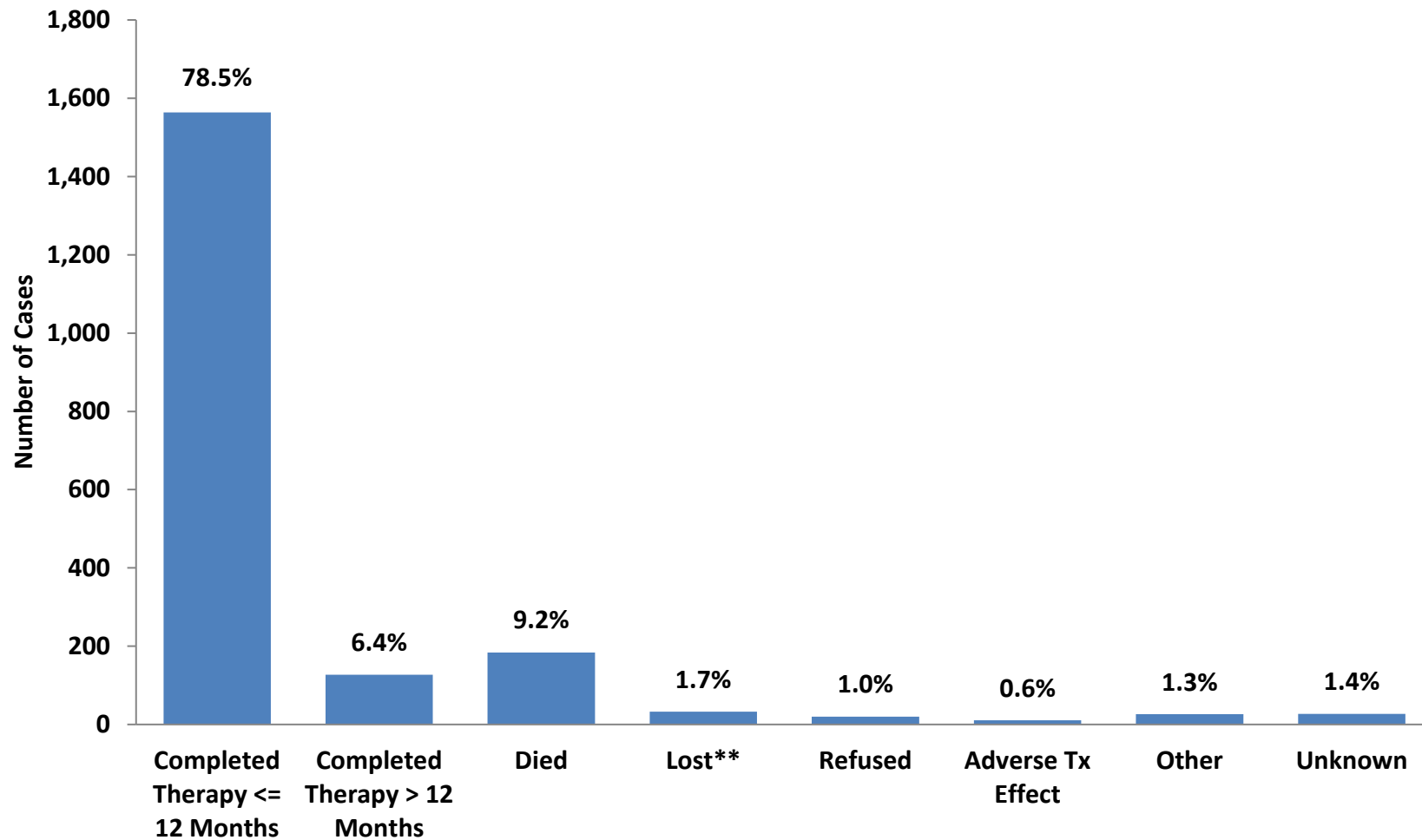
Figure 14. Tuberculosis Cases* by Outcome of Treatment: California, 2019



* Patient was alive at diagnosis and started on an initial drug regimen of two or more drugs.

** Patient could not be located prior to the completion of treatment.

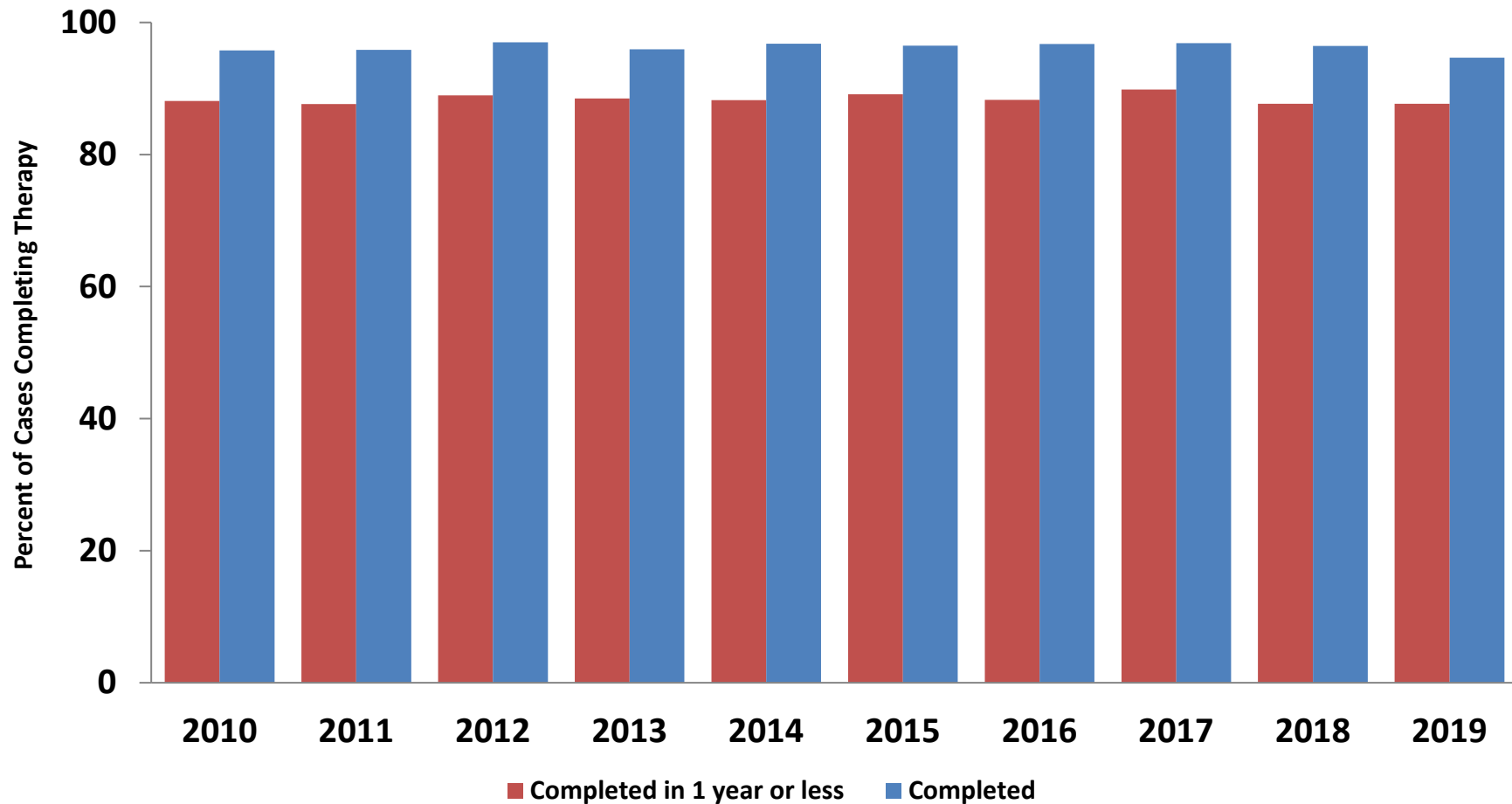
Figure 15. Outcome in Tuberculosis Cases for Whom One Year or Less of Treatment was Indicated*: California, 2019



* Excludes cases with rifampin resistant disease, cases with meningeal disease, and cases less than 15 years of age with disseminated tuberculosis disease.

** Patient could not be located prior to the completion of treatment.

Figure 16. Completion of Tuberculosis Therapy among Patients for Whom One Year or Less of Therapy was Indicated*: California, 2010-2019



*Consistent with CDC's National Tuberculosis Indicators Project completion of therapy measure, 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 or moved out of the United States less than one year after treatment initiation.

Technical Notes

Reporting Jurisdictions

California has 61 jurisdictions that report TB morbidity. There are 58 counties and the cities of Berkeley, Long Beach, and Pasadena. Reports from Alameda County exclude TB cases from the city of Berkeley, and reports from Los Angeles County exclude cases from the cities of Long Beach and Pasadena. Since 1993, local health jurisdictions have used the [Report of Verified Case of Tuberculosis \(RVCT\) form](https://www.cdc.gov/tb/programs/rvct/default.htm) (<https://www.cdc.gov/tb/programs/rvct/default.htm>) to report TB cases; an expanded version of this form was implemented in California in 2010. This version of the RVCT was used for case data collection through 2021. Another revision of the RVCT was implemented in California in 2022 and will be used moving forward starting with 2022 case data collection. This most recent update includes molecular drug susceptibility test results, an important new laboratory tool to monitor drug resistance among TB patients, as well as supplemental data collection on Multi-Drug Resistant (MDR) TB. California cleans, compiles and analyzes these data for state and local use, and also reports these data to the Centers for Disease Control and Prevention (CDC).

TB Cases

A TB case submitted to the TBCB Registry by June 2, 2022, was included as a 2021 case in this report if the case was confirmed as active TB between January 1 and December 31, 2021. After reporting the case, a jurisdiction may subsequently decide that a reported case did not have TB. Also, a few cases may be reported after the submission deadline. These changes will be reflected in future reports. Therefore, the total number of TB cases counted in a given year may change, usually by a small number of cases. This small change in case numbers may also be reflected in the two sets of TB numbers released each year, a provisional case count used in early reports and materials generated in March for World TB Day, and a final case count which is used in this report.

Population Data

Population data were derived primarily from the following sources at the State of California, Department of Finance.

State and local health jurisdiction totals are from the following sources:

- *E-2 California County Population Estimates and Components of Change by Year, July 1, 2010-2021*, December 2021
- *E-4 Population Estimates for Cities, Counties, and the State 2011-2021 with 2010 Census Benchmark*, May 2021.
Proportions of population subgroups (sex, age, race and ethnicity) for California are from the following sources:
 - *Race/Ethnic Population with Age and Sex Detail, 1970-1989*, December 1998
 - *Race/Ethnic Population with Age and Sex Detail, 1990-1999*, Revised May 2009
 - *Race/Hispanics Population with Age and Gender Detail: 2000-2010*, Revised March 2013
 - *P-3 Population Projections Race/Ethnicity and Sex by Individual Years of Age, 2010-*

2060, July 2021

State and county population totals are from the estimate series. Populations for the cities of Berkeley, Long Beach and Pasadena were estimated by obtaining the ratio of city to county population totals from the E-4 report and applying the ratio to the E-2 county population totals. Population totals for the jurisdiction of Alameda were then calculated by subtracting Berkeley calculated population from Alameda County total; population total for the jurisdiction of Los Angeles was calculated by subtracting Long Beach and Pasadena calculated populations from Los Angeles County total. Demographic populations were estimated by applying the population proportion of each demographic subgroup to the state total (estimate series).

Population denominators used for TB rate calculations of non-U.S.-born and U.S.-born persons, persons born by individual countries, and persons with more detailed Asian and Pacific Islander race information were calculated by applying the proportion of each group from the United States Census Bureau's *American Community Survey* made available through the *Integrated Public Use Microdata Series (IPUMS)*:¹ Version 11.0, to the California total population for 2021 from California Department of Finance, *E-2 California County Population Estimates and Components of Change by Year, July 1, 2010-2021*. At the time of preparation of this report, *American Community Survey* data for 2021 fully stratified by race, sex, age and country of origin were not available, and due to the effects of the COVID-19 pandemic on data collection and quality, the standard 2020 data were also not available; therefore, the proportion of non-U.S.-born and U.S.-born persons from 2019 were also used for those years. These rates will be updated in future reports.

Small Case Numbers/Small Cell Size

We have chosen not to report rates when the total number of TB cases is less than five. Rates of zero, based on no TB cases, are also not reported. Where the rate is not reported, changes in rate over time are also not reported. Additionally, data tables were reviewed and modified if necessary, to ensure compliance with [California Health and Human Services guidelines](https://chhsdata.github.io/dataplaybook/documents/CHHS-DDG-V1.0-092316.pdf) (https://chhsdata.github.io/dataplaybook/documents/CHHS-DDG-V1.0-092316.pdf).

Ranking of Jurisdictions

Jurisdictions are ranked in order of decreasing 2021 case rate with the highest rank first. Those jurisdictions with one to four cases are not given a rate and are given the same rank; they are listed according to decreasing number of cases. Jurisdictions with no cases of TB are given the same rank and are listed in alphabetical order.

TB Case Definition and Verification Criteria

For surveillance purposes, a case of TB is defined by laboratory and clinical evidence of disease caused by *Mycobacterium tuberculosis (Mtb)* complex. TB cases with culture or nucleic acid amplification evidence of *Mtb*, or acid-fast bacilli in a smear from a clinical specimen (when a culture cannot be obtained, or culture results are negative or

contaminated) are classified as laboratory-confirmed. In the absence of laboratory confirmation, persons with a positive tuberculin skin test (TST) or positive interferon gamma release assay (IGRA) for *Mtb*, abnormal chest imaging (in those with pulmonary disease), and treatment with two or more anti-TB medications will be classified as clinically confirmed TB. Reported cases not meeting one or more of the clinical criteria for TB are classified as provider-diagnosed cases because the health care providers and TB control programs have determined there is sufficient evidence of active TB disease to report the case.

The following hierarchy is applied in determining the verification criteria for TB disease:

1. Positive culture for *Mtb*
2. Positive nucleic acid amplification test
3. Positive acid-fast bacilli test
4. Clinical case confirmation
5. Provider diagnosis

Race and Ethnicity

The RVCT has one variable for race and one for ethnicity. If a case is classified as “Hispanic” ethnicity on the RVCT, then the case is reported as “Hispanic” in this report, regardless of race.

Beginning in 2003, the federal Office of Management and Budget (OMB) mandated separate reporting of Asian and Pacific Islander/Native Hawaiian races, as well as the opportunity for persons to identify themselves by one or more racial groups. In this report, tables presenting race and ethnicity include the following categories: white non-Hispanic, black non-Hispanic, Hispanic, Asian, Native Hawaiian or Pacific Islander, Native American or Alaska native, and multi-race. For persons of Asian, Native Hawaiian, and Pacific Islander race, detailed race subcategory information is also collected. Tables of case counts/case rates for these detailed race subcategories are also included in this 2021 report.

Country of Origin

Persons born in one of the 50 states or the District of Columbia or born abroad to a parent who was a U.S. citizen are considered U.S.-born. Persons born in Puerto Rico, Guam, the Commonwealth of the Northern Mariana Islands, U.S. Virgin Islands, Midway Island, U.S. Minor Outlying Islands, and U.S. Misc. Pacific Islands are also considered U.S.-born. This closely aligns with the definition used by the U.S. Census Bureau², and is used in Tables 2, 3, 6, 7, 8, 10, 23, 32 and 33. In tables focused on countries of birth (Tables 9, 18, 19, 74), the birth country is used regardless of whether the case was considered U.S.-born.

HIV/AIDS Status

In 2011, California implemented reporting of HIV status of TB cases on the RVCT. During 1993–2014, TB cases co-infected with HIV, and reported with HIV or AIDS were also identified by matching TBCB Registry data with the HIV/AIDS case registry in the California Department of Public Health Office of AIDS. A positive result from either

source was considered to be indicative of co-infection with HIV/AIDS in tables presenting HIV status prior to 2011. For tables reporting HIV status from 2011 onward only the HIV status reported on the RVCT is used.

Primary Reason for TB Evaluation

The primary reason for a patient's initial evaluation for TB was added to the TB case report form in 2010. Because multiple factors may be present at the time of a person's initial TB evaluation (e.g., a person with TB symptoms evaluated during the course of a contact investigation of a family member), and only the primary reason may be reported, the following definitions and hierarchies are used.

TB symptoms: the person sought evaluation because of signs or symptoms of TB disease (e.g., persistent cough, fever, lymphadenopathy, night sweats, weight loss or symptoms of extra-pulmonary disease).

Abnormal chest image: the initial chest radiograph was consistent with TB disease and was performed for a reason other than suspicion of TB disease. If the radiograph was performed following a positive TST or IGRA result obtained during targeted testing, "Targeted Testing" is considered to be the primary reason the patient was evaluated for TB.

Contact investigation: the person's TB was identified during the course of a contact investigation or source case finding, regardless of whether the person was symptomatic at the time.

Targeted testing: a positive TST or IGRA result was obtained during a screening performed specifically because the person was considered to be at high risk for TB. However, health care worker or employment/administrative testing, contact investigation, and immigration medical exam supersede targeted testing as the primary reason a patient was evaluated, when one of those situations is applicable.

Health care worker: a positive TST or IGRA result was obtained during the course of routine screening of health care workers. Health care worker supersedes targeted testing and employment/administrative testing. However, evaluation of health care workers for other reasons (e.g., TB symptoms or contact investigation) supersedes health care worker.

Employment/administrative testing: persons whose TB testing was performed before or periodically during employment to meet administrative requirements. If employment was health-care, "health care worker" is considered the primary reason the patient was evaluated.

Immigration medical exam: TB disease was found during a medical examination that was part of the immigration requirement process that is mandatory for certain categories of U.S. entrants (e.g., immigrant, refugee, asylee).

Incidental lab result: the clinical evaluation was for something other than TB. Specimens

were collected and submitted for evaluation of TB and other diseases for diagnostic completeness, but TB was not expected.

Risk Factors for TB

In 2010, reporting of certain additional medical and epidemiologic risk factors began. Persons with medical co-morbidities such as diabetes mellitus, end-stage renal disease, organ transplantation, tumor necrosis factor (TNF) alpha antagonist therapy, or other immunosuppressive medications that suppress a patient's immune response have a higher risk of TB; these data provide a better understanding of these high-risk groups.

Non-medical epidemiologic risks for TB include contact to an MDR TB case, or to an infectious TB patient. If the patient was a contact to an MDR case, he/she should be reported as "contact of MDR case," rather than "contact of infectious case." The association with the MDR case must be within the last two years. A case should be reported as a missed contact if the current case was identified as a contact of a known TB patient (within 2 years of current diagnosis) but was not identified or evaluated at that time. Incomplete LTBI treatment includes patients who started treatment for a previous diagnosis of LTBI but did not complete the regimen.

Drug Susceptibility Reports

Because the Initial Drug Susceptibility Report (Follow-up 1) may be submitted several months after the initial case report, all results may not have been available at the time this report was prepared. At the time of report preparation, drug susceptibility testing was approximately 96 percent complete for culture-positive TB cases. As additional Follow-up 1 reports are submitted, overall proportions of drug resistance may change slightly. These updated results will be available in future reports in tables presenting trends in drug resistance.

Total MDR TB cases (defined as cases with an isolate resistant to at least isoniazid and rifampin reported on the Initial Drug Susceptibility Report [Follow-up 1] or the Case Completion Report [Follow-up 2]) are presented in Figure 13 in the Report on Tuberculosis on California, 2021.

Case Completion Reports

Because the Case Completion Report (Follow-up 2) is not submitted until many months after a TB case is initially reported, data reported on cases counted in 2019 are the most recent available and are presented in this report. These data include health care provider, directly observed therapy and treatment outcomes. Data in these tables are from the final Follow-up 2 submitted and, therefore, represent the overall treatment completion rate for cases beginning therapy for TB disease in California. Treatment completion may have occurred in the jurisdiction reporting the case, in another California jurisdiction, or another state. Treatment outcomes (completion of therapy, or death during treatment) for patients who were referred to CureTB for follow-up outside the U.S. are also included as results

become available.

Treatment Outcomes

Categories for completion of therapy are: completed therapy in 12 months or less (includes patients whose treatment was completed in 366 days or less); and completed therapy in more than 12 months (treatment completed in more than 366 days, or treatment completed in an undetermined amount of time). If the day of the month is missing from the treatment start or stop date (but the month and year are available), the missing day is set to the first of the month. Because the day of the month is much more likely to be missing from the stop date than the start date, the bias in calculating the duration of therapy is toward shorter duration of therapy.

Cases known to have started treatment, but for whom no Follow-up 2 is available are included in the “No Information” category. All other outcome categories reflect the “Reason Therapy Stopped” variable of the Follow-up 2.

Treatment outcomes are reported for all cases, and for cases expected to complete TB therapy in one year or less. Thus, cases with rifampin-resistant disease (including MDR TB), those with meningeal disease, and children less than 15 years of age with disseminated TB disease are excluded. Completion of TB therapy is also presented using methodology used by CDC: patients with rifampin-resistant disease, patients with meningeal, bone or joint disease, patients under 15 years of age with disseminated disease, and patients who died or moved out of the country less than one year after initiation of treatment are excluded.

TB Genotypes

TB genotyping is a laboratory-based approach used to analyze the genetic material (e.g., DNA) of *Mtb*. TB genotyping results, combined with epidemiologic data, can help identify persons with TB disease involved in the same chain of recent transmission, and is a valuable tool in contact investigations. It can also universally be used to help to distinguish recent infection from progression of an old infection. Genotyping is recommended for isolates from sputum and other clinical specimens that are positive for *Mtb*.

The number of cases with genotyped isolates that were clustered (matched) with a genotyped isolate from one or more case in the same jurisdiction within a three-year time period, and the number of clusters by cluster size are presented. A cluster is defined as two or more cases with matching spoligotype and 24-locus mycobacterial interspersed repetitive unit-variable number tandem repeat type (GENType) within a county during the specified 3-year time period.

Characteristics of cases with genotyped isolates identified as the *Mycobacterium bovis* strain of *Mtb* are also presented. Cases with genotyped isolates identified as the bacillus Calmette-Guerin (BCG) strain of *M. bovis* are excluded from this report, as they are considered to occur as the result of cancer immunotherapy or vaccination to protect against TB and should not be reported.

Latent TB Infection (LTBI)

Estimates of LTBI prevalence is an important tool to understanding the potential pool of persons who may one day progress to active TB in the future, and for whom testing, and treatment of the infection can decrease TB morbidity in the future. To estimate populations by nativity, the proportions of non-U.S.-born and U.S.-born persons for California and selected LHDs from the U.S. Census Bureau's *American Community Survey* made available through the *Integrated Public Use Microdata Series* (IPUMS):¹ Version 11.0, were applied to population totals from the California Department of Finance estimates series (see Population Data above). The prevalence of latent TB infection (LTBI) was then estimated by applying the proportions of U.S.-born persons with a positive TST and proportions of non-U.S.-born persons with a positive IGRA from the [National Health and Nutrition Examination Survey](http://www.cdc.gov/nchs/nhanes/index.htm) (<http://www.cdc.gov/nchs/nhanes/index.htm>), and reported in Miramontes (available at: <http://www.ncbi.nlm.nih.gov/pmc/articles/PMC4633161>), to the U.S.- and non-U.S.-born populations stratified by race and ethnicity. Due to ACS sampling methods, estimates of LTBI are not available for all LHDs in California. Other methods have been used to estimate LTBI in California and the U.S. (Haddad et al.³ and Mirzazadeh et al.⁴).

Medical and Societal Costs of TB

Direct medical costs were defined as costs of inpatient and outpatient treatment and case management of active TB cases not including workup leading to diagnosis of TB or costs of contact investigation. Societal costs were defined as direct medical costs, indirect costs incurred due to clinic visits, such as transportation and childcare, and productivity losses due to death caused by TB.

Direct medical and societal costs were estimated using costs from a systematic review of TB costs (Oh et al. 2017 BMC Res Notes⁵) and estimates published by Castro et al. 2017 IJTLD⁶. Costs from Oh et al. in 2015 dollars were adjusted to current year dollars using medical care consumer price index and from national to California dollars using a weighted average of California county Medicare geographic adjustment factors with weights set by the California TB case distribution by county 2010-2017. Costs from Castro et al. on productivity losses in 2010 dollars were adjusted to current year dollars using the average hourly earnings index and from national to California using the California cost of living adjustment.

- ¹ Ruggles S, Flood S, Foster S, Goeken R, Pacas J, Schouweiler M, Sobek M. *Integrated Public Use Microdata USA: Version 11.0*. Minneapolis: University of Minnesota, 2021.
- ² United States Census Bureau. Accessed July 20, 2020. Available at: <https://www.census.gov/topics/population/foreign-born/about.html>
- ³ Haddad MB, Raz KM Lash TL, et al. Simple estimates for local prevalence of latent tuberculosis infection, United states, 2011-2015. *Emerg Infect Dis*. 2018 Oct;24(10):1930-1933.
- ⁴ Mirzazadeh A, Kahn JG, Haddad MB, Hill AN, Marks SM, Readhead A, Barry PM, Flood J, Mermin JH, Shete PB. State-level prevalence estimates of latent tuberculosis infection in the United States by medical risk factors, demographic characteristics and nativity. *PLoS One*. 2021 Apr 1;16(4) e0249012.
- ⁵ Oh P, Pascopella L, Barry PM, Flood JM. A systematic synthesis of direct costs to treat and manage tuberculosis disease applied to California, 2015. *BMC Res Notes*. 2017 Aug 30;10(1):434.
- ⁶ Castro KG, Marks SM, Hill AN, Chen MP, Miramontes R, Winston CA, LoBue PA. Estimating tuberculosis cases and their economic costs averted in the United States over the past two decades. *Int J Tuberc Lung Dis*. 2016 Jul;20(7):926-33.