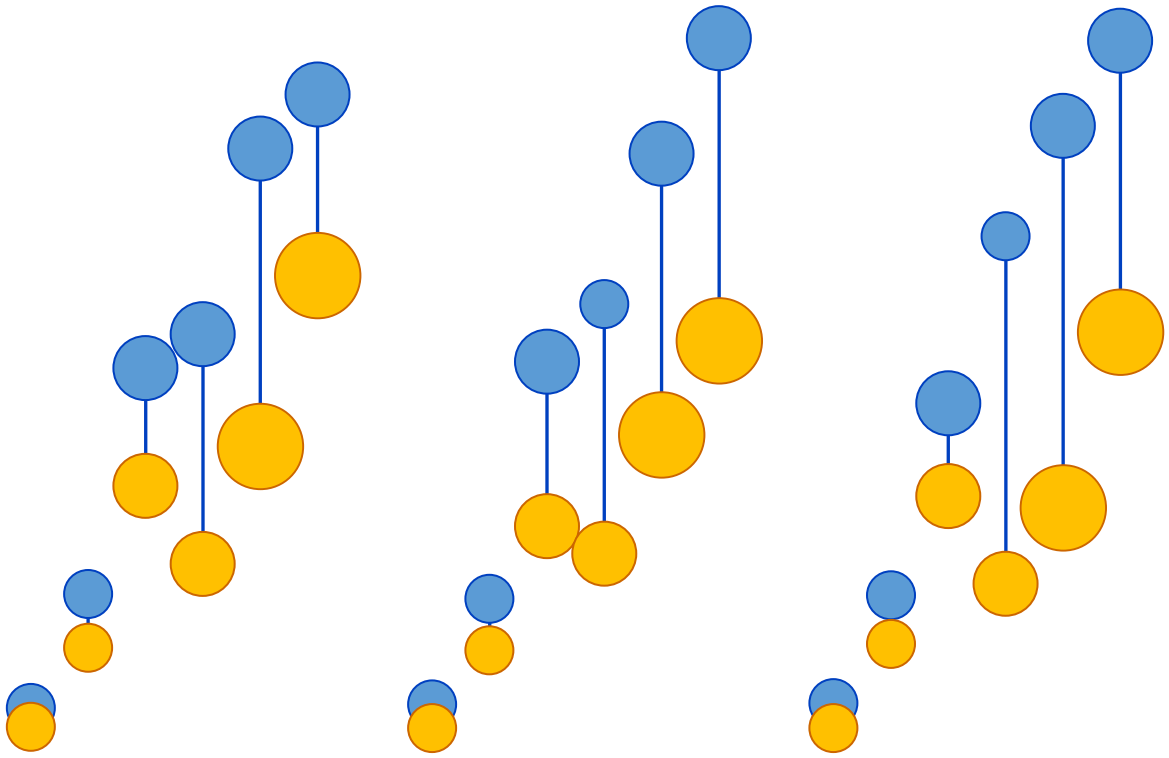
Report on Tuberculosis in California, 2018



Gavin Newson, Governor

State of California

Mark A. Ghaly, MD, MPH, Secretary

California Health and Human Services Agency

Susan Fanelli, Acting Director

California Department of Public Health

Report on Tuberculosis in California, 2018

Gavin Newsom
Governor
State of California

California Department of Public Health
Center for Infectious Diseases
Division of Communicable Disease Control
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July 2019

Report on Tuberculosis in California, 2018
California Department of Public Health
Center for Infectious Diseases
Division of Communicable Disease Control
Tuberculosis Control Branch

July 2019

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This report and related Excel data tables can be found at the following link:
https://www.cdph.ca.gov/Programs/CID/DCDC/Pages/TB-Disease-Data.aspx

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Cover figure: The figure represents TB incidence rates (IR) in persons of low and high measures of socio-economic status (SES) by country of origin. Three SES measures represented are, from left to right, income, crowding, and education. Countries of origin in each SES measure, from left to right are: United States, Mexico, India, China, Vietnam, and the Philippines. Blue circles indicate persons with low SES and the yellow circles represent persons with higher SES. The size of each dot represents the magnitude of the rate: smallest dots, IR rate is less than 15; medium dots, IR is 15 to less than 45; largest dots, IR is greater than 45. For each measure, and in each country of origin, persons of lower SES have higher rates of TB than persons in higher SES strata. Many thanks to Yasser Bakhsh, MBBS, MPH, for contributing his analysis and graphic for this cover.

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

SUSAN FANELLI
Acting Director

GAVIN NEWSOM
Governor

July 11, 2019

Dear Colleagues,

I am pleased to present the 2018 Report on Tuberculosis in California. The 2,092 active TB cases reported in 2018 represent an increase of nearly three percent from the previous year. Despite our earlier successes, the recent increase is a reminder that we cannot relax our efforts to control and prevent TB in our state.

The data in this report provide valuable information on where to focus efforts to identify new TB cases, as well prevent future ones. In 2018, 53% of California's TB cases were among Asians, of whom 96% were born outside the United States. The age of patients with TB is increasing, with a median age of 55, driven primarily by age increases among the non-U.S.-born.

Last year we also saw many successes in our work against TB. There were decreases in TB cases among vulnerable populations including young children and persons living with HIV. The number of multidrug-resistant (MDR) TB cases fell and no extensively drug-resistant (XDR) cases were reported. Rapid molecular test use for diagnosis of TB and drug resistance increased, and at least some TB therapy was provided by directly observed therapy (DOT) to nearly all cases.

To return to the steeper declines in TB seen in previous years, we must increasingly turn our attention to the more than 2 million Californians with latent TB infection. Through collaboration with our national, state and local partners in both public and private health care settings we can speed our progress toward our goal of TB elimination.

I look forward to continuing to work with you toward our shared vision of a California free of tuberculosis.

Sincerely,

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.

CDPH Division of Communicable Disease Control implemented an internet-based surveillance system for reportable diseases including TB in 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.

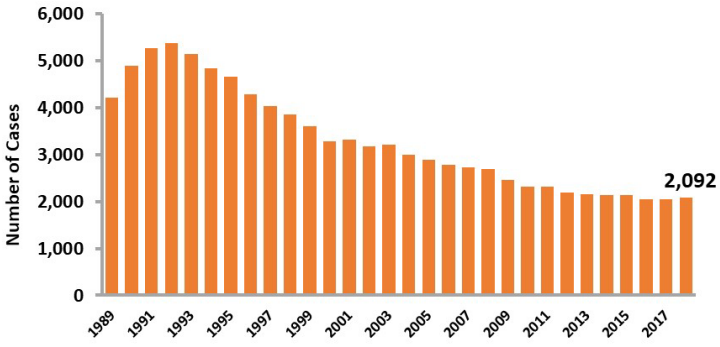
TB in California: 2018 Summary

Active tuberculosis (TB) is an illness caused by the bacterium *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. Those that have been infected but are not sick have latent tuberculosis infection (LTBI). Persons with LTBI can become sick with active TB in the future if they are not treated. The California Department of Public Health, Tuberculosis Control Branch works together with local and national partners to prevent and control TB, including addressing racial and ethnic disparities in the disease, treatment and management of drug-resistant TB, and identifying and controlling outbreaks. These efforts, together with renewed focus on diagnosing and treating persons with LTBI will move us closer to a TB-free California.

California Overview

- More than 2 million* Californians (6% of the population) have LTBI which can progress to active TB without diagnosis and treatment.
- In 2018, California reported 2,092 new active TB cases, compared with 2,058 cases in 2017.
- California's annual TB incidence was 5.3 cases per 100,000 persons, which is nearly double the national incidence rate of 2.8.
- Medical and societal costs of TB reached more than $200 million* California in 2018.
- TB cases were reported in 44 of California's 61 (72%) local health jurisdictions; 15 (34%) of those reported 1-4 cases.
- Among California's TB cases, an estimated 6% were imported from outside the United States (U.S.), 12% resulted from recent transmission, and 82% were due to progression of LTBI to active TB.

Reported TB Cases: California, 1989–2018



The resurgence of TB began in the 1980s and peaked in 1992. Case counts began decreasing again in 1993, but the decline has stalled in recent years.

Most Affected Populations

Persons Born Outside the U.S. Bear Significant Burden

- The TB rate among persons born outside of the United States (16.2 per 100,000) was nearly 14 times higher than the rate among U.S.-born persons (1.2 per 100,000).
- In 2018, 83% of California's TB cases occurred in persons who were born outside the U.S.
- In 2018, nine percent of non-U.S.-born TB patients were diagnosed within 1 year after arriving in the U.S., compared to 23% in 1993 when information on time in the U.S. was first collected. Half of TB cases in non-U.S.-born patients occurred 20 years or more after arrival in the U.S.

Proportion of TB Cases by National Origin — California, 2018

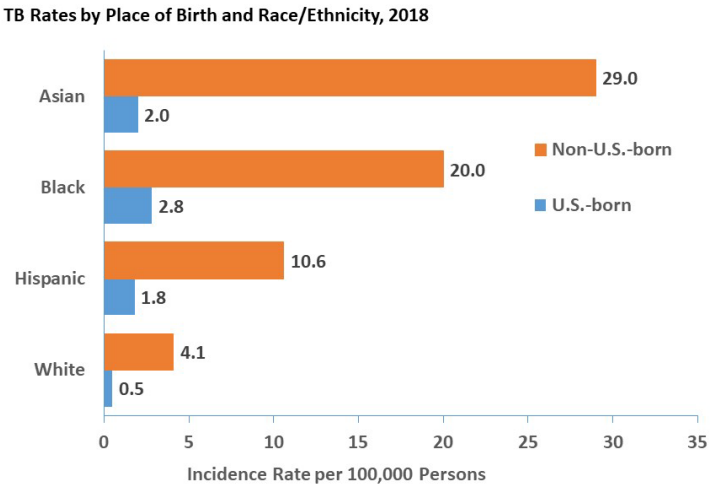
*See Technical Notes for information on estimating number of persons with LTBI and costs of TB.

This document reflects data as of April 19, 2019.

TB in California: 2018 Summary

Racial/Ethnic Disparities Persist

- The rate among Asians, Blacks and Hispanics born outside the U.S. were 58, 40 and 21 times higher, respectively, than of U.S.-born whites.
- Over half (53%) of California's TB cases occurred among Asians in 2018, up from 45% in 2009.



Medical Comorbidities

- In 2018, 36% 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 (27% of adult cases).
- HIV infection greatly increases a patient's risk for progression from LTBI to active TB disease, as well as for TB-related death.
- In 2018, 87% of all patients with TB were tested for HIV. Of those tested, 59 (3.2%) were HIV-positive, down from 101 (5.4%) in 2011, the first year these data were reported on the TB case report form.

Children and Older Adults

- The proportion of TB cases in older adults is growing. In 2018, 34% of TB cases were reported in persons 65 years of age or older, compared to 25% in this age category in 2009.
- More than 250 (12%) persons age 80 or older were diagnosed with TB in 2018.
- Since 2009, the median age of all TB patients rose from 48 to 55 years, driven predominantly by the rising median age of foreign-born TB cases from 50 years in 2009 to 57 years in 2018.
- There were 28 TB cases among children less than 5 years of age in 2018, a decrease from 70 cases in 2009.

Special Populations

- Congregate living situations such as correctional facilities and homeless shelters may pose challenges for TB control due to the potential for a large number of persons to be exposed and infected with TB.
- In 2018, 67 (3.2%) TB patients were residing in a correctional facility at the time of their diagnosis, compared to 38 (1.8%) the previous year.
- Data on homeless shelter stays are not collected, however, 90 (4.3%) TB patients were homeless at some point in the year prior to their TB diagnosis in 2018.

Death Among Persons with TB

- During 2014-2016, 625 persons (10% of TB cases) died with TB. Of persons who died with TB, 22% died before receiving TB treatment.

This document reflects data as of April 19, 2019.

TB in California: 2018 Summary

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 74% of cases reported in 2018.
- In 2018, pulmonary disease was diagnosed in 82% of TB cases, indicating a risk of transmission to others; of those, 17% also had TB in another site. Eighteen percent of TB patients had only extrapulmonary disease.
- TB was diagnosed by laboratory findings in 86% of cases; 14% of cases were clinically confirmed.
- Of pulmonary TB cases with an abnormal chest x-ray, cavitation was seen in more than 20%, indicating more advanced disease.
- Ninety-one percent of TB patients received at least some of their treatment via directly observed therapy.
- Fifty-nine percent of TB patients had at least some of their care provided by a local health department; 41% received care only from their private provider or in an institutional setting.

TB Transmission is Occurring in California

- An estimated 12% of TB cases resulted from transmission of TB in California during 2018.
- In 2018, transmission occurred in 1 confirmed and 1 probable outbreak, and 5 ongoing TB outbreaks, each involving at least 4 persons.

Drug-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 second line drugs, fluoroquinolones and injectables.
- Patients with MDR and XDR TB generally have poorer outcomes because the most effective TB drugs are ineffective against their disease
- In 2018, there were 19 (1.2%) MDR TB cases in California, a decrease from 30 MDR TB cases reported in 2017.
- Despite a worldwide increase in MDR TB, the proportion of TB cases in California that are MDR has remained consistent (1–2%) since drug susceptibility data began being systematically collected in 1993.
- Since 1993, the start of routine tracking of drug resistance, 24 XDR TB cases have been reported in California. No XDR cases were reported in 2018.

Outcomes of TB Treatment

- Among persons reported with TB in 2016 who started anti-TB treatment, 85% completed treatment, nearly 10% died, 1% were lost, and 0.5% refused to complete treatment.
- Of TB patients for whom one year or less of treatment was recommended, 88% completed treatment in that time period.

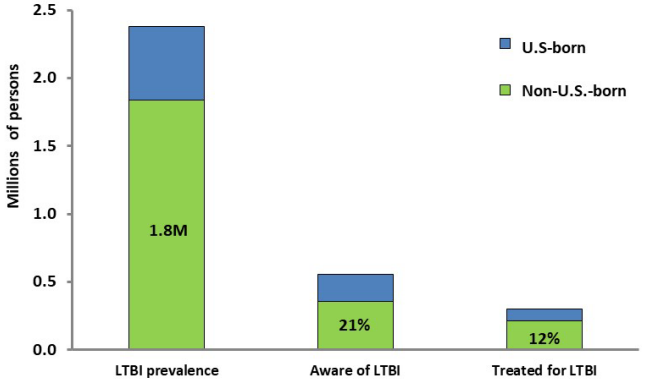
This document reflects data as of April 19, 2019.

TB in California: 2018 Summary

Treating Latent TB Infection is Critical

- Approximately 82% of persons who become sick with TB have had longstanding infection, LTBI, before they develop disease. LTBI cannot be transmitted to others.
- More than 2 million Californians who have LTBI, including 17% of the population born outside the U.S. and 2% of the population born in the U.S. Most are not aware of and have not been treated for LTBI and are at risk for progressing to active tuberculosis.
- LTBI is not currently a reportable condition in California.
- LTBI estimates were calculated using the 2011-2012 National Health and Nutrition Examination Survey results for race/ethnicity and nativity strata applied to 2018 California population data from the California Department of Finance.

Estimated latent TB infection prevalence, awareness and treatment, California, 2018



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

- Risk assessment tools are available for use by medical providers to identify persons at risk for LTBI for testing and treatment

A Plan to Eliminate TB

CDPH, in collaboration with the California TB Elimination Advisory Committee and the California TB Controllers Association, developed a TB Elimination Plan which outlines actions over 5 years to make 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 tuberculosis data, including performance trends on national and state TB objectives: https://www.cdph.ca.gov/Programs/CID/DCDC/Pages/TB-Disease-Data.aspx
- Read more about the plan to eliminate TB from California: https://www.cdph.ca.gov/Programs/CID/DCDC/CDPH%20Document%20Library/TBCB-TB-Elimination-Plan-2016-2020.pdf
- Who should be tested for LTBI? See the California TB Risk Assessment Tools: https://www.cdph.ca.gov/Programs/CID/DCDC/Pages/TB-Risk-Assessment.aspx

This document reflects data as of April 19, 2019.

Figure 1. Number of Tuberculosis Cases: California, 1930-2018

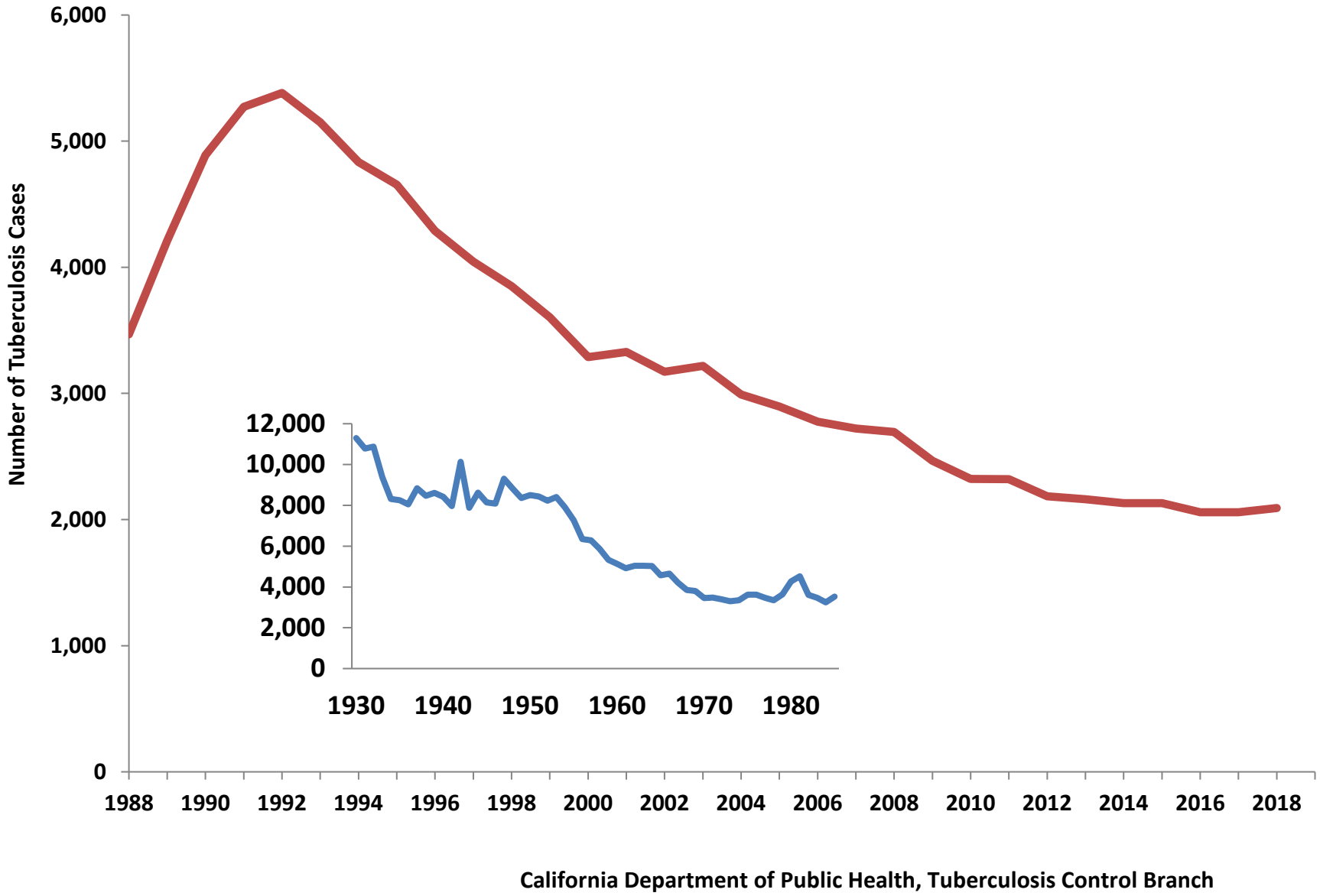
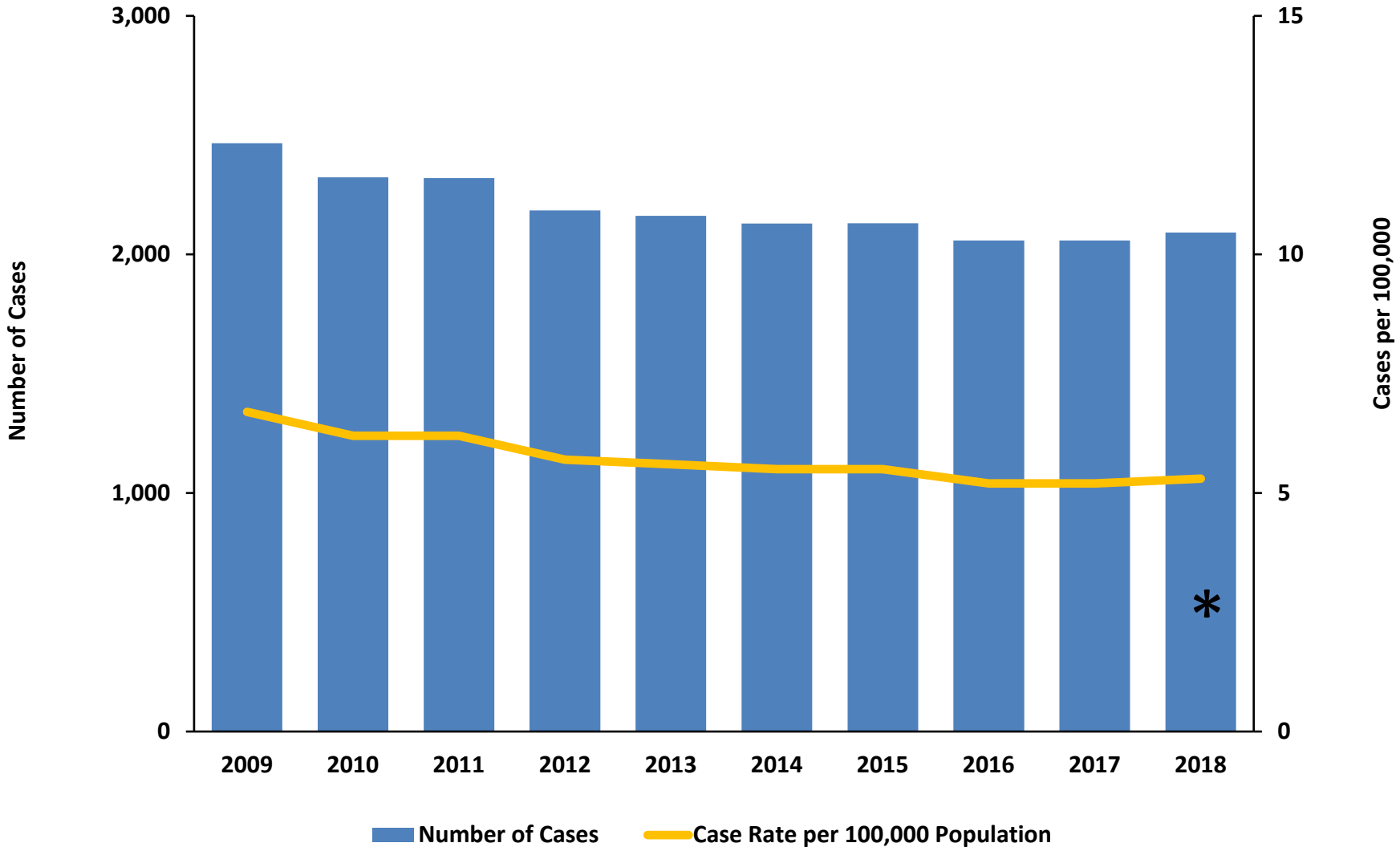


Figure 2. Number of Tuberculosis Cases and Case Rates: California: 2009-2018



* National Case Rate (2.8 per 100,000)

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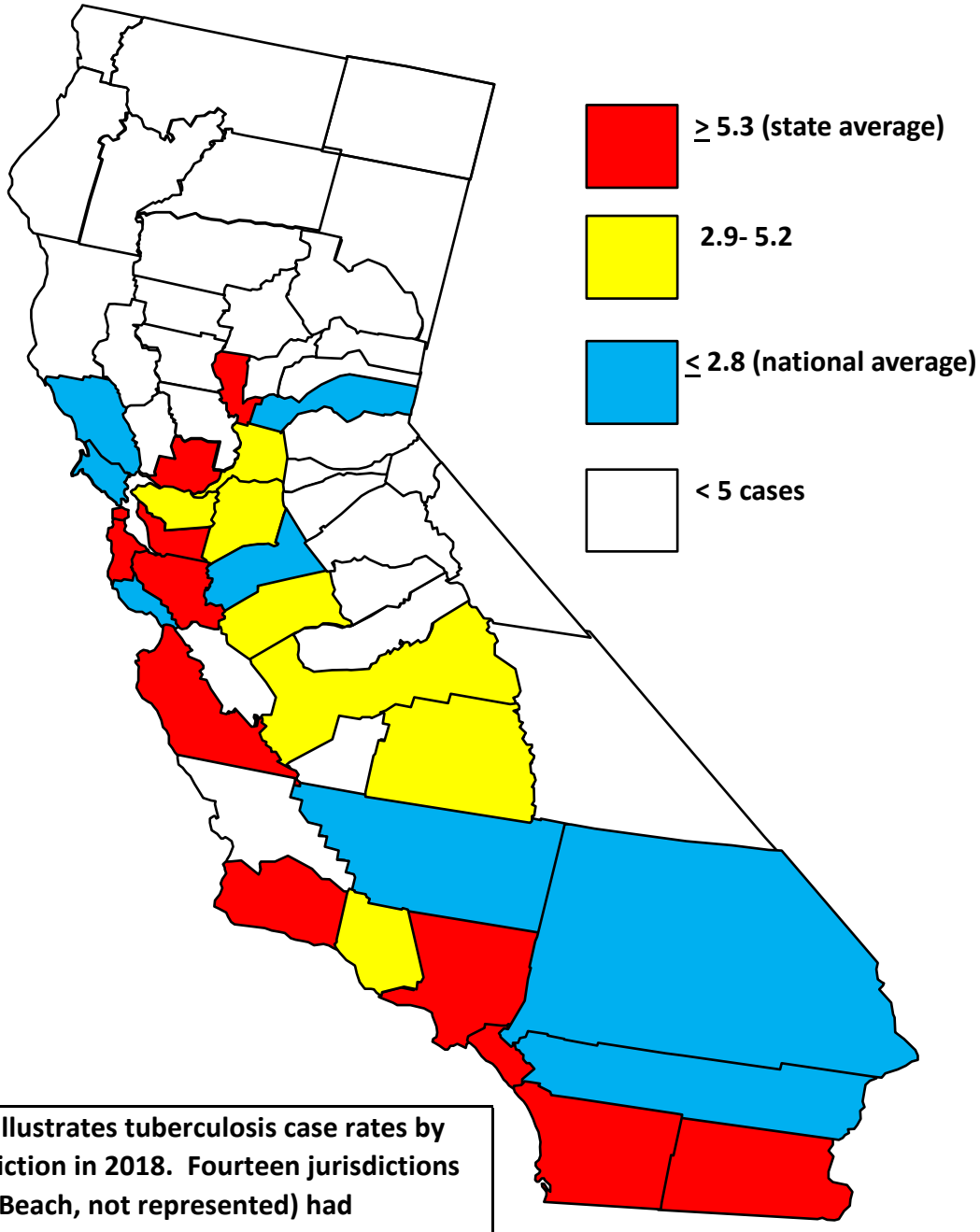
Figure 3. Tuberculosis in California, 2018



Note: The map illustrates tuberculosis case rates by reporting jurisdiction in 2018. Fourteen jurisdictions (including Long Beach, not represented) had tuberculosis case rates equal to or above the state average of 5.3 cases per 100,000 population. Seven jurisdictions (including Berkeley, not represented) had case rates greater than the national rate and less than the state rate (2.9 to 5.2 cases per 100,000 population). Eleven jurisdictions had case rates less than or equal the national rate (2.8 cases per 100,000 population). Case rates were not calculated for 32 jurisdictions (including Pasadena, not represented) because there were fewer than five cases in these areas.

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Figure 4. Tuberculosis Cases by Race/Ethnicity: California, 2018

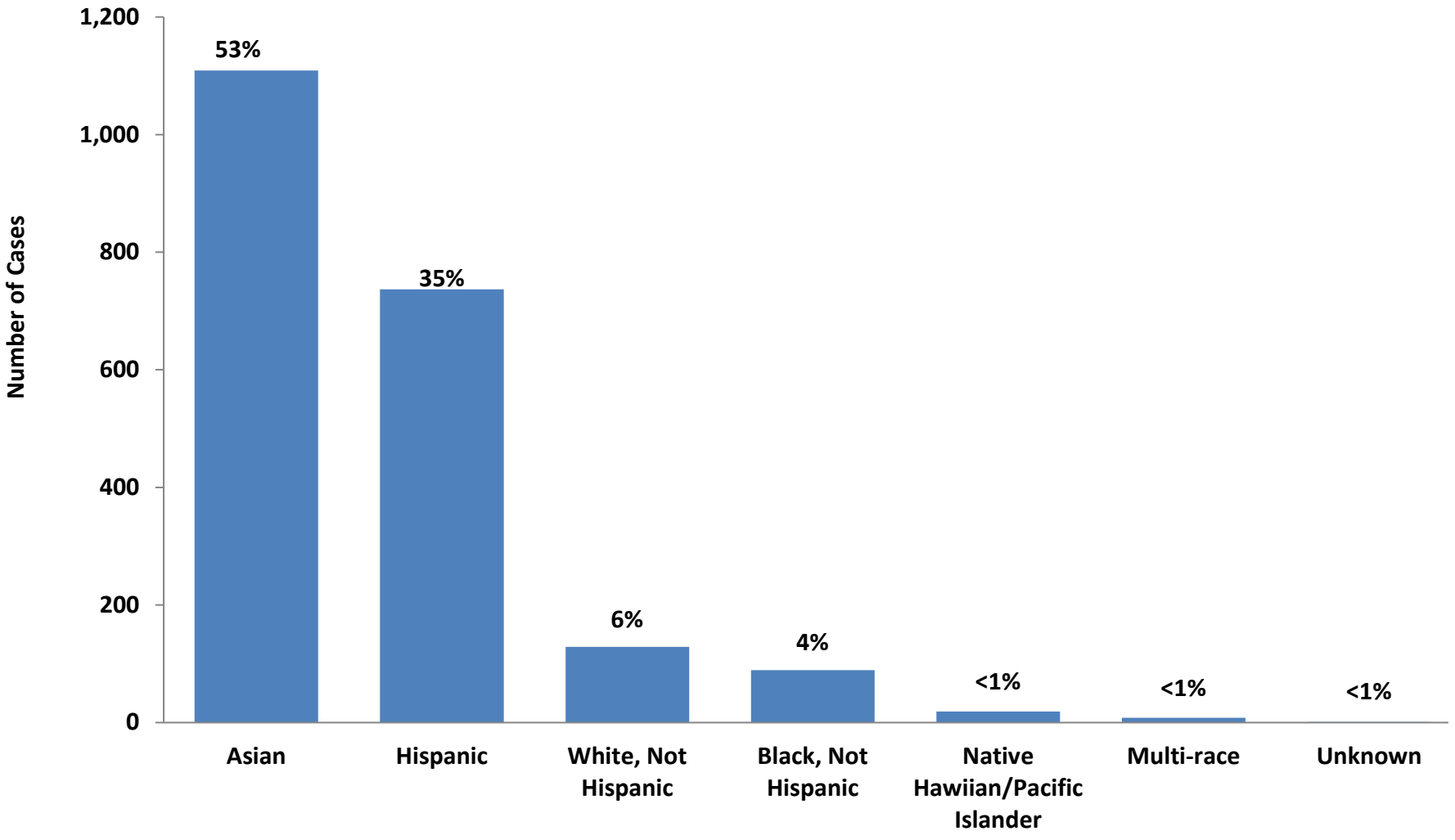

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Figure 5. Tuberculosis Case Rates by Race/Ethnicity: California, 2009-2018

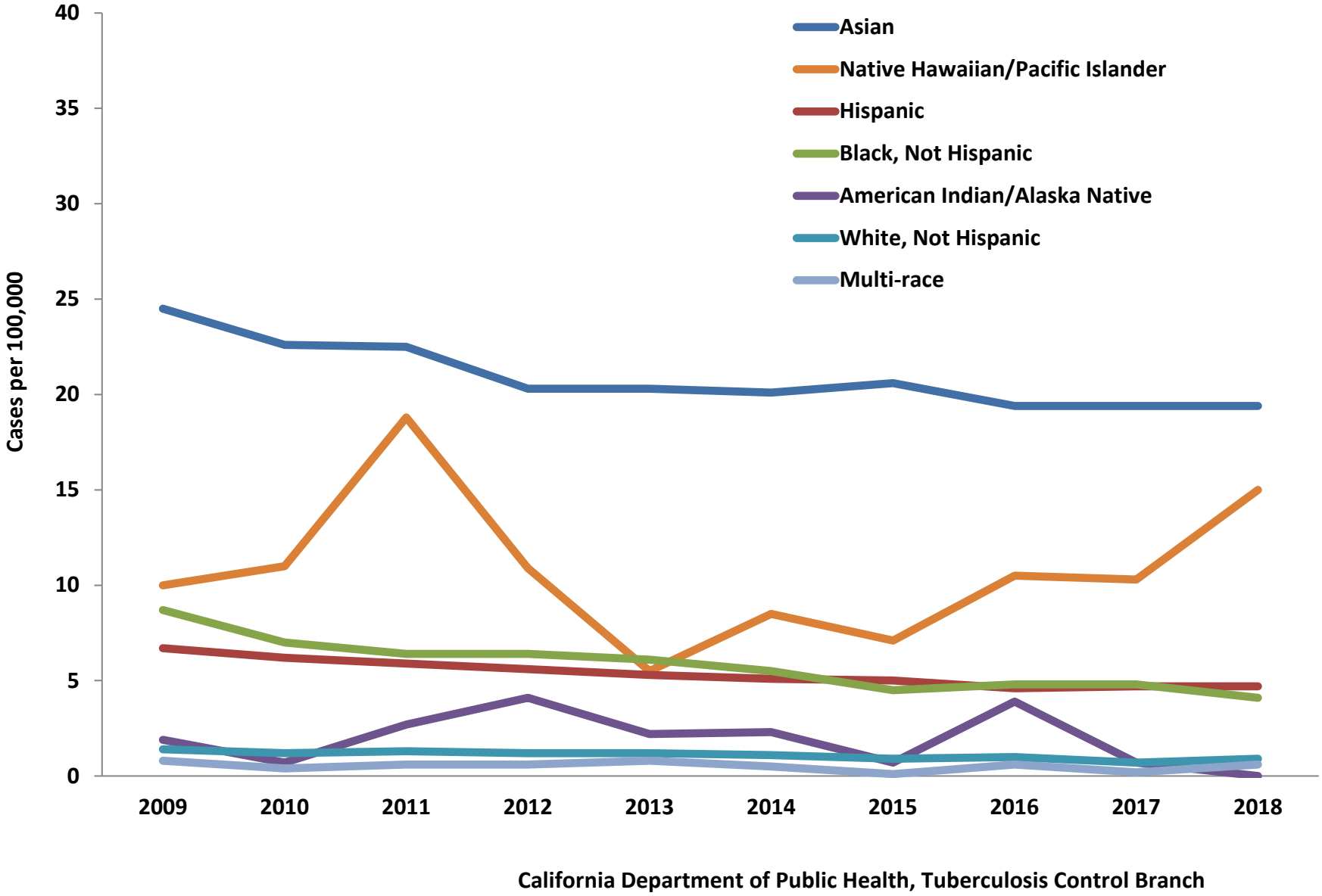


Figure 6. Tuberculosis Cases in Non-U.S.-born and U.S.-born Persons: California, 2009-2018

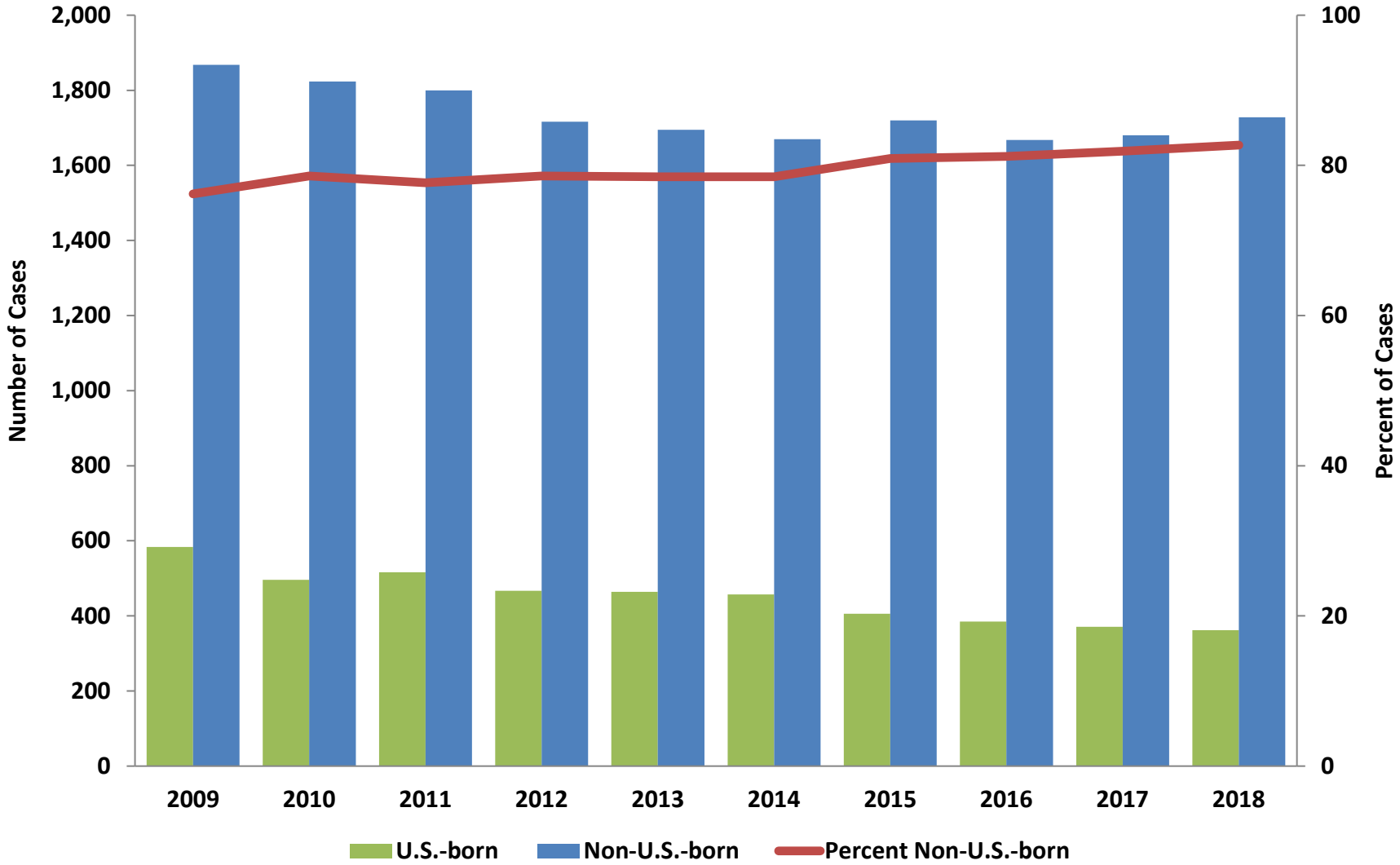
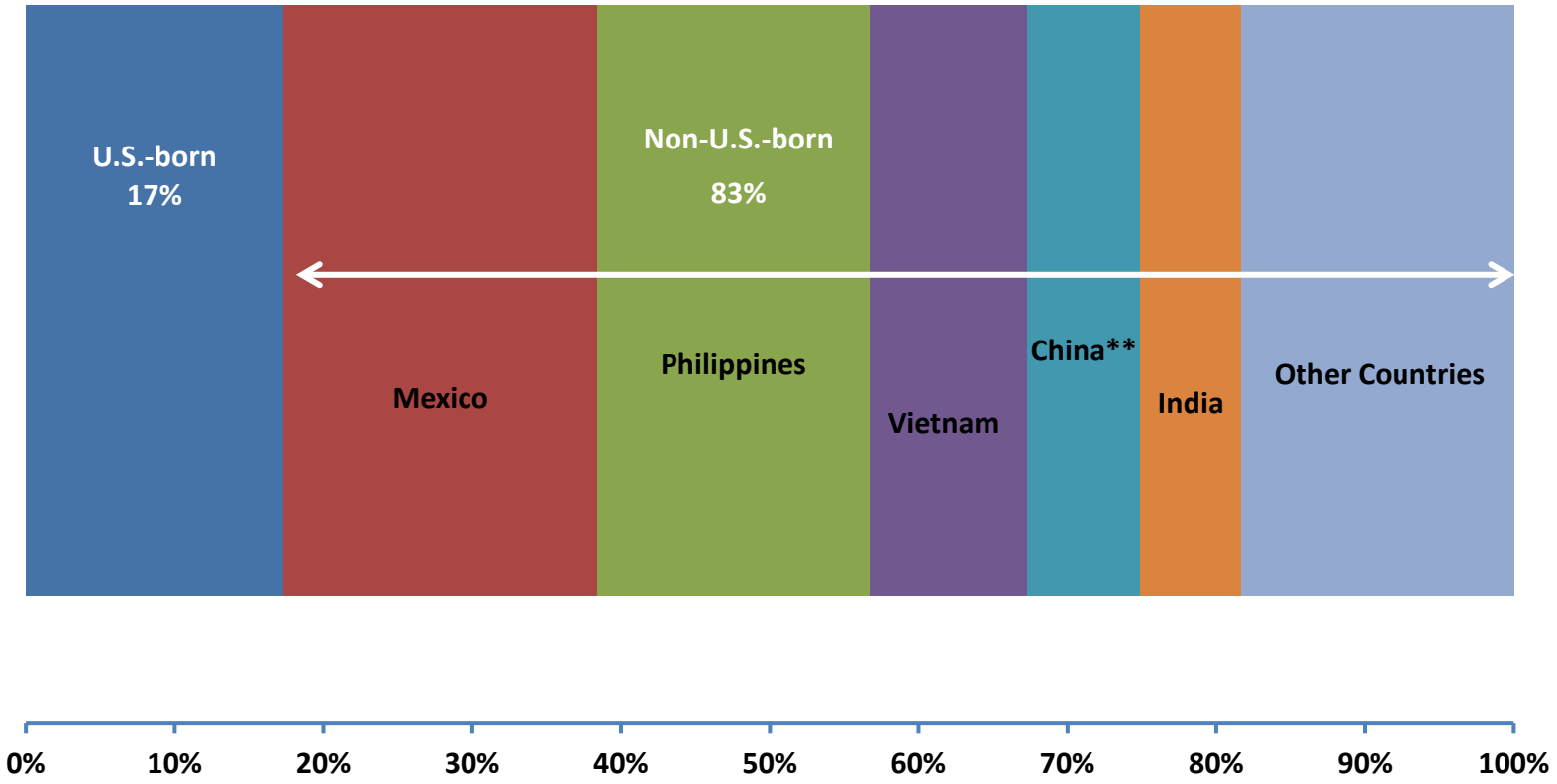


Figure 7. Tuberculosis Cases by Country of Origin:* California, 2018



* Excludes cases for whom country of origin is unknown
** People's Republic of China includes Hong Kong

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Figure 8. Tuberculosis Cases in Persons 0-4 Years of Age: California, 2009-2018

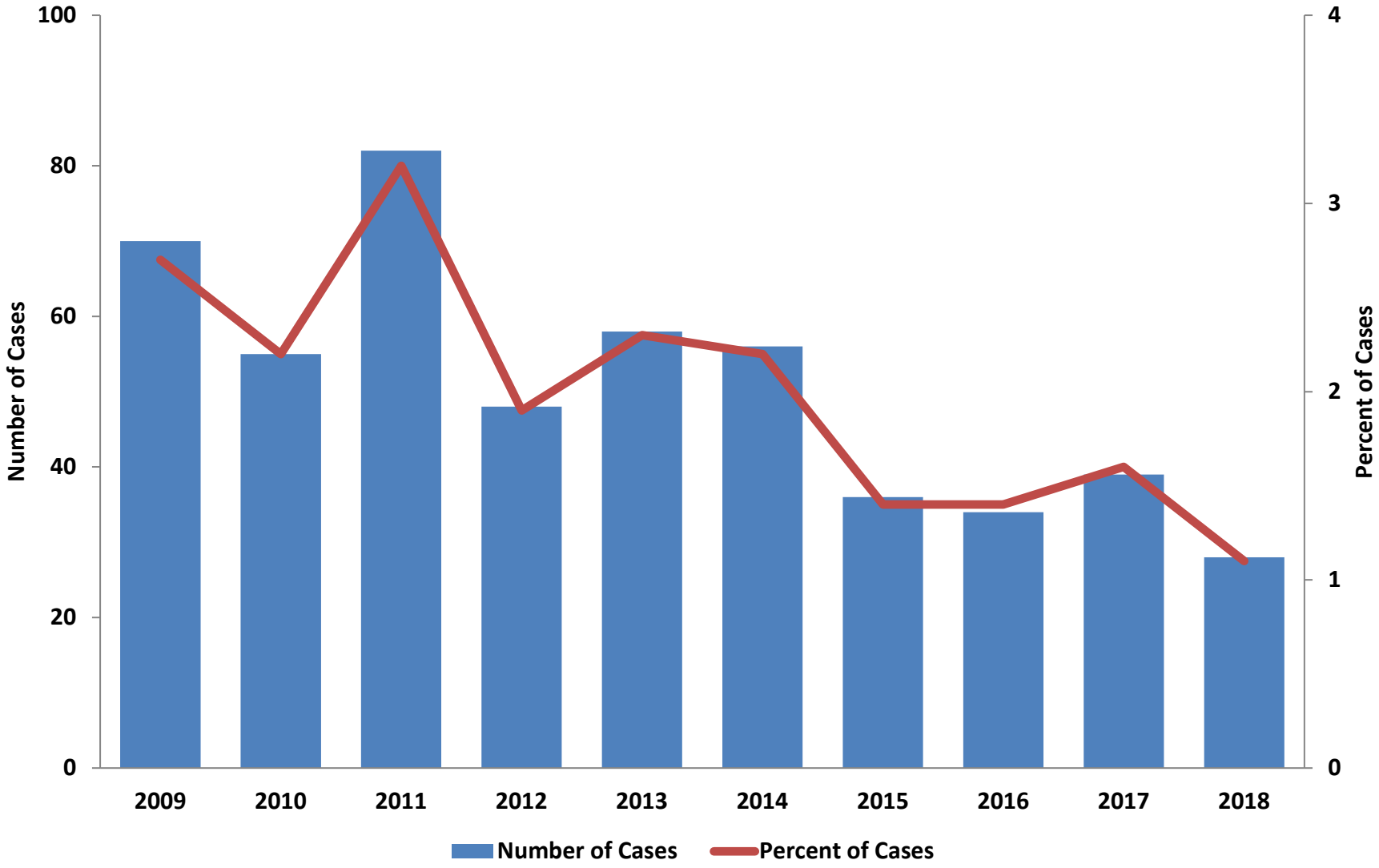

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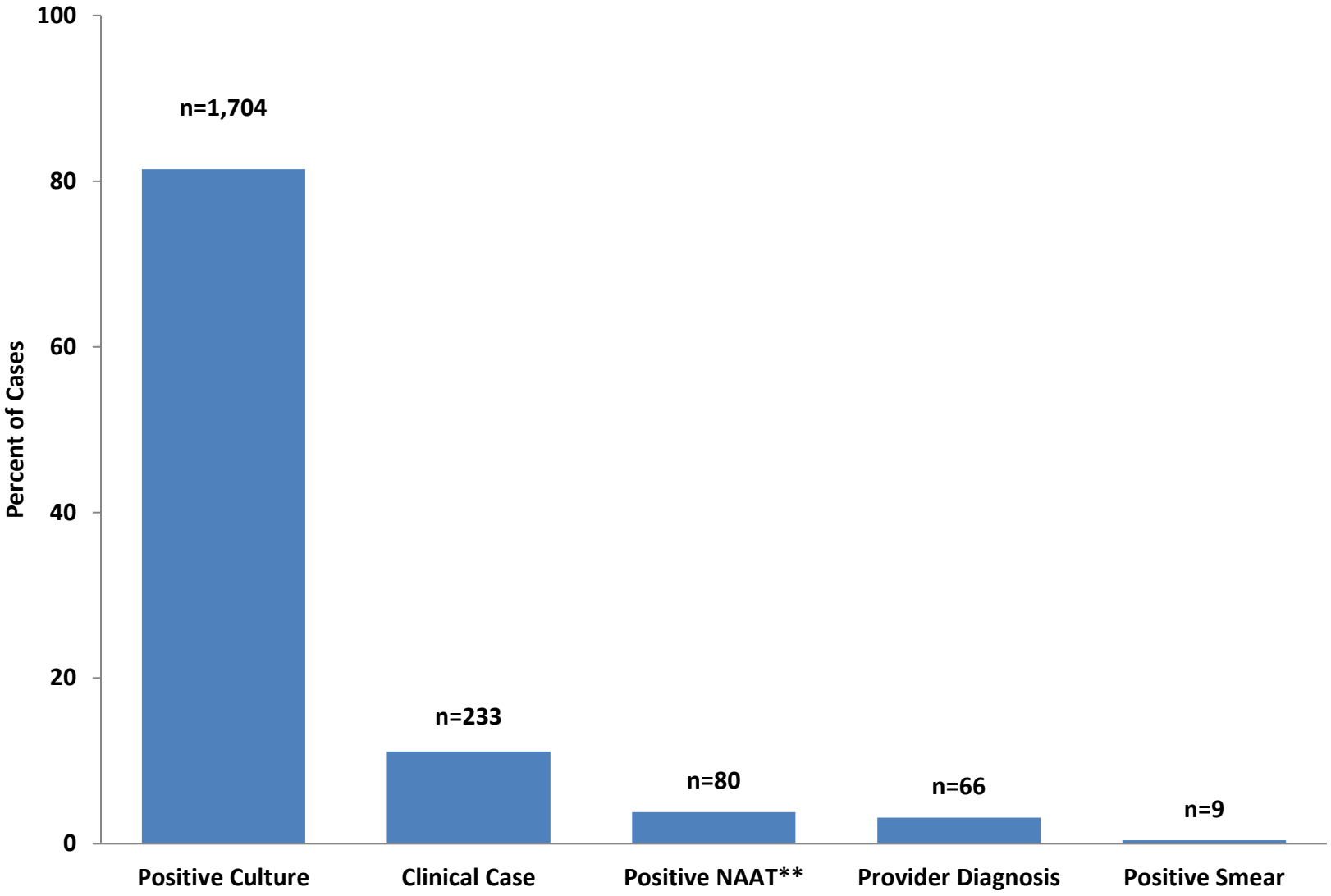
Figure 9. Tuberculosis Cases by Verification Criteria*: California, 2018



* See Technical Notes for description of verification criteria.

**NAAT = Nucleic Acid Amplification Test

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Figure 10. Deaths in Persons with Tuberculosis: California, 2007-2016

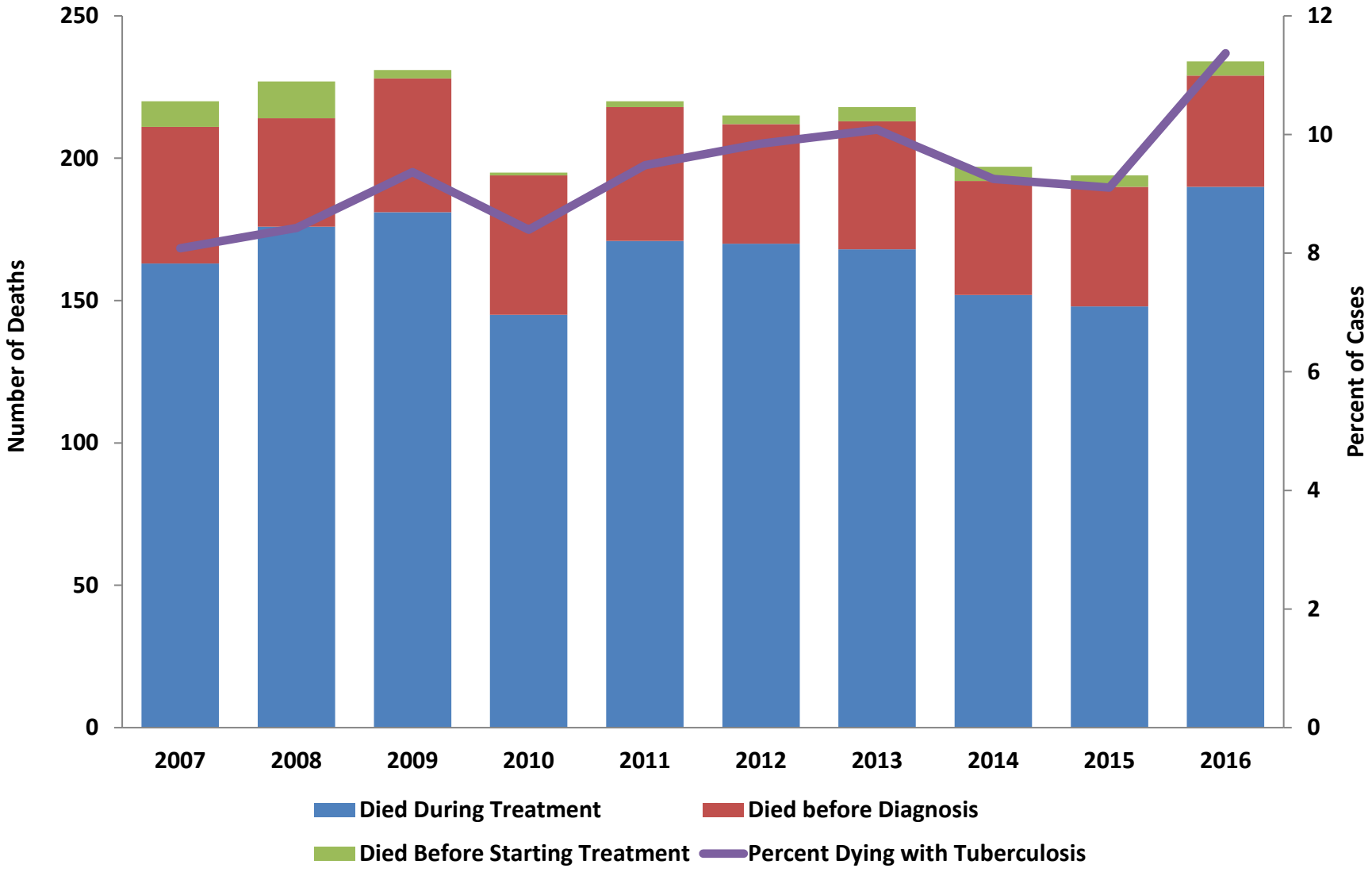

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Figure 11. Tuberculosis Cases by HIV/AIDS Diagnosis: California, 2009-2018

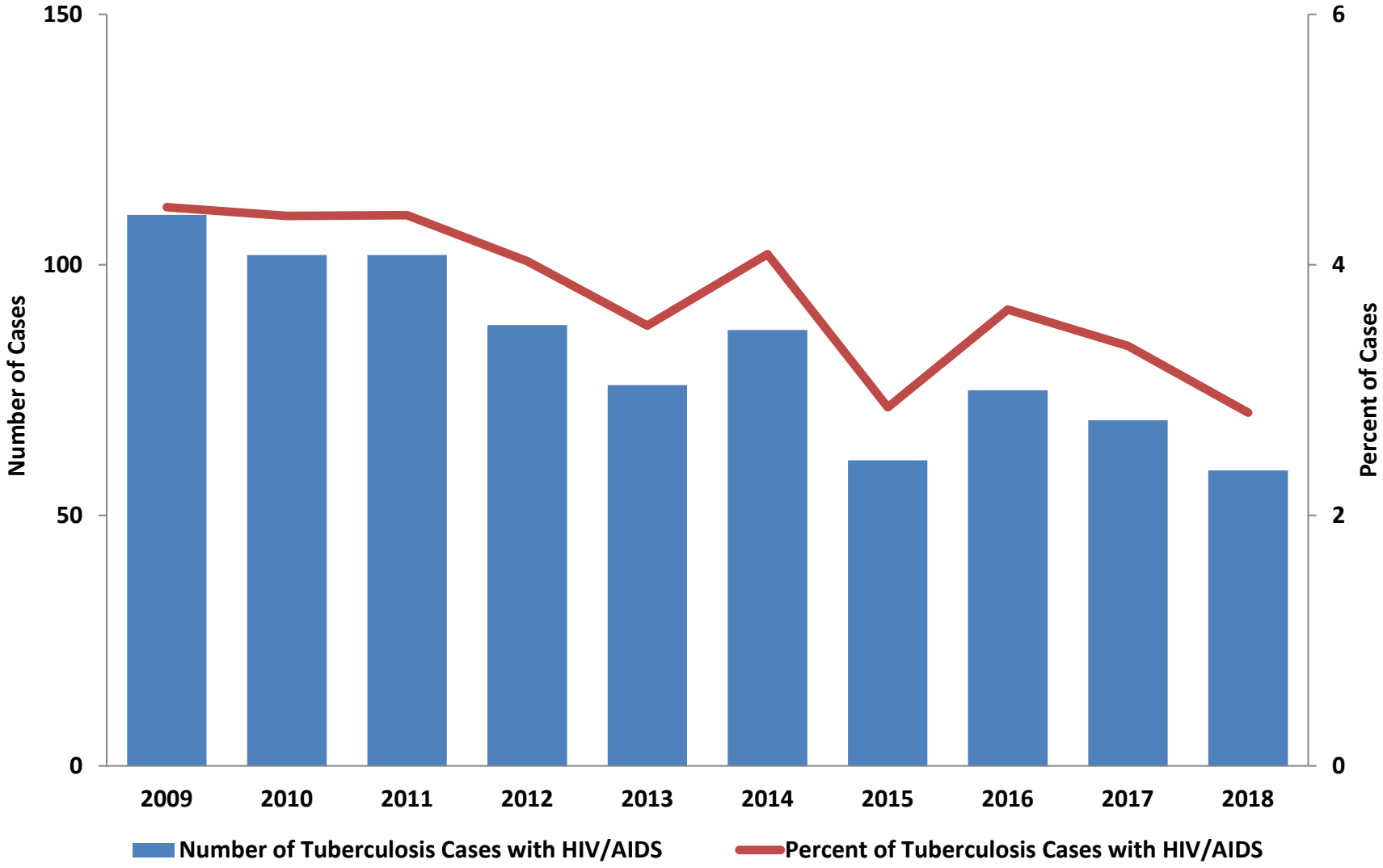

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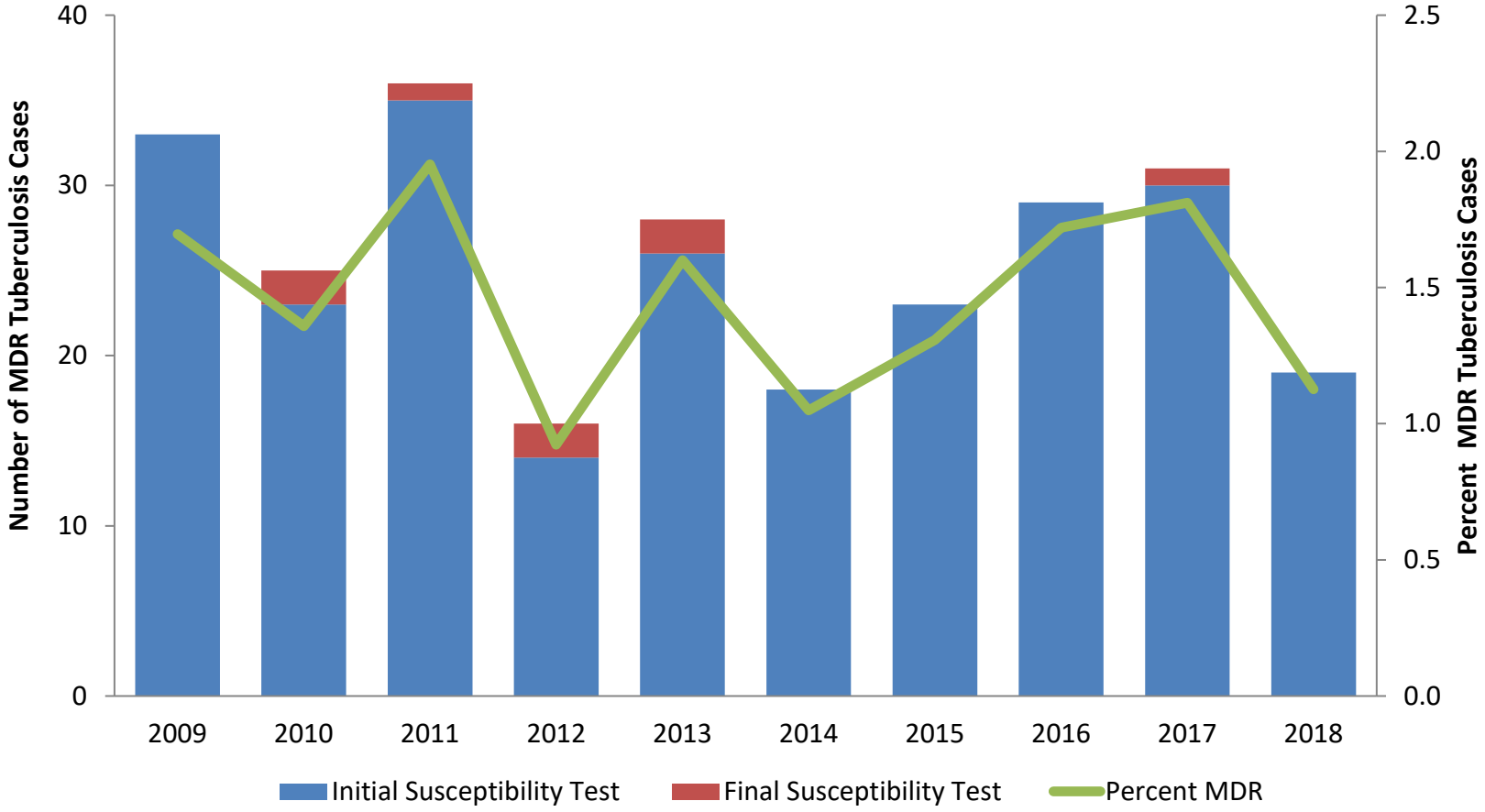
Figure 12. Tuberculosis Cases with Multidrug Resistance (MDR) on Initial or Final Drug Susceptibility Testing*: California, 2009-2018**



*** 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 2018.**

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Figure 13. Tuberculosis Cases with Initial Multidrug Resistance (MDR)*: California, 2014-2018

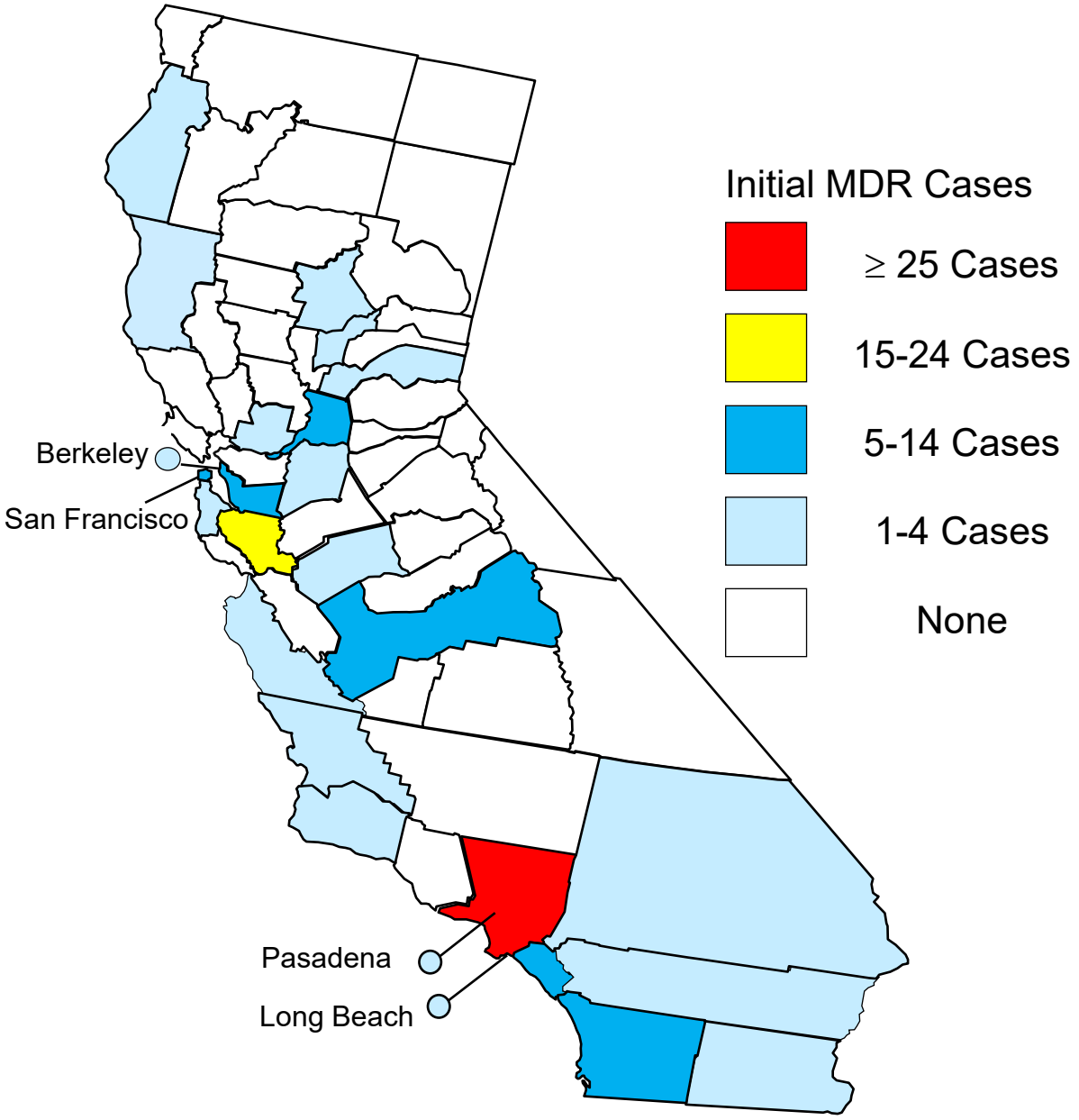

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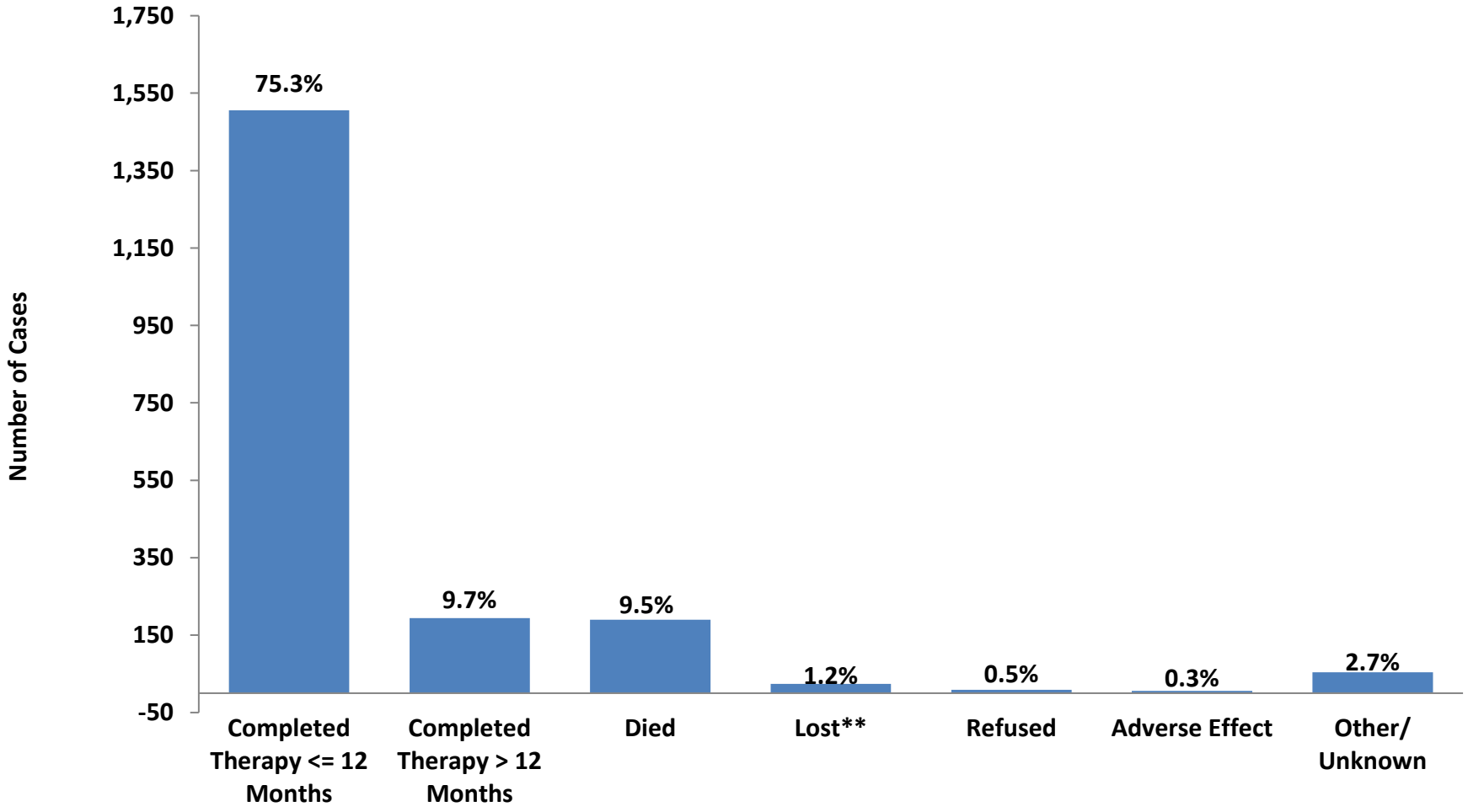
Figure 14. Tuberculosis Cases* by Outcome of Treatment: California, 2016



*** 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.**

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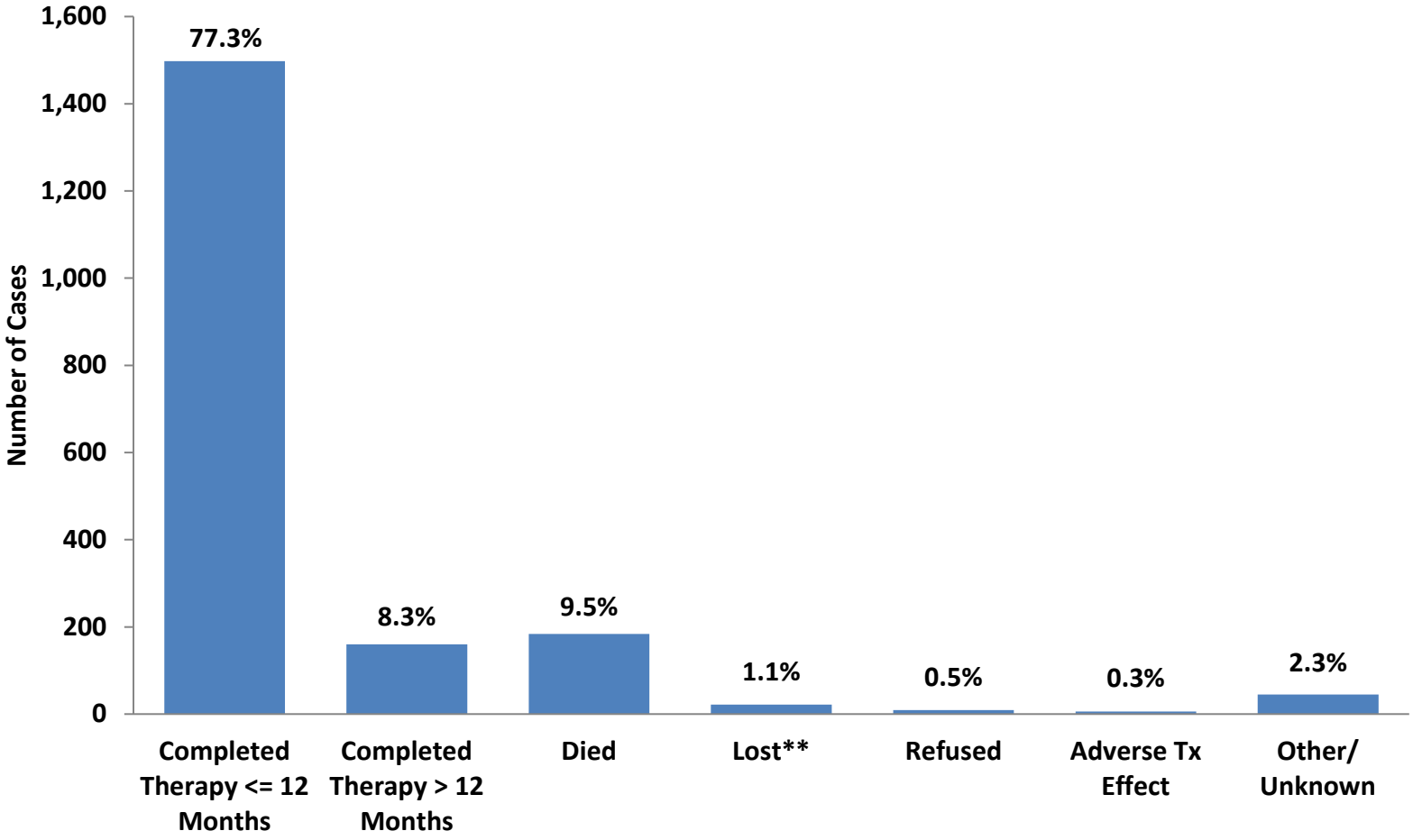
Figure 15. Outcome in Tuberculosis Cases for Whom One Year or Less of Treatment was Indicated*: California, 2016



* 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.

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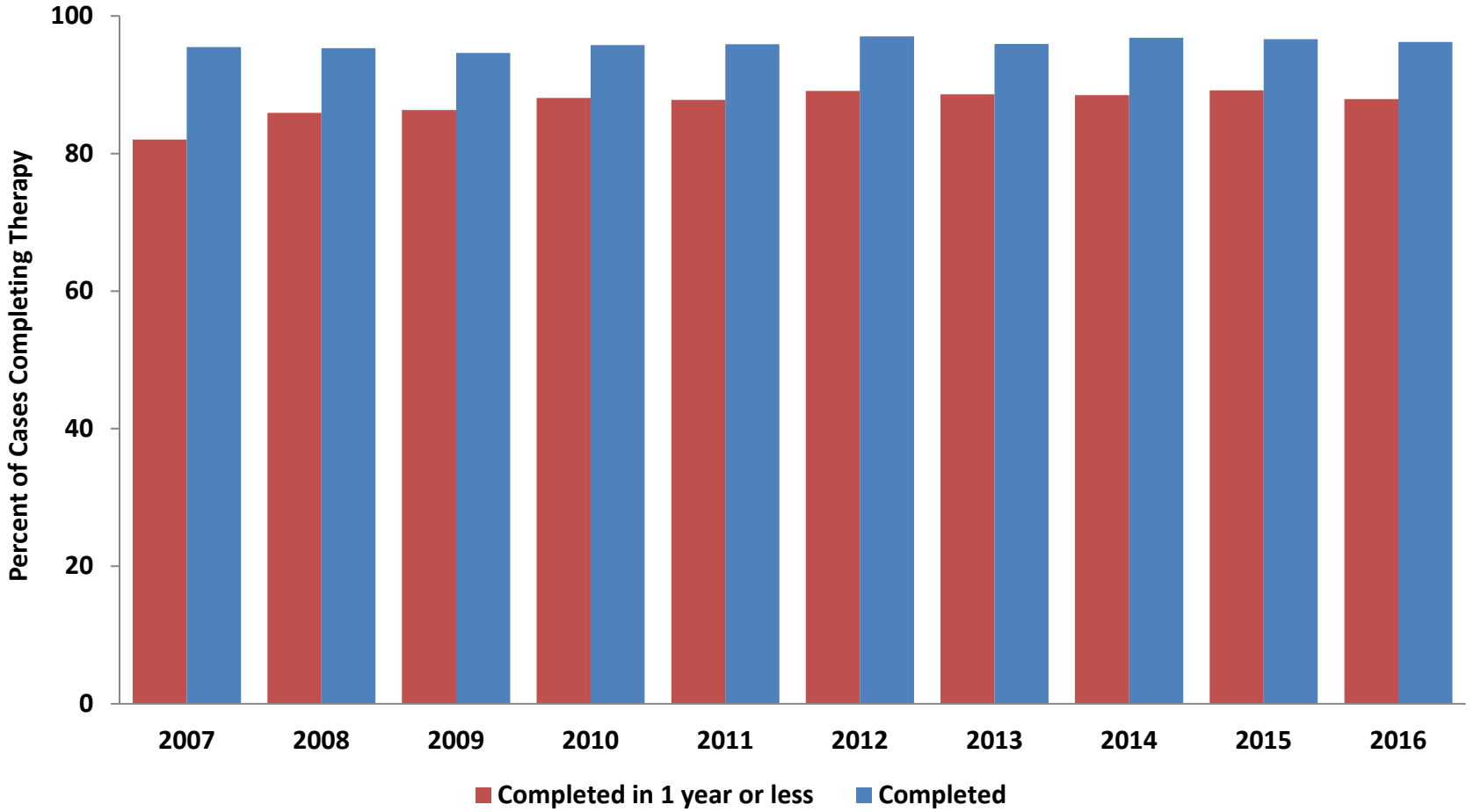
Figure 16. Completion of Tuberculosis Therapy: California, 2007 - 2016



Note: 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.

California Department of Public Health, Tuberculosis Control Branch

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) to report TB cases; an expanded and updated version of this form was implemented in California in 2010. 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 April 19, 2019 was included as a 2018 case in this report if the case was confirmed as active TB between January 1 and December 31, 2018. 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, 2010-2018,* December 2018
- *E-4 Population Estimates for Cities, Counties, and the State 2011-2018 with 2010 Census Benchmark,* May 2018.

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 State and County Population Projections by Race/Ethnicity, Sex, and Age, 2010-2060,* June 2017

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).

Populations of non-U.S.-born and U.S.-born persons 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 6.0, to the California total population for 2016 from California Department of Finance, *E-2 California County Population Estimates and Components of Change by Year, July 1, 2011-2018.* At the time of preparation of this report, *America Community Survey* data for 2018 fully stratified by race, sex, age and country of origin were not available, therefore the proportion of non-U.S.-born and U.S.-born persons from 2017 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://emsa.ca.gov/wp-content/uploads/sites/47/2017/10/CHHS-DDG-V1.0-092316.pdf).

Ranking of Jurisdictions

Jurisdictions are ranked in order of decreasing 2018 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.

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 new 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 98 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, 2018.

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 2016 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 percentage of cases with isolates positive for *Mtb* whose specimens were submitted for genotyping for 2014-2018 is presented. 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 also 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 6.0, 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), and reported in Miramontes (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.[2]) which provide similar results to estimates presented in this report.

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 Notes[3]) and estimates published by Castro et al. 2017 IJTLD[4]. 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 2010-2016. 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, Genadek K, Goeken R, Grover J, Sobek M. *Integrated Public Use Microdata Series: Version 6.0* [dataset]. Minneapolis: University of Minnesota, 2015. http://doi.org/10.18128/D010.V6.0.

[2] 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.

[3] 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.

[4] 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.