



Self-Study Modules On Tuberculosis



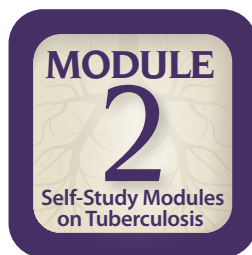
MODULE 2

Epidemiology of Tuberculosis



**Centers for Disease
Control and Prevention**
National Center for HIV/AIDS,
Viral Hepatitis, STD, and
TB Prevention

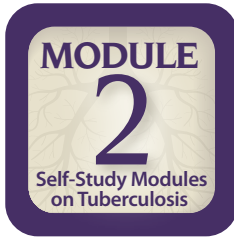




Epidemiology of Tuberculosis

U.S. DEPARTMENT OF HEALTH AND HUMAN SERVICES
Centers for Disease Control and Prevention
National Center for HIV/AIDS, Viral Hepatitis, STD, and TB Prevention
Division of Tuberculosis Elimination

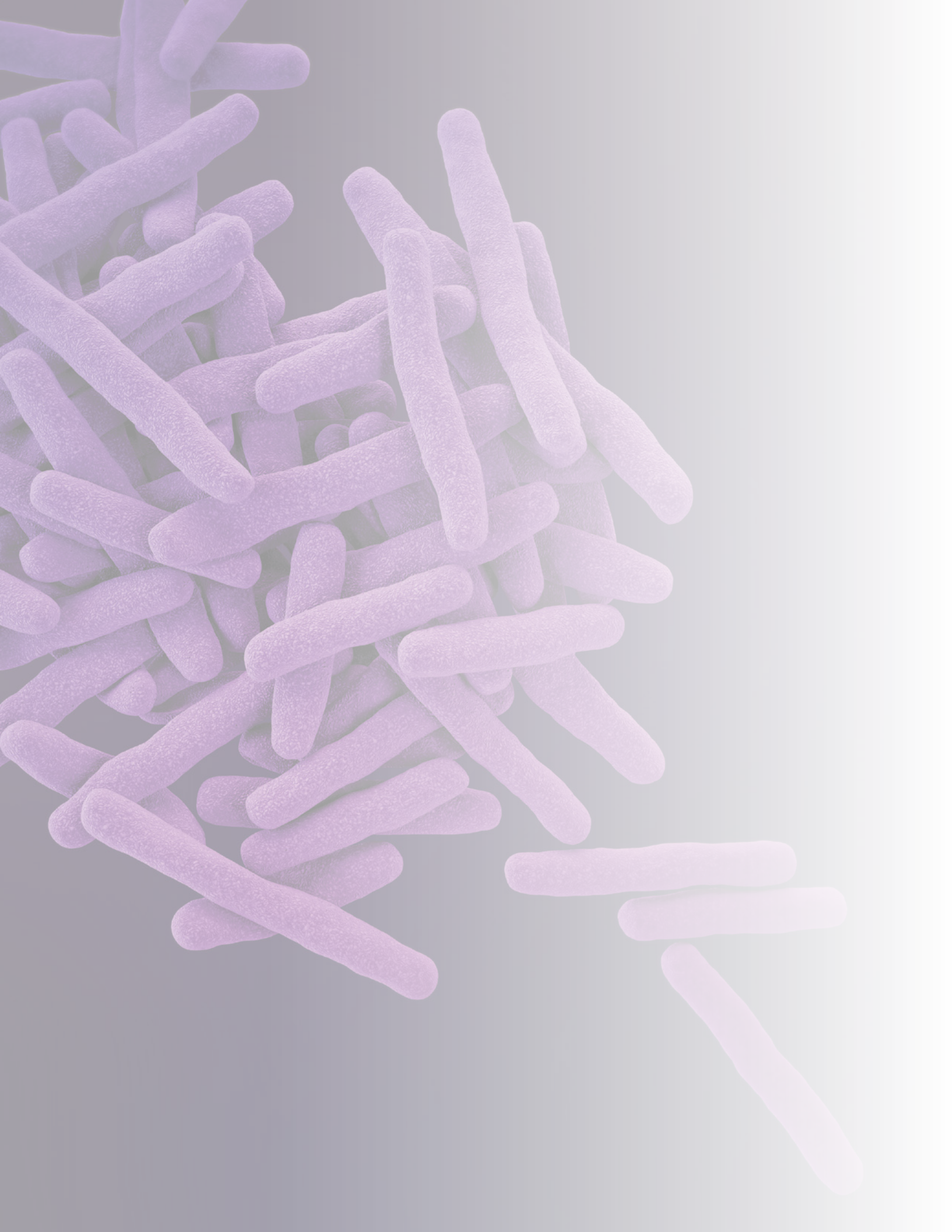
Atlanta, Georgia
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Epidemiology of Tuberculosis

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Background

Epidemiology is the study of diseases and other health problems in groups of people. Epidemiologists determine the frequency and pattern (the distribution) of health problems in different communities. They find out who has a specific health problem, how often the problem occurs, and where the problem occurs. Using this information about who, when, and where, epidemiologists try to determine why the health problem is occurring.

Public health officials use epidemiologic information to design ways to prevent and control the diseases in the community. By finding out who is at risk for a specific health problem, they can target their prevention and control strategies at this group.

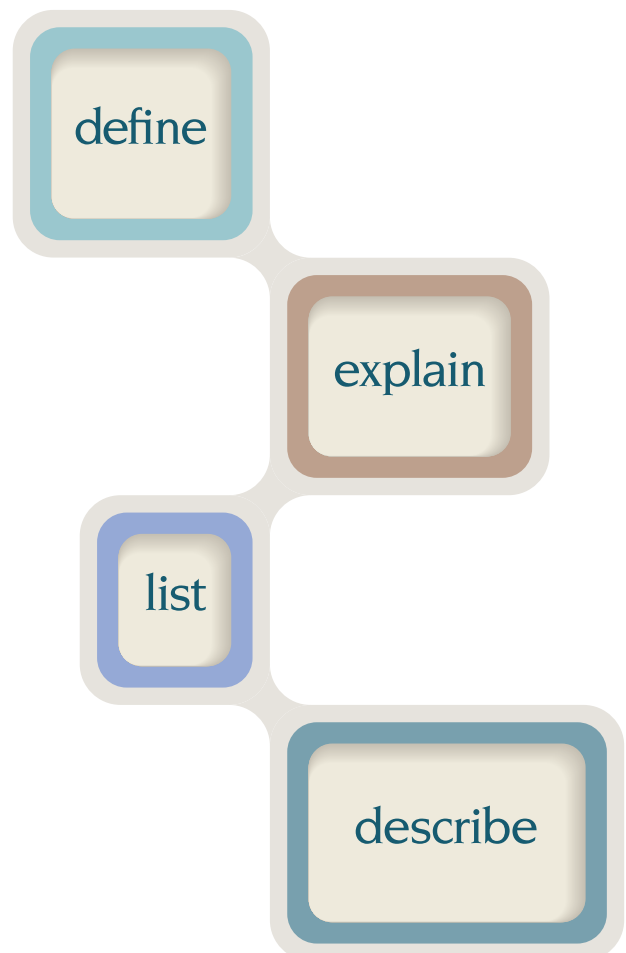
This module examines recent trends in TB in the United States and describes groups of people who are at higher risk for latent TB infection (LTBI) and TB disease. Groups of people who are at higher risk for TB vary from area to area; state and local health departments are responsible for determining specifically who is at risk in their area.

Note: The Self-Study Modules on Tuberculosis are a series of educational modules designed to provide information about TB in a self-study format. The target audiences include outreach workers, nurses, physicians, administrators, health educators, and students from a variety of settings. The Modules should not be used as a substitute for guidelines and should not be used for patient care decisions.

Objectives

After working through this module, you will be able to

1. Describe how the number of TB cases reported in the United States has changed over the last 65 years.
2. List five factors that contributed to the increase in the number of TB cases between 1985 and 1992.
3. List three improvements TB programs were able to make with increased federal, state, and other funds and resources that have contributed to a decrease in TB cases since 1993.
4. List the groups of people who are more likely to be exposed to or infected with *M. tuberculosis*.
5. List the groups of people who are more likely to develop TB disease once infected with *M. tuberculosis*.





Doctor reviewing a chest x-ray.

New Terms

New terms introduced in this module are included below. These terms appear in bold in the module text.

case rate—the number of cases that occur during a certain time period, divided by the size of the population during that time period; the case rate is often expressed in terms of a population size of 100,000 persons

civil surgeons—domestic health care providers who screen immigrants living in the United States and applying for a permanent residence visa or citizenship

congregate setting—a setting in which a group of persons reside, meet, or gather either for a limited or extended period of time in close physical proximity. Examples include prisons, nursing homes, schools, and homeless shelters.

contacts—persons exposed to someone with infectious TB disease; can include family members, roommates or housemates, close friends, coworkers, classmates, and others

epidemiology—the study of the distribution and causes of disease and other health problems in different groups of people

gastrectomy—a partial or full surgical removal of the stomach

health care facilities—places where people receive health care, such as hospitals or clinics

infection control procedures—measures to prevent the spread of TB

jejunoileal bypass—surgical operation performed to reduce absorption in the small intestine

non-U.S.–born persons¹—people born outside of the United States; non-U.S.–born persons from areas of the world where TB is common (for example, Asia, Africa, Latin America, Eastern Europe, and Russia) are more likely to be infected with *M. tuberculosis*

panel physicians—overseas health care providers who screen U.S. immigration applicants for TB disease

¹For surveillance purposes, non-U.S.–born persons are defined as people born outside of the United States or its territories and not born with a parent who is a U.S. citizen.

Introduction to TB Epidemiology

TB infection is one of the most common infections in the world. It is estimated that nearly 2 billion people (about one fourth of the world's population) are infected with *M. tuberculosis*. Every year, about 10 million people develop TB disease and 1.6 million people die of it. In fact, TB disease is the leading cause of death due to infectious disease in the world.

It is estimated that nearly 2 billion people are infected with *M. tuberculosis* worldwide.

In the United States, physicians and other health care providers are required by law to report TB cases to their state or local health department. Reporting is very important for TB control. When the health department learns about a new case of TB, it should take steps to ensure that the person receives appropriate care and treatment. The health department should also start a contact investigation. This means first interviewing a person who has TB disease to determine who else may have been exposed to TB. The people who have been exposed to TB are then tested for TB infection and TB disease. For more information on contact investigations, refer to *Module 8, Contact Investigations for Tuberculosis*.

Physicians and other health care providers are required by law to report TB cases to their state or local health department.

The 50 states, the District of Columbia, New York City, Puerto Rico, and seven other jurisdictions in the Pacific and Caribbean report TB cases to the federal Centers for Disease Control and Prevention (CDC) using a standard case reporting mechanism called the Report of Verified Case of Tuberculosis (RVCT). Each reported TB case is checked to make sure that it meets certain criteria. All cases that meet the criteria are counted each year. These data are used by CDC to monitor national TB trends, identify priority needs, and create the Annual Surveillance Report. For more information on criteria for reporting TB cases, refer to *Module 3, Targeted Testing and the Diagnosis of Latent Tuberculosis Infection and Tuberculosis Disease*. For more information on the RVCT, refer to CDC's *Tuberculosis Surveillance Data Training - Report of Verified Case of Tuberculosis Instruction Manual*, available from the CDC website (www.cdc.gov/tb).

In 1953, when nationwide TB reporting first began, there were more than 84,000 TB cases in the United States. From 1953 through 1984, the number of TB cases decreased by an average of 6% each year. In 1985, the number of TB cases reached a low of 22,201.

In 1986, however, there was an increase in TB cases, the first significant rise since 1953. Between 1985 and 1992 there was a resurgence of TB, with the number of new cases increasing from 22,201 in 1985 to 26,673 in 1992, an increase of about 20% (Figure 2.1).

From 1985 through 1992, the number of new TB cases in the United States increased by about 20%.

The resurgence in TB cases between 1985 and 1992 can be attributed to at least five factors:

- Inadequate funding for TB control and other public health efforts
- The HIV epidemic
- Increased immigration from countries where TB is common
- The spread of TB in certain settings (for example, correctional facilities and homeless shelters)
- The spread of multidrug-resistant TB (MDR TB)

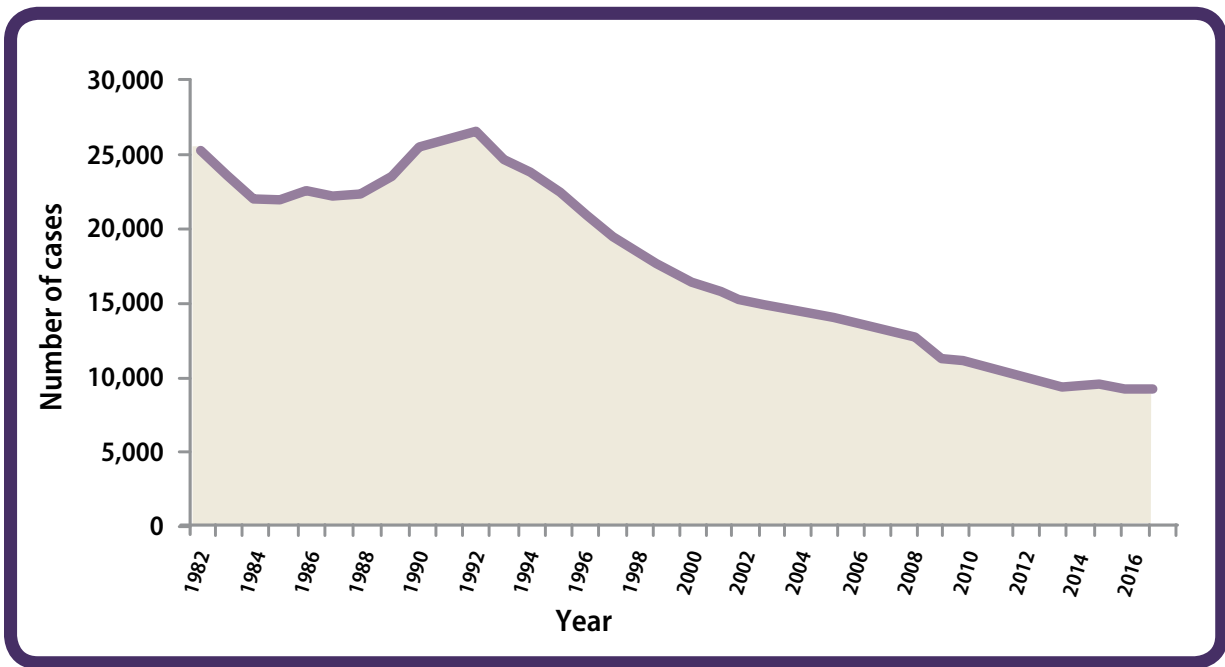


Figure 2.1 Reported TB cases, United States, 1982-2017.

Figure 2.1 presents the number of reported TB cases in the United States from 1982-2017. In 1993, the upward trend of new TB cases reversed. Case counts decreased each year from 1993 to 2014, and again in 2016 and 2017. In 2015, a slight increase occurred in the total number of TB cases reported in the United States.

In 1993, the upward trend of new TB cases reversed. Case counts decreased each year from 1993 to 2014, and again in 2016 and 2017. However, in 2015, a slight increase occurred in the total number of TB cases reported in the United States (Figure 2.1). In 2017, there were a total of 9,105 new cases of TB, resulting in the lowest number of reported TB cases since national reporting began in 1953.

Case counts decreased each year from 1993 to 2014, and again in 2016 and 2017. However, in 2015, a slight increase occurred in the total number of TB cases reported in the United States.

The overall decline in reported TB cases since 1993 may be attributed to the increase in resources used to strengthen TB control efforts. The increase in federal, state, and other funds and resources allowed TB programs to improve their control efforts to

- Promptly identify persons with TB
- Start appropriate initial treatment for TB cases
- Ensure patients complete treatment
- Conduct contact investigations

Despite national trends reflecting an overall decline in the number of TB cases reported annually in the United States between 1993 and 2017, there are still several areas of ongoing concern:

- While TB cases declined nationally, TB cases continue to be reported in almost every state and actually increased in some areas.
- More than 80% of U.S. TB cases are believed to be associated with longstanding, untreated latent TB infection.
- More than two-thirds of all TB cases in the United States are among non-U.S.–born persons.
- TB affects racial/ethnic minorities disproportionately. Hispanics, non-Hispanic blacks or African Americans, and Asians continue to have TB at higher rates than white, non-Hispanics.
- Drug-resistant TB (MDR TB and extensively drug-resistant TB [XDR TB]) remains a serious public health concern. Patients who do not complete treatment or do not take anti-TB drugs as directed can develop and spread strains of TB that are resistant to available drugs.

Despite trends reflecting an overall decline in the number of TB cases in the United States between 1993 and 2017, there are still several areas of ongoing concern.

The number of TB cases at a certain place and time is often expressed as a **case rate**. A case rate is the number of cases that occur during a certain time period, divided by the size of the population during that time period. (The case rate is often expressed in terms of a population size of 100,000 persons.) For example, in the United States in 2017, there were 9,105 new TB cases in a population of approximately 325,719,178 people. In other words, the TB case rate was 2.8 TB cases per 100,000 persons. Figure 2.2 depicts the states that reported a case rate above the national average in 2017 (2.8/100,000 population) in blue.

In 2017, the TB case rate in the United States was 2.8 TB cases per 100,000 persons.

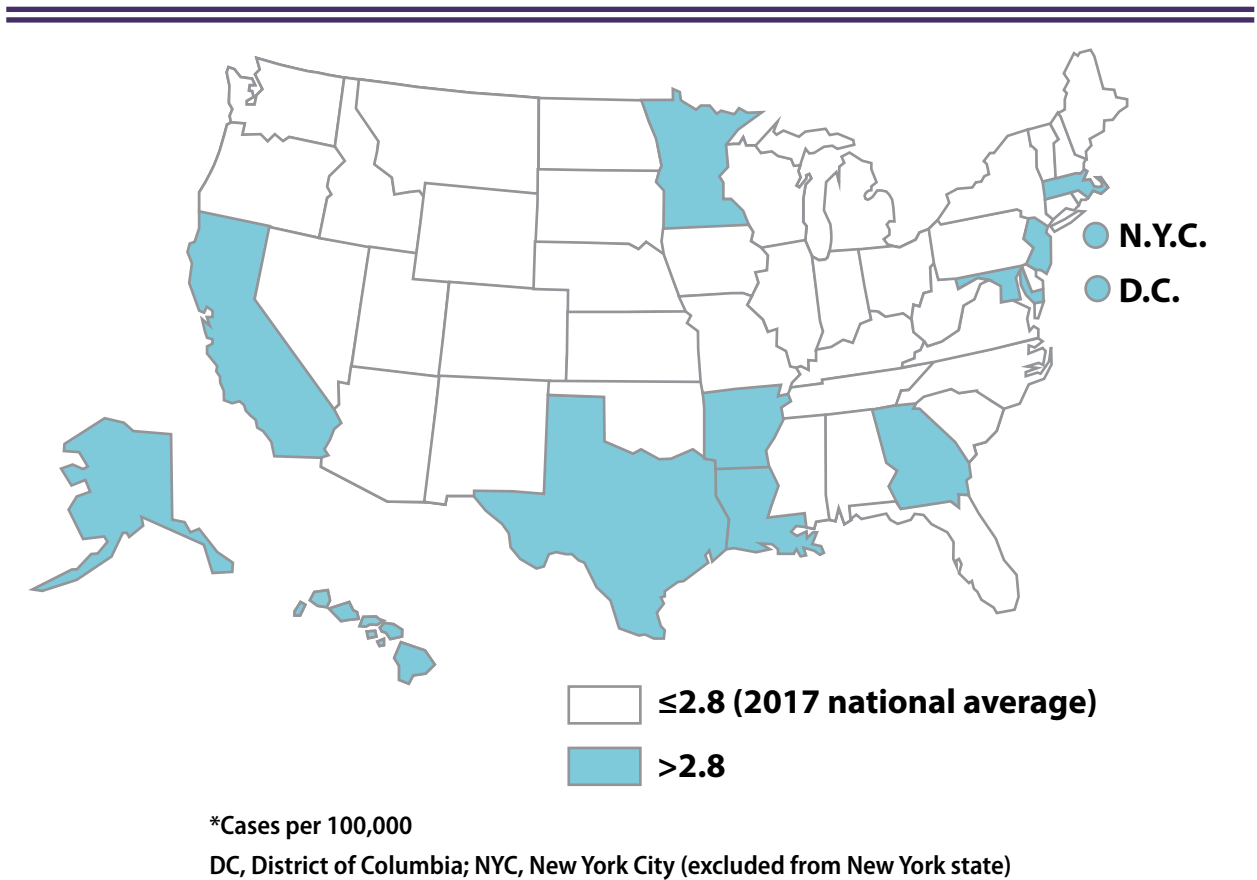


Figure 2.2 TB case rates by state, United States, 2017.

The map depicts TB case rates by state in 2017. States that reported a case rate above the national average in 2017 (2.8/100,000 population) are shown in blue. States that reported a case rate less than or equal to the national average in 2017 are shown in white.



Study Questions 2.1–2.5

- 2.1 What happened to the number of TB cases in the United States between 1953 and 1984?**
- 2.2 What happened to the number of TB cases in the United States between 1985 and 1992? Select one.**
- A. From 1985 through 1992, the number of new TB cases increased by 5%
 - B. From 1985 through 1992, the number of new TB cases increased by 10%
 - C. From 1985 through 1992, the number of new TB cases increased by 20%
 - D. From 1985 through 1992, the number of new TB cases increased by 30%
- 2.3 Name five factors that may have contributed to the increase in the number of TB cases between 1985 and 1992.**
- 2.4 Overall, what has been happening to the number of TB cases in the United States since 1993? Select one.**
- A. Since 1993 there has been an overall decline in the number of TB cases reported annually in the United States
 - B. Since 1993 there has been no change in the number of TB cases reported annually in the United States
 - C. Since 1993 there has been a steady increase in the number of TB cases reported annually in the United States
 - D. Since 1993 there has been a drastic increase each year in the number of TB cases reported annually in the United States
- 2.5 Name four improvements TB programs were able to make with increased federal, state, and other funds and resources that contributed to the decrease in TB cases since 1993.**

Answers to study questions are on pages 23–27

Race and Ethnicity

Information about the race and ethnicity of people who are reported to have TB shows that TB affects certain racial and ethnic minorities disproportionately. Of all the TB cases reported in the United States in 2017, approximately 87% occurred among persons who were Asian, black or African American, Hispanic or Latino, American Indian or Alaska Native, or Native Hawaiian or Other Pacific Islander. (Hispanic is an ethnicity, not a race. People of Hispanic origin may be of any race.)

In 2017, approximately 87% of all TB cases occurred among persons who were Asian, black or African American, Hispanic or Latino, American Indian or Alaska Native, Native Hawaiian or Other Pacific Islander.

In 2017, about 28% of the TB cases were in Hispanics, a group which made up about 18% of the total United States population. Similarly, 21% of the reported TB cases in the United States were in non-Hispanic blacks or African Americans, even though this group made up only about 12% of the total population. Furthermore, 36% of the TB cases were in Asians who made up 6% of the population; 1% in American Indian or Alaska Natives who made up 1% of the population; and 1% in Native Hawaiian or Other Pacific Islanders, who were less than 1% of the United States population. Persons reporting two or more races, not including persons of Hispanic or Latino ethnicity, accounted for 1% of all cases.

In other words, the percentage of TB cases that occur in Hispanics, blacks or African Americans, and Asians is higher than expected based on the percentage of these minorities in the U.S. population (Figures 2.3 and 2.4).

The percentage of TB cases that occur in Hispanics, blacks or African Americans, and Asians is higher than expected based on the percentage of these minorities in the U.S. population.

Figure 2.3 Reported TB cases by race and ethnicity*, United States, 2017.

*All races are non-Hispanic. Multiple race indicates two or more races reported for a person, but does not include persons of Hispanic/Latino origin.

*Percentages are rounded.

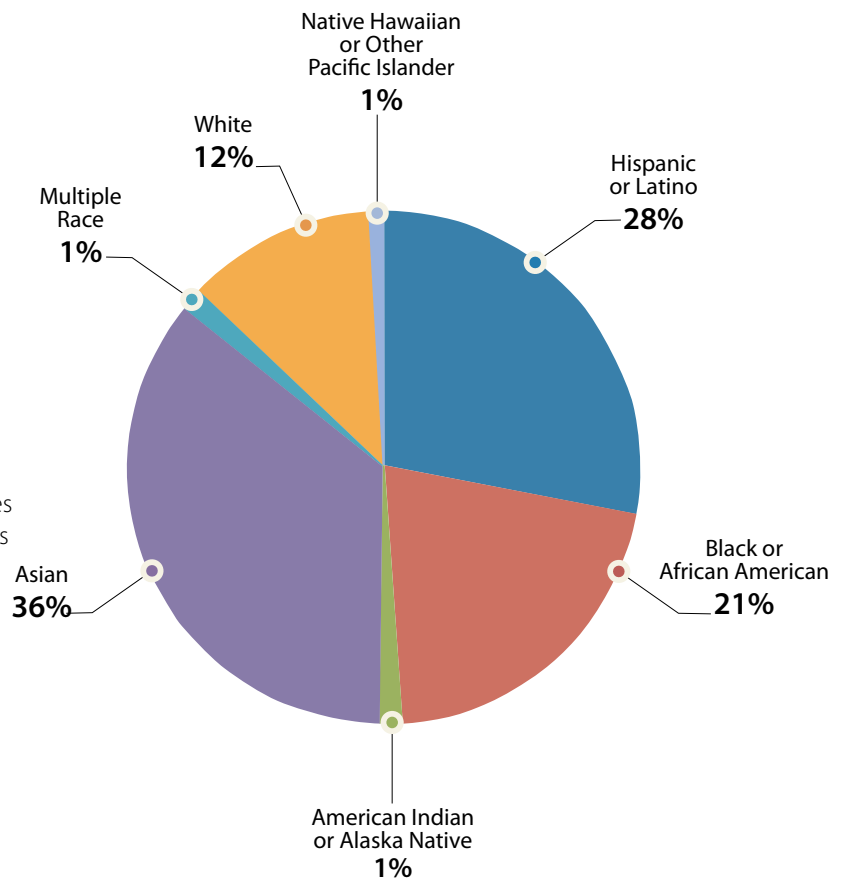
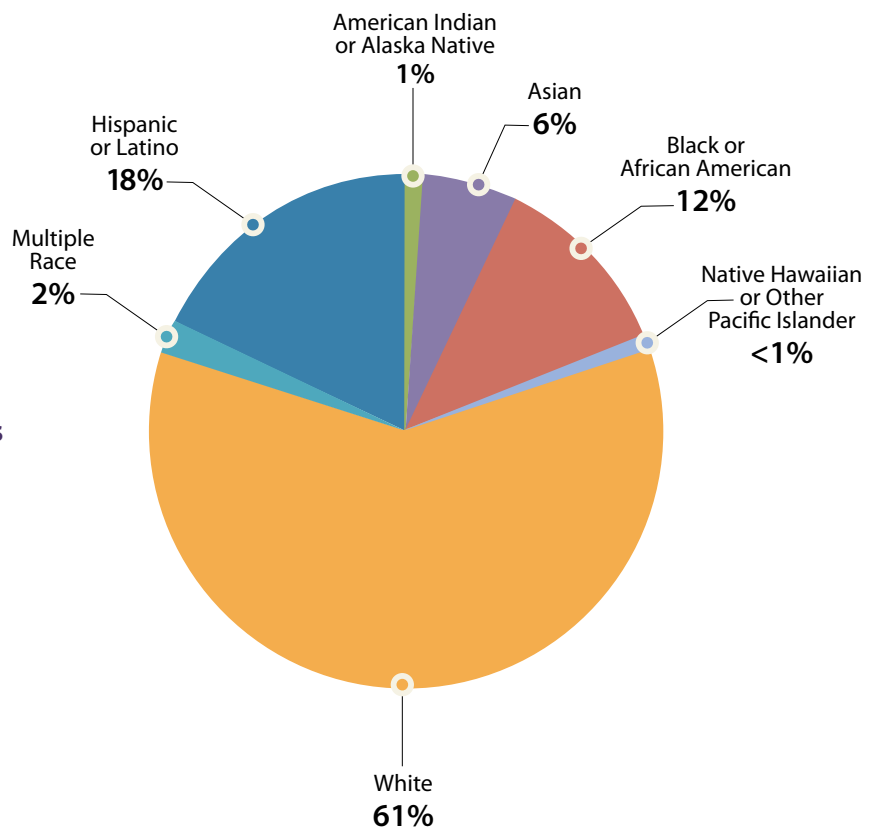


Figure 2.4 Racial and ethnic groups by percentage of U. S. population annual estimates, 2017.



TB case rates also show that certain racial and ethnic minorities are disproportionately affected by TB. In 2017, the TB case rate for non-Hispanic whites was 0.5, which means there were 0.5 TB cases in non-Hispanic whites for every 100,000 non-Hispanic whites in the general population. The case rate for Asians was 17.7 cases per 100,000 persons, about 33 times higher. This means that Asians were about 33 times more likely than non-Hispanic whites to have TB. Similarly, the case rate for Native Hawaiians or Other Pacific Islanders was about 35 times higher than the case rate for non-Hispanic whites; for non-Hispanic blacks, about 9 times higher; for Hispanics, about 8 times higher; and for American Indians or Alaska Natives, about 7 times higher (Table 2.1).

TB case rates also show that certain racial and ethnic minorities are disproportionately affected by TB.

TB case rates are higher for some racial and ethnic groups, probably because a greater proportion of people in these groups have other risk factors for TB. These risk factors include birth in a country where TB is common, HIV infection, low socioeconomic status (for example, low level of employment or income), and exposure to TB in high-risk settings (for example, corrections, homeless shelters, and some health care facilities).

TB rates are higher for some racial and ethnic groups, probably because a greater proportion of people in these groups have other risk factors for TB.

Table 2.1 – Relative Risk* for TB by Race and Ethnicity, 2017.

Race/Ethnicity	TB Case Rate (number of TB cases for every 100,000 persons in this race/ethnicity)	Relative Risk***
Native Hawaiian or Other Pacific Islander	19.1	35
Asian	17.7	33
Black or African American	4.7	9
Hispanic or Latino	4.4	8
American Indian or Alaska Native	3.9	7
Multiple Race**	1.0	2
Non-Hispanic White	0.5	Reference Group

* The relative risk is a comparison of case rates between two groups. In this table, all case rates are compared to the case rate for non-Hispanic whites because non-Hispanic whites have the lowest case rate for one race reported for a person. For example, the relative risk for Asians is 33, because the case rate for this group is about 33 times higher than the case rate for non-Hispanic whites.

** Indicates two or more races reported for a person. Persons reporting two or more races, not including persons of Hispanic or Latino ethnicity, accounted for 1% of all cases.

*** Relative risk numbers rounded to nearest whole number. Calculations are based on unrounded numbers.



Study Question 2.6

2.6 Which racial and ethnic groups are disproportionately affected by TB?

Answers to study questions are on pages 23–27

People at High Risk for TB Infection and TB Disease

Health departments, CDC, and others can compare the occurrence of TB cases in different places, time periods, and groups of people by using case rates. The rates of TB are higher in certain groups than in others. These high-risk groups can be divided into two categories (Table 2.2):

- People at high risk for exposure to or infection with *Mycobacterium tuberculosis*
- People at high risk for developing TB disease after infection with *Mycobacterium tuberculosis*

Detailed information regarding some of these high-risk groups is presented on the following pages.

In certain groups, the rates of TB are higher than in others.

Table 2.2 – Groups at High Risk for TB Infection and TB Disease.

People at High Risk for Exposure to or Infection with <i>M. tuberculosis</i>	People at High Risk for Developing TB Disease after Infection with <i>M. tuberculosis</i>
<ul style="list-style-type: none"> • Contacts of people known or suspected to have TB disease • People born in or who frequently travel to countries where TB disease is common, including Mexico, the Philippines, Vietnam, India, China, Haiti, and Guatemala, or other countries with high rates of TB • People who live in, or have lived in, high-risk congregate settings (for example, homeless shelters or correctional facilities) • Employees of high-risk congregate settings • Health care workers who serve patients with TB disease • Populations defined locally as having an increased incidence of LTBI or TB disease, possibly including medically underserved, low-income populations, or persons who abuse drugs or alcohol • Infants, children, and adolescents exposed to adults who are at increased risk for LTBI or TB disease 	<ul style="list-style-type: none"> • People living with HIV • Children younger than 5 years of age • People recently infected with <i>M. tuberculosis</i> (within the past 2 years) • People with a history of untreated or inadequately treated TB disease • Persons who are receiving immunosuppressive therapy such as tumor necrosis factor-alpha (TNF) antagonists, systemic corticosteroids equivalent to/greater than 15 mg of prednisone per day, or immunosuppressive drug therapy following organ transplantation • Persons with silicosis, diabetes mellitus, chronic renal failure, leukemia, or cancer of the head, neck, or lung • Persons who have had a gastrectomy or jejunioileal bypass • Low body weight • Cigarette smokers and persons who abuse drugs or alcohol • Populations defined locally as having an increased incidence of disease due to <i>M. tuberculosis</i>, including medically underserved, low-income populations

Contacts

Contacts are persons who have spent time with someone who has infectious TB disease. They are at high risk of being infected with *M. tuberculosis*. Contacts may include family members, coworkers, friends, or others who have been in contact with the TB patient.

Contacts are at high risk of being infected with *M. tuberculosis*.

Non-U.S.–Born Persons

In the United States, TB infection and TB disease occur often among people born in areas of the world where TB is common, such as Asia, Africa, Russia, Eastern Europe, and Latin America. Most of these non-U.S.–born persons become exposed to and infected with *M. tuberculosis* in their country of birth. Of all TB cases reported to CDC in 2017, more than two-thirds (70%) were in non-U.S.–born persons. This is more than twice the percentage compared to 1993, when 29% of reported TB cases were in non-U.S.–born persons.

Of all TB cases reported to CDC in 2017, 70% were in non-U.S.–born persons.

To address the high rate of TB in non-U.S.–born persons, CDC and other national and international public health organizations are working to

- Improve the overseas and domestic screening process of immigrants and refugees
- Strengthen the current notification system that alerts health departments about the arrival of immigrants or refugees with suspected TB
- Test recent arrivals from countries where TB is common for TB infection and ensure completion of treatment

People who apply for immigration and refugee status are screened for TB disease before coming to the United States by health care providers known as **panel physicians**. Immigrants with TB disease are required to receive treatment before they enter the United States. Also, many immigrants have latent TB infection, but not TB disease, at the time of screening. These individuals might develop TB disease months or years after they come to the United States. Health departments are notified of immigrants who were suspected of having latent TB infection or TB disease on their overseas examination. This notification system allows health departments to ensure patients receive a medical evaluation and TB treatment if necessary.

People who apply for immigration are screened for TB overseas by panel physicians before entering the United States.

Immigrants living in the United States who apply for permanent residence or citizenship are required to be tested for TB infection and evaluated for TB disease by U.S.-based health care providers known as **civil surgeons**.

Congregate Settings

In certain **congregate settings**, such as correctional facilities, homeless shelters, nursing homes, or **health care facilities**, the risk of being exposed to TB is higher than in other places. This is because many people in these facilities are at risk for TB disease. The risk of transmission and exposure to TB is even higher if the facility is crowded.

The risk of being exposed to TB is higher in certain settings because many people in these facilities are at risk for TB disease.

For example, the risk of TB disease is higher in correctional facilities because the incarcerated population contains a high proportion of people at greater risk for TB than the overall population. These risk factors include, but are not limited to, HIV infection and a history of homelessness or drug use. The physical structure of correctional facilities can include close living quarters, overcrowding, and the potential for inadequate ventilation. Finally, the movement of inmates into and out of facilities and inmates returning to the community can interrupt therapy.

Other settings where people are at risk for TB are homeless shelters and drug treatment centers. People who live or work in these settings are at higher risk of being exposed to TB.

TB can also be a problem in nursing homes and other assisted living facilities. In 2017, 25% of TB cases were in people 65 years or older, even though this age group made up only about 16% of the population. This may be because many elderly people may have been exposed to and infected with *M. tuberculosis* when they were younger, at a time when TB was more common than it is today. A nursing home with a concentration of elderly persons, who may have weak immune systems, creates a high-risk setting for TB transmission.

Health Care Workers

People who work in health care facilities, such as clinics and hospitals, might be exposed to TB on the job. The risk of exposure depends on the number of persons with TB in the facility, the employee's duties, and the effectiveness of the infection control procedures in the facility.

People who work in health care facilities might be exposed to TB on the job.

Each facility where there is a high risk of TB transmission should ensure that appropriate TB prevention and control measures are in effect to protect residents and staff. Infection control procedures, or measures to prevent the spread of TB, are discussed in more detail in *Module 5, Infectiousness and Infection Control*.

Populations Defined Locally as Having an Increased Incidence of Latent TB Infection or TB Disease

Populations that may have an increased incidence of latent TB infection or TB disease include persons experiencing homelessness, medically underserved, low-income populations, or persons who abuse drugs or alcohol.

For example, TB rates are 10 times higher for people experiencing homelessness than for people who have stable housing. Homeless people may be at higher risk of developing TB disease once infected because of malnutrition, medical conditions such as HIV infection or diabetes, and poor access to health care. Congregation in crowded shelters can also increase the risk of TB transmission.

TB rates are 10 times higher for people experiencing homelessness.

Low income has been linked to a higher risk of exposure to TB. Possible reasons include factors that are often associated with low income such as crowding, inadequate living conditions, malnutrition, and poor access to health care.

People who abuse drugs or alcohol are also more likely to be exposed to or infected with *M. tuberculosis*. This may be because a large proportion of people in this risk group have other risk factors for exposure to TB, such as being in correctional facilities, drug treatment centers, or having poor access to health care.

People who abuse drugs are also at high risk of developing TB disease once infected, perhaps because they are more likely to be HIV infected. They may also have other medical conditions that weaken the immune system.

People who abuse drugs or alcohol are more likely to be exposed to or infected with *M. tuberculosis*. They are also at high risk of developing TB disease once infected.

Children

Children younger than 5 years of age are at a particularly high risk for rapidly developing TB disease after infection with *M. tuberculosis*. In 2017, about 5% of all reported TB cases were in children younger than 15 years of age.

The occurrence of latent TB infection and TB disease in children provides important information about the spread of TB in homes and communities. When a child has TB infection or disease, it means that

- TB was transmitted relatively recently
- The person who transmitted TB to the child may still be infectious
- Other adults and children in the household or community have probably been exposed to TB; if they are infected, they may develop TB disease in the future

The occurrence of TB infection and disease in children provides important information about the spread of TB in homes and communities.

Persons Living with HIV

HIV infection is the strongest known risk factor for the development of TB disease in people with latent TB infection. **Worldwide, TB is responsible for the deaths of one in three people living with HIV/AIDS, thus making it the leading cause of death among people living with HIV.**

Worldwide, TB is responsible for the deaths of one in three people living with HIV/AIDS.

Because HIV weakens the immune system, people with TB infection and HIV infection are at **very high risk** of developing active TB disease. In fact, the risk of developing TB disease is about 7% to 10% **each year** for people who are infected with both *M. tuberculosis* and HIV (if the HIV is not treated). In contrast, the risk of developing TB disease is 10% **over a lifetime** for people infected only with *M. tuberculosis* (see *Module 1, Transmission and Pathogenesis of Tuberculosis*).

Because of concerns about confidentiality, a few states have laws and regulations that do not allow HIV/AIDS programs to share HIV status data on TB patients with TB programs. Many state health departments compare TB and AIDS registries to estimate the proportion of reported TB patients with HIV coinfection. For all ages, the estimated percentage of HIV coinfection in persons with TB who reported HIV testing (positive, negative, or indeterminate test results) decreased from 48% to 6% from 1993 to 2017, and from 63% to 9% among persons aged 25 to 44 years during this period.

The risk of developing TB disease is 7% to 10% each year for people who are infected with both *M. tuberculosis* and HIV (if the HIV is not being treated), whereas it is 10% over a lifetime for people infected only with *M. tuberculosis*.



Study Questions 2.7–2.9

- 2.7 Name seven groups of people who are more likely to be exposed to or infected with *M. tuberculosis*.
- 2.8 What are public health agencies doing to address the high rate of TB in non-U.S.–born persons?
- 2.9 Why is the risk of being exposed to TB higher in certain settings, such as nursing homes or correctional facilities?

Answers to study questions are on pages 23–27



Study Questions 2.10–2.11

2.10 What are some reasons why rates of TB disease are higher in correctional facilities?

2.11 When a child has latent TB infection or TB disease, what does it tell us about the spread of TB in the child's home or community? Name three things.

Answers to study questions are on pages 23–27



Case Study 2.1

For each of the following people, choose the factor(s) known to increase the risk of being exposed to or infected with *M. tuberculosis*. Each person may have more than one risk factor.

A. Mr. Wong:

works at a nursing home
rides the subway every day
emigrated from Asia

B. Ms. Montoya:

was born in Latin America
has a father who had pulmonary TB disease

C. Ms. Parker:

volunteers in the emergency room of an inner-city hospital
works in a day care center

D. Mr. Dudley:

was released from prison last year
sleeps in a homeless shelter
receives immunosuppressive therapy

Answers to case study questions are on page 28



Study Questions 2.12–2.14

- 2.12 Name at least eight groups of people who are more likely to develop TB disease once infected.**
- 2.13 What is the strongest known risk factor for the development of TB disease? Select one.**
- A. Diabetes
 - B. Asthma
 - C. Low body weight
 - D. HIV infection
- 2.14 How does being infected with both *M. tuberculosis* and HIV affect the risk for TB disease? Select one.**
- A. People who are infected with both *M. tuberculosis* and HIV are much more likely to develop TB disease than people who are infected only with *M. tuberculosis*
 - B. The risk of developing TB disease is about 7% to 10% each year for people who are infected with both *M. tuberculosis* and HIV who are not being treated for HIV
 - C. A person who has HIV infection can become infected with *M. tuberculosis* and then rapidly develop TB disease
 - D. All of the above

Answers to study questions are on pages 23–27



Case Study 2.2

For each of the following people, circle the factor(s) known to increase the risk of developing TB disease once infected. Each person may have more than one risk factor.

- A. Mr. Sims:
 - injects heroin
 - has HIV

- B. Mr. Allen:
 - has diabetes
 - has high blood pressure

- C. Ms. Li:
 - has chest x-ray findings suggestive of previous TB disease
 - has heart problems

- D. Mr. Vinson:
 - is overweight
 - became infected with *M. tuberculosis* 6 months ago

Answers to case study questions are on page 28

Additional Resources

1. Bamrah S, Yelk Woodruff RS, Powell K, Ghosh S, Kammerer JS, Haddad MB. Tuberculosis Among the Homeless, United States, 1994–2010. *Int J Tuberc Lung Dis* 2013; 17:1414–9.
2. Cantwell MF, McKenna MT, McCray E, Onorato IM. Tuberculosis and Race/Ethnicity in the United States: Impact of Socioeconomic Status. *Am J Respir Crit Care Med* 1997; 157:1016-20.
3. CDC. CDC Messages and Resources: U.S. Preventive Services Task Force Recommendation on Latent Tuberculosis Infection. Atlanta, GA: U.S. Department of Health and Human Services, CDC; January 2018. https://www.cdc.gov/tb/publications/lbti/pdf/CDC_USPSTF_LTBI_Messages_and_Resources2018.pdf.
4. CDC. Reported Tuberculosis in the United States, 2017. Atlanta, GA: U.S. Department of Health and Human Services, CDC; October 2017. (Note: This publication is prepared and released annually.) <https://www.cdc.gov/tb/statistics/reports/2017/default.htm>.
5. CDC. Tuberculosis Surveillance Data Training – Report of Verified Case of Tuberculosis Instruction Manual. Atlanta, GA: Department of Health and Human Services, CDC; 2009. www.cdc.gov/tb/programs/rvct/default.htm.
6. Global TB Institute at Rutgers, the State University of New Jersey. Basic Epidemiology for Tuberculosis Program Staff, 2nd Edition; 2013. <http://globaltb.njms.rutgers.edu/educationalmaterials/productfolder/basicapi.php>.
7. Horsburgh CR, Moore M, Castro K. Epidemiology of Tuberculosis in the United States. In: Tuberculosis (second edition). Edited by William N. Rom and Stuart M. Gray. Philadelphia: Lippincott, Williams & Wilkins; 2005.
8. LoBue PA, Mermin JH. Latent Tuberculosis Infection: the Final Frontier of Tuberculosis Elimination in the USA. *Lancet Infect Dis*. 2017;17(10):e327–e333.
9. U.S. Census Bureau. Annual Estimates of the Resident Population by Sex, Race, and Hispanic Origin for the United States, States, and Counties: April 1, 2010 to July 1, 2017. Washington, DC: US Census Bureau; 2018. <https://www.census.gov/data/tables/2017/demo/popest/nation-detail.htm>.
10. U.S. Census Bureau. USA QuickFacts from the US Census Bureau. Washington, DC: US Census Bureau; 2017. <https://www.census.gov/quickfacts/fact/table/US/PST045217>.



Answers to Study Questions

2.1 What happened to the number of TB cases in the United States between 1953 and 1984?

From 1953 through 1984, the number of TB cases reported in the United States decreased by an average of 6% each year.

2.2 What happened to the number of TB cases in the United States between 1985 and 1992? Select one.

- A. From 1985 through 1992, the number of new TB cases increased by 5%
- B. From 1985 through 1992, the number of new TB cases increased by 10%
- C. From 1985 through 1992, the number of new TB cases increased by 20%
- D. From 1985 through 1992, the number of new TB cases increased by 30%

The correct answer is C. From 1985 through 1992, the number of new TB cases increased by 20%.

2.3 Name five factors that contributed to the increase in the number of TB cases between 1985 and 1992.

- Inadequate funding for TB control and other public health efforts
- The HIV epidemic
- Immigration from countries where TB is common
- The spread of TB in certain settings (for example, correctional facilities and homeless shelters)
- The spread of multidrug-resistant TB (MDR TB)

2.4 Overall, what has been happening to the number of TB cases in the United States since 1993? Select one.

- A. Since 1993 there has been an overall decline in the number of TB cases reported annually in the United States.
- B. Since 1993 there has been no change in the number of TB cases reported annually in the United States.
- C. Since 1993 there has been a steady increase in the number of TB cases reported annually in the United States.
- D. Since 1993 there has been a drastic increase each year in the number of TB cases reported annually in the United States.

The correct answer is A. Since 1993 there has been an overall decline in the number of TB cases reported annually in the United States. Case counts decreased each year from 1993 to 2014, and again in 2016 and 2017. However, in 2015, a slight increase occurred in the total number of TB cases reported in the United States.



Answers to Study Questions (Continued)

2.5 Name four improvements TB programs were able to make with increased federal, state, and other funds and resources that contributed to the decrease in TB cases since 1993.

The increase in funds allowed TB programs to

- Promptly identify persons with TB
- Start appropriate initial treatment for TB cases
- Ensure patients complete treatment
- Conduct contact investigations

2.6 Which racial and ethnic groups are disproportionately affected by TB?

Asians, Native Hawaiians or Other Pacific Islanders, non-Hispanic blacks, Hispanics, and American Indians or Alaska Natives are disproportionately affected by TB.

2.7 Name seven groups of people who are more likely to be exposed to or infected with *M. tuberculosis*.

- Contacts of people known or suspected to have infectious TB
- People born in or who frequently travel to countries where TB disease is common, including Mexico, the Philippines, Vietnam, India, China, Haiti, and Guatemala, or other countries with high rates of TB
- People who live in, or have lived in, high-risk congregate settings (for example, homeless shelters or correctional facilities)
- Employees of high-risk congregate settings
- Health care workers who serve patients with TB disease
- Populations defined locally as having an increased incidence of TB infection or TB disease, possibly including medically underserved, low-income populations, or persons who abuse drugs or alcohol
- Infants, children, and adolescents exposed to adults who are at increased risk for TB infection or TB disease



Answers to Study Questions (Continued)

2.8 What are public health agencies doing to address the high rate of TB in non-U.S.–born persons?

To address the high rate of TB in non-U.S.–born persons, CDC and other national and international public health organizations are working to

- Improve the overseas and domestic screening process of immigrants and refugees
- Strengthen the current notification system that alerts health departments about the arrival of immigrants or refugees with suspected TB
- Test recent arrivals from countries where TB is common for TB infection and to ensure completion of treatment

2.9 Why is the risk of being exposed to TB higher in certain settings, such as nursing homes or correctional facilities?

The risk of being exposed to TB is higher in certain settings because many people in these facilities are at risk for TB. The risk of exposure to TB is even higher if the facility is crowded.

2.10 What are some reasons why rates of TB disease are higher in correctional facilities?

The incarcerated population contains a higher proportion of people at greater risk for TB than the general population. These risk factors include, but are not limited to, HIV-infection and a history of homelessness or drug use. The physical structure of correctional facilities can include close living quarters, overcrowding, and the potential for inadequate ventilation. Finally, the movement of inmates into and out of facilities and inmates returning to the community can interrupt therapy.

2.11 When a child has latent TB infection or TB disease, what does it tell us about the spread of TB in the child's home or community? Name three things.

When a child has TB infection or TB disease, it indicates that

- TB was transmitted relatively recently
- The person who transmitted TB to the child may still be infectious
- Other adults and children in the household or community have probably been exposed to TB; if they are infected, they may develop TB disease in the future



Answers to Study Questions (Continued)

2.12 Name at least eight groups of people who are more likely to develop TB disease once infected.

- People living with HIV
- Children younger than 5 years of age
- People recently infected with *M. tuberculosis* (within the past 2 years)
- People with a history of untreated or inadequately treated TB disease
- Persons who are receiving immunosuppressive therapy such as tumor necrosis factor-alpha (TNF) antagonists, systemic corticosteroids equivalent to/greater than 15 mg of prednisone per day, or immunosuppressive drug therapy following organ transplantation
- Persons with silicosis, diabetes mellitus, chronic renal failure, leukemia, or cancer of the head, neck, or lung
- Persons who have had a gastrectomy or jejunioileal bypass
- Low body weight
- Cigarette smokers and persons who abuse drugs or alcohol
- Populations defined locally as having an increased incidence of disease due to *M. tuberculosis*, including medically underserved, low-income populations

2.13 What is the strongest known risk factor for the development of TB disease? Select one.

- A. Diabetes
- B. Asthma
- C. Low body weight
- D. HIV infection

The correct answer is D. HIV infection is the strongest known risk factor for the development of TB disease in people with TB infection. HIV infection weakens the body's immune system, making it more likely that a person who has TB infection will develop TB disease.



Answers to Study Questions (Continued)

2.14 How does being infected with both *M. tuberculosis* and HIV affect the risk for TB disease? Select one.

- A. People who are infected with both *M. tuberculosis* and HIV are much more likely to develop TB disease than people who are infected only with *M. tuberculosis*
- B. The risk of developing TB disease is 7% to 10% each year for people who are infected with both *M. tuberculosis* and HIV
- C. A person who has HIV infection can become infected with *M. tuberculosis* and then rapidly develop TB disease
- D. All of the above

The correct answer is D. People who are infected with both *M. tuberculosis* and HIV are much more likely to develop TB disease than people who are infected only with *M. tuberculosis*. The risk of developing TB disease is about 7% to 10% each year for people who are infected with both *M. tuberculosis* and HIV who are not being treated for HIV.



Case Study Answers

2.1 For each of the following people, choose the factor(s) known to increase the risk of being exposed to or infected with *M. tuberculosis*. Each person may have more than one risk factor.

(✓) indicates correct answer)

A. Mr. Wong

- ✓ works at a nursing home
- ✓ emigrated from Asia
- rides the subway every day

B. Ms. Montoya

- ✓ was born in Latin America
- ✓ has a father who had pulmonary TB disease

C. Ms. Parker

- ✓ volunteers in the emergency room of an inner-city hospital
- works in a day care center

D. Mr. Dudley

- ✓ was released from prison last year
- ✓ sleeps in a homeless shelter
- ✓ receives immunosuppressive therapy

2.2 For each of the following people, choose the factor(s) known to increase the risk of developing TB disease once infected. Each person may have more than one risk factor.

(✓) indicates correct answer)

A. Mr. Sims

- ✓ injects heroin
- ✓ has HIV

B. Mr. Allen

- ✓ has diabetes
- has high blood pressure

C. Ms. Li

- ✓ has chest x-ray findings suggestive of previous TB disease
- has heart problems

D. Mr. Vinson

- is overweight
- ✓ became infected with *M. tuberculosis* 6 months ago





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