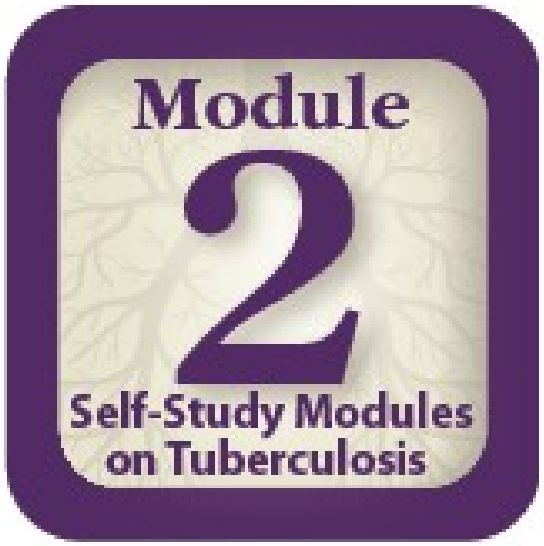
Self-Study Modules on Tuberculosis



Epidemiology of Tuberculosis

Module 2: Objectives

At completion of this module, learners will be able to:

1. **Describe how the number of TB cases reported in the U.S has changed over the last 60 years**
2. **List 5 factors that contributed to the increase of TB cases between 1985 and 1992**
3. **List 3 improvements TB programs made with increased funds that have contributed to a decrease in TB cases since 1993**
4. **List groups of people who are more likely to be exposed to or infected with *M. tuberculosis***
5. **List groups of people who are more likely to develop TB disease once infected with *M. tuberculosis***

Module 2: Overview

- Introduction to TB Epidemiology
- People at High Risk for TB Infection and TB Disease
- Case Studies

Introduction to TB Epidemiology

Epidemiology (1)

Epidemiology is the study of the distribution and causes of disease and other health problems in groups of people.

Epidemiology (2)

- **Epidemiologists:**
  - **Determine frequency and pattern of health problems in communities**
  - **Try to figure out why health problems are occurring**

Global Epidemiology of TB

- **TB is one of the leading causes of death due to infectious disease in the world**
- **Almost 2 billion people are infected with *M. tuberculosis***
- **Each year about:**
  - **9 million people develop TB disease**
  - **1.5 million people die of TB**

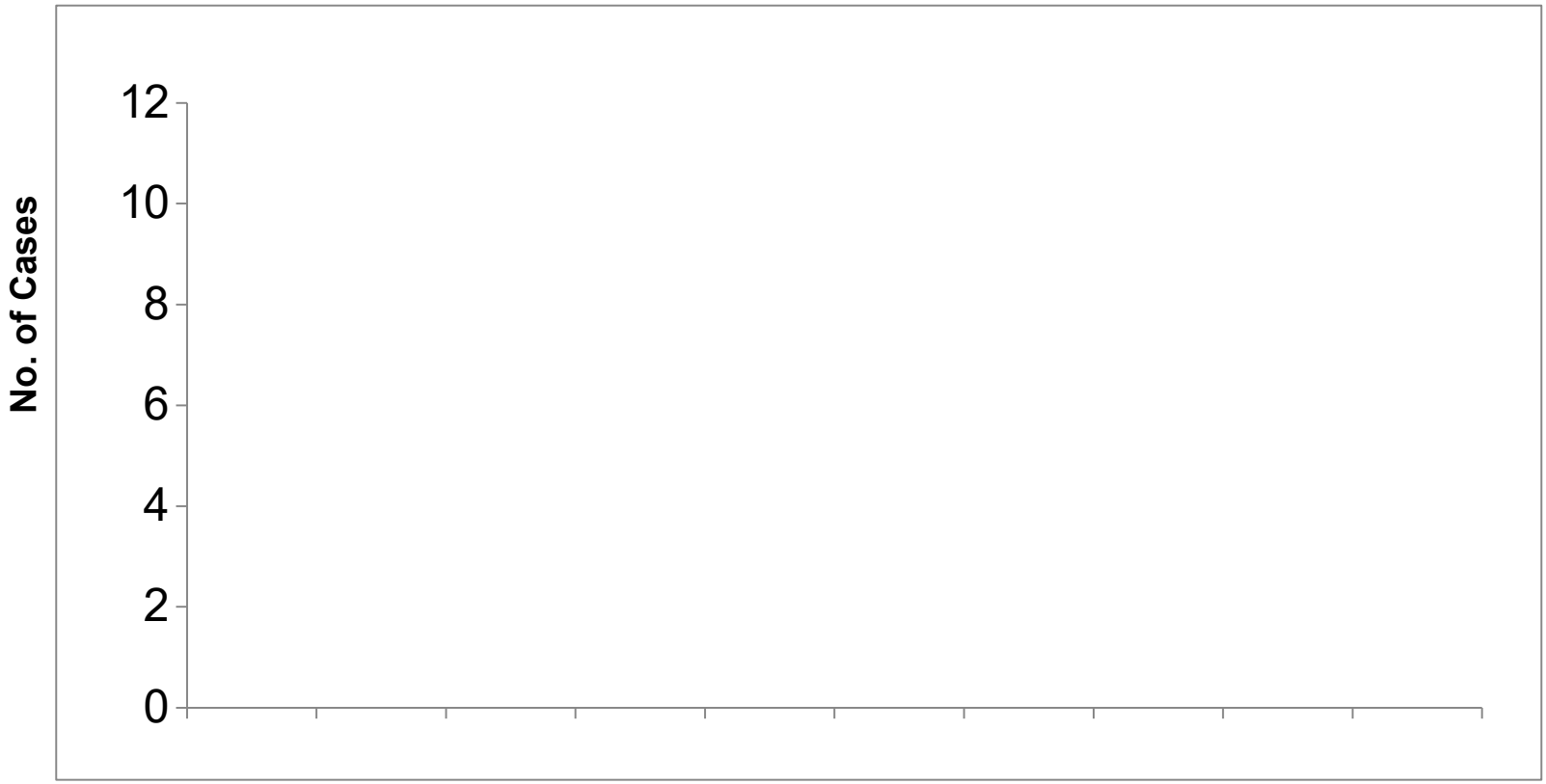
TB Reporting in U.S.

- The Report of Verified Case of Tuberculosis (RVCT) is the national TB surveillance data collection form and is used for reporting all verified TB cases to CDC
  - The 50 states, District of Columbia, New York City, Puerto Rico, and 7 other jurisdictions in the Pacific and Caribbean report TB cases to CDC
- Health care providers are required by law to report TB cases to state or local health departments

U.S. Epidemiology of TB
1953 - 1986

- **1953:**
  - **More than 84,000 cases of TB**
- **1953-1984:**
  - **TB cases declined about 6% each year**
- **1985:**
  - **TB cases reached a low of 22,201**
- **1986:**
  - **Significant increase in TB cases began**

U.S. TB Resurgence (1)
1986 - 1992



Reported TB Cases, U.S., 1982-2014

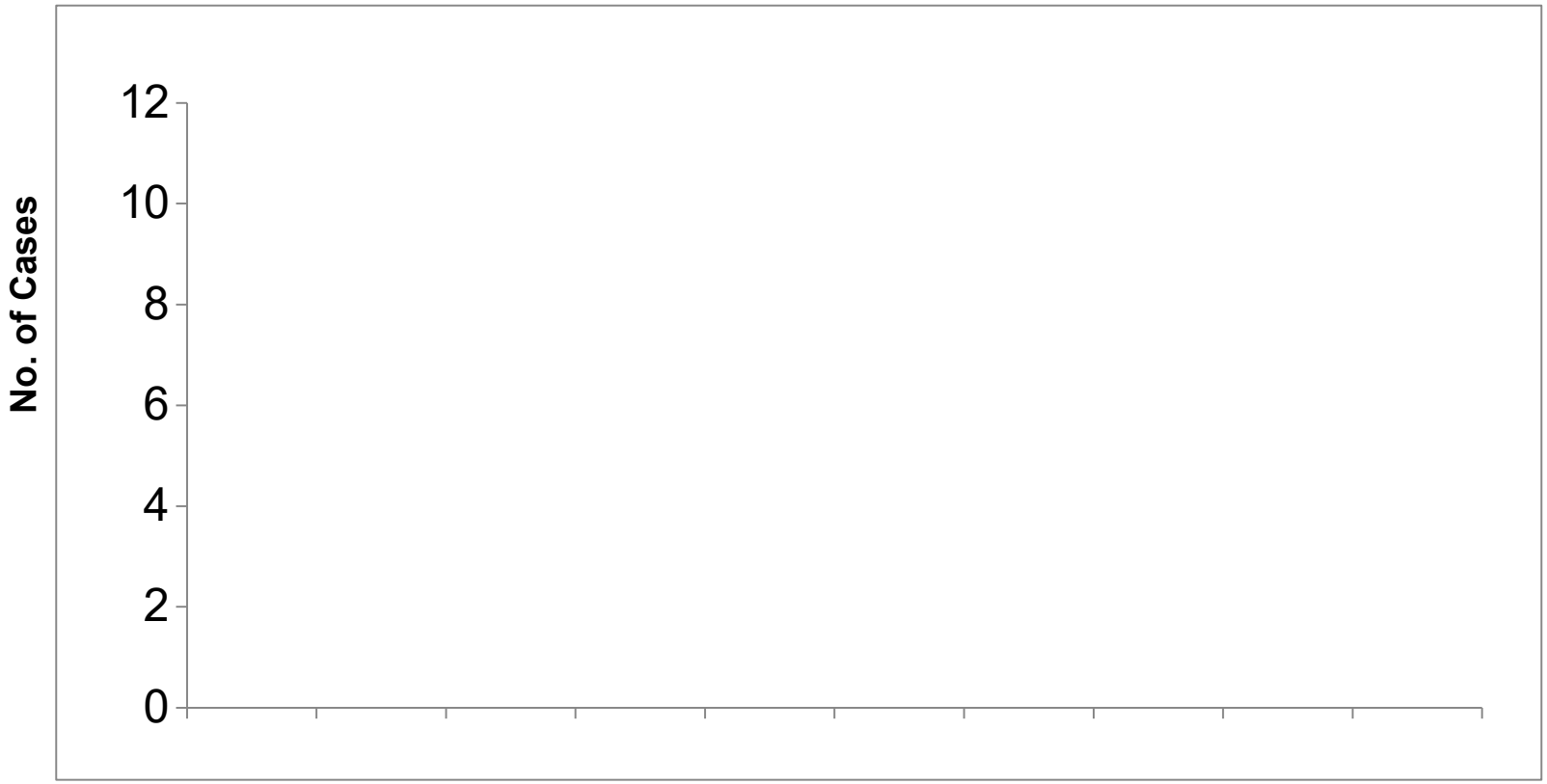
U.S. TB Resurgence (2)
1986 - 1992

- **Contributing factors:**
  - **Inadequate funding for TB control and other public health efforts**
  - **HIV epidemic**
  - **Increased immigration from countries where TB is common**
  - **Spread of TB in certain settings (e.g., homeless shelters and correctional facilities)**
  - **Spread of multidrug-resistant TB (MDR TB)**

U.S. TB Control and Prevention (1)
1993 - 2014

- **1993-2014:**
  - **Number of TB cases reported annually in U.S. steadily declined**
- **Increased federal funds and other resources allowed TB programs to improve control efforts to:**
  - **Promptly identify persons with TB**
  - **Start appropriate initial treatment for TB cases**
  - **Ensure patients complete treatment**
  - **Conduct contact investigations**

U.S. TB Control and Prevention (2)
1993 - 2014



Reported TB Cases, U.S., 1982-2014

Continuing Challenges in TB Control

- **TB is reported in almost every state and is increasing in some areas**
- **More than half of all TB cases in the U.S. are among foreign-born persons**
- **TB affects racial/ethnic minorities disproportionately**
- **MDR TB and extensively drug-resistant TB (XDR TB) remain serious public health concerns**

TB Case Rates (1)

- **A case rate is the number of TB cases that occur during a certain time period, divided by size of the population at that time**

- **Often expressed in terms of a population size of 100,000 persons**

TB Case Rates (2)

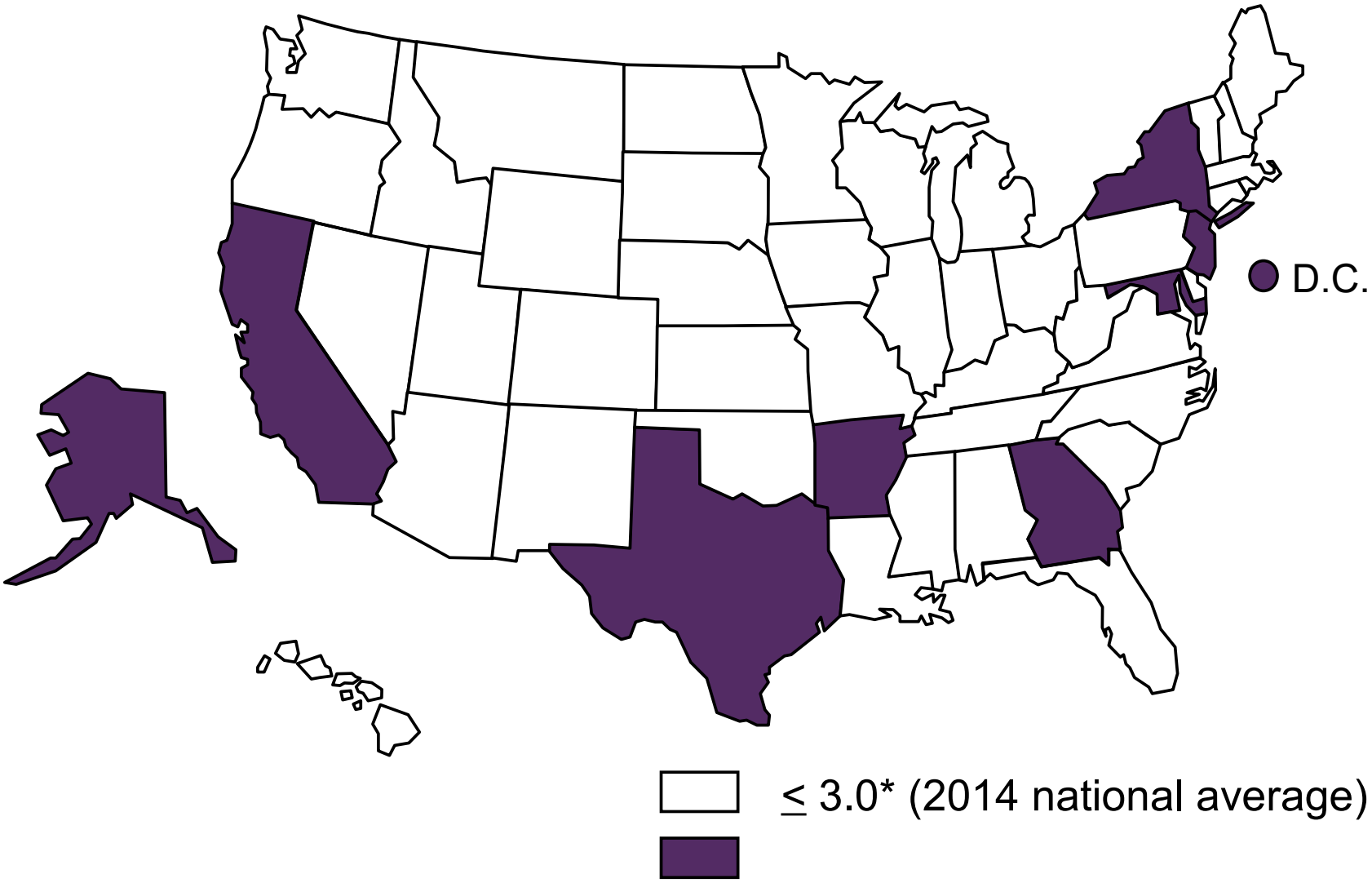
Example:

- **In the U.S. in 2014, there were 9,421 new TB cases in a population size of 318,857,056**

$$\frac{9{,}421}{318{,}857{,}056} \times 100{,}000 = 2.96$$

- **In 2014, the U.S. TB case rate was 2.96 TB cases per 100,000 persons (rounded to 3.0)**

TB Case Rates by State, 2014



*Cases per 100,000

TB Case Rates (3)

- Health departments, CDC, and others can compare the occurrence of TB in different places, time periods, and groups of people using case rates

- Comparisons have shown that rates of TB are higher in certain groups than in others

Epidemiology of TB
Study Question 2.1

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

From 1953 - 1984, the number of TB cases reported in the U.S. decreased by an average of 6% each year.

Epidemiology of TB
Study Question 2.2

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

From 1985 - 1992, the number of new TB cases increased by 20%.

Epidemiology of TB
Study Question 2.3

Name 5 factors that may have contributed to the increase in the number of TB cases between 1985 and 1992.

- Inadequate funding for TB control and other public health efforts
- HIV epidemic
- Increased immigration from countries where TB is common
- Spread of TB in certain settings (e.g., correctional facilities and homeless shelters)
- Spread of MDR TB

Epidemiology of TB
Study Question 2.4

What happened to the number of TB cases in the United States from 1993 to 2014?

From 1993 to 2014, there was a steady decline in the number of TB cases reported annually in the United States.

Epidemiology of TB
Study Question 2.5

Name 3 improvements TB programs were able to make with increased federal, state, and other funds that contributed to the decrease in TB cases since 1993.

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

Race and Ethnicity (1)

- **TB affects certain racial and ethnic minorities disproportionately**
- **In 2014, about 85% of TB cases in the U.S. were among racial and ethnic minorities**
- **Percentage of TB cases in racial and ethnic minorities is higher than expected based on percentage of these minorities in the U.S. population**

Race and Ethnicity (2)

Reported TB cases by race and ethnicity, U.S, 2014*

***All races are non-Hispanic. Multiple Race indicates two or more races reported for a person. Does not include persons of Hispanic or Latino origin.**

Race and Ethnicity (3)

Racial and ethnic groups by percentage of U.S. population, 2014

Race and Ethnicity (4)

- **Disparities may exist due to racial and ethnic minorities having other risk factors for TB, such as:**
  - **Birth in a country where TB is common**
  - **HIV infection**
  - **Low socioeconomic status**
  - **Exposure to TB in high-risk settings**

Relative Risk for TB (1)

Relative risk is a comparison of case rates between two groups.

Relative Risk for TB (2)

Example:

- **The case rate for Asians is 17.8 compared to 0.6 for non-Hispanic whites. Therefore, the relative risk for Asians is about 29 times higher than non-Hispanic whites**

$$\frac{\text{17.8 (TB case rate for Asians)}}{\text{0.6 (TB case rate for non-Hispanic whites)}} = 29.6$$

Relative Risk for TB (3)
Race and Ethnicity, 2014

Race/Ethnicity	TB Case Rate	Relative Risk
Asians	17.8	29.6
Native Hawaiians or Other Pacific Islanders	16.9	28.1
Blacks or African Americans	5.1	8.5
American Indians or Alaska Natives	5.0	8.3
Hispanics or Latinos	5.0	8.3
Multiple Race	2.8	4.6
Non- Hispanic Whites	0.6	1

Race and Ethnicity
Study Question 2.6

Which racial and ethnic groups are disproportionally 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.

People at High Risk for TB Infection and TB Disease

High-Risk Groups

- **High-risk groups can be divided into two categories:**
  - **High risk for <u>exposure to or infection</u> with *M. tuberculosis***
  - **High risk for <u>developing TB disease</u> after infection with *M. tuberculosis***

People at High Risk for Exposure to or Infection with *M. tuberculosis*

- Contacts
- People who have come to the U.S. within the last 5 years from areas of the world where TB is common
- Persons who visit areas with a high prevalence of TB disease
- People who live or work in high-risk congregate settings
- Health care workers who serve patients at increased risk
- Populations defined locally as having an increased incidence of LTBI or TB disease, possibly 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

People at High Risk for Developing TB Disease after Infection with *M. tuberculosis* (1)

- People living with HIV
- Children younger than 5 years of age
- People infected with *M. tuberculosis* within past 2 years
- People with a history of untreated or inadequately treated TB disease
- People who are receiving immunosuppressive therapy
- People with silicosis, diabetes mellitus, chronic renal failure, leukemia, or cancer of the head, neck, or lung

People at High Risk for Developing TB Disease after Infection with *M. tuberculosis* (2)

- Persons who have had a gastrectomy or jejunoileal bypass
- Low body weight
- Cigarette smokers and persons who abuse drugs or alcohol
- Populations defined locally as having an increased risk

High-Risk Groups for TB Infection (1)
Contacts

- **Contacts are persons who have spent time with someone who has infectious TB disease**

- **May include:**
  - **Family members**
  - **Coworkers**
  - **Friends**

High-Risk Groups for TB Infection (2)

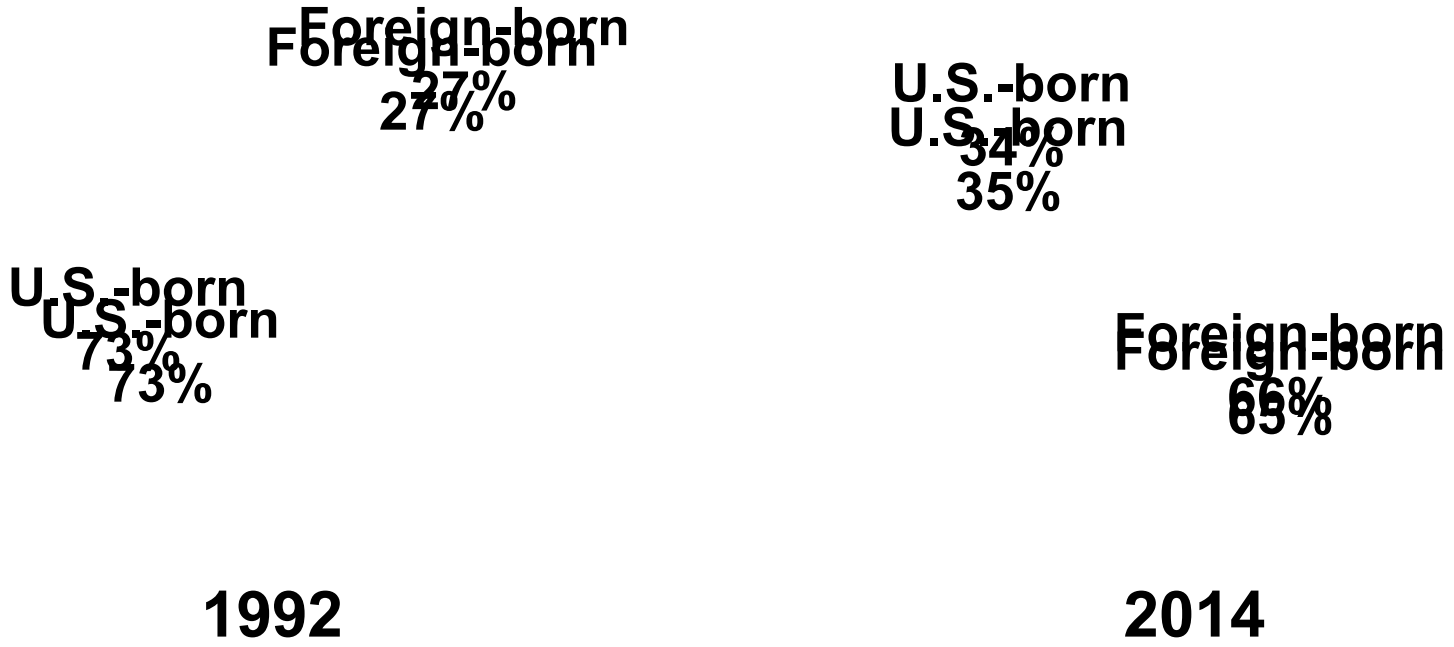
Foreign-Born Persons/Immigrants

In the U.S., LTBI and TB disease often occur among people born in areas of the world where TB is common:

- **Asia**
- **Africa**
- **Russia**
- **Eastern Europe**
- **Latin America**

High-Risk Groups for TB Infection (3)

Foreign-Born Persons/Immigrants



Cases of TB in foreign-born and U.S.-born, 1992 and 2014

High-Risk Groups for TB Infection (4)
Foreign-Born Persons/Immigrants

- **To address high rates of TB in foreign-born persons, CDC and other public health organizations are working to:**
  - **Improve the overseas and domestic screening process for immigrants and refugees**
  - **Strengthen the notification system that alerts health departments about the arrival of immigrants and refugees with suspected TB disease**
  - **Test recent arrivals from countries where TB is common for TB infection and ensure completion of treatment**

High-Risk Groups for TB Infection (5)
Foreign-Born Persons/Immigrants

- **Individuals applying for immigration and refugee status from overseas:**
  - **Must be screened for TB by panel physicians before entering the U.S.**
  - **Must have completed treatment before entering the U.S. if diagnosed with TB disease**

High-Risk Groups for TB Infection (6)
Foreign-Born Persons/Immigrants

- **Immigrants living in the U.S. who apply for permanent residence or citizenship:**
  - **Must be tested for TB infection and evaluated for TB disease by U.S.- based civil surgeons**

High-Risk Groups for TB Infection (7)
Congregate Settings

- **In certain congregate settings, the risk of being exposed to TB is higher than other places. This may include:**
  - **Correctional facilities**
  - **Homeless shelters**
  - **Nursing homes**
  - **Health care facilities**

High-Risk Groups for TB Infection (8)
Congregate Settings

- **Risk of exposure to TB is higher than in other settings**
- **Risk is higher if facility is crowded**

High-Risk Groups for TB Infection (9)

- **Higher risk in correctional facilities may be due to:**

Correctional Facilities

  - **Incarcerated population includes a high proportion of people at greater risk for TB than overall population (risk factors may include HIV-infection and a history of homelessness or drug use)**
  - **Physical structure of correctional facilities (e.g., close living quarters, overcrowding, potential for inadequate ventilation)**
  - **Movement of inmates into and out of facilities can lead to interruption of therapy**

High-Risk Groups for TB Infection (10)
Health Care Workers

- Might be exposed to TB at work
- Risk depends on:
  - Number of persons with TB in facility
  - Job duties
  - Infection control procedures

High-Risk Groups for TB Infection (11)
Populations Defined Locally

Populations that may have an increased risk include

- **Persons experiencing homelssness**
- **Medically underserved populations**
- **Low-income groups**
- **Persons who abuse drugs or alcohol**

High-Risk Groups for TB Infection (12)
Populations Defined Locally

- **Low-income is linked to higher risk of TB exposure**
- **Possible reasons include factors associated with low-income:**
  - **Inadequate living conditions**
  - **Crowding**
  - **Malnutrition**
  - **Poor access to health care**
- **TB rates are 10 times higher for people experiencing homelessness**

High-Risk Groups for TB Infection (13)
Children and Adolescents

- High risk if exposed to adults in high-risk groups
- If a child has TB infection or disease, it suggests that:
  - TB was transmitted relatively recently
  - Person who transmitted TB to child may still be infectious
  - Others may have been exposed

High-Risk Groups for TB Disease (1)

Infants and Children Younger than 5 Years

High risk for rapidly developing TB disease due to underdeveloped immune system

High-Risk Groups for TB Disease (2)
People Living with HIV

- **HIV is the strongest known risk factor for developing TB disease**
- **TB is the leading cause of death for people with HIV/AIDS**
- **Risk of developing TB disease is 7% - 10% <u>each year</u> for people who are infected with both TB and HIV (if the HIV is not treated)**

High-Risk Groups for TB Infection Study Question 2.7

Name 7 groups of people who are more likely to be exposed or infected with *M. tuberculosis.*

- **Contacts of people known or suspected to have TB**
- **People who have come to the U.S. within last 5 years from countries where TB is common**
- **Persons who visit areas with a high prevalence of TB disease**
- **People who live or work in high-risk congregate settings**
- **Health care workers who serve high-risk groups**
- **Populations defined locally as having an increased incidence of LTBI or TB disease, possibly 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**

High-Risk Groups for TB Infection Study Question 2.8

What are public health agencies doing to address the high rate of TB in foreign born persons?

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

High-Risk Groups for TB Infection Study Question 2.9

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

- **Many people in these facilities are at risk for TB disease**
- **Risk of exposure is higher if facility is crowded**

High-Risk Groups for TB Infection Study Question 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**
- **An increasing number of inmates are infected with HIV, which means that they are more likely to develop TB disease if they become infected with *M. tuberculosis***
- **Some correctional facilities are crowded and may have inadequate ventilation, which promotes the spread of TB**
- **Therapy can be interrupted when inmates are moved into and out of facilities**

High-Risk Groups for TB Infection Study Question 2.11

When a child has TB infection or disease, what does it tell us about the spread of TB in the child's home or community? Name 3 things.

- **TB was transmitted relatively recently**
- **The person who transmitted TB to the child may still be infectious**
- **Other adults and children in the home or community have probably been exposed to TB**

High-Risk Groups for TB Disease Study Question 2.12

Name 8 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 infected with *M. tuberculosis* within the past 2 years
- People with a history of untreated or inadequately treated TB disease
- People receiving immunosuppressive therapy
- People with silicosis, diabetes mellitus, chronic renal failure, leukemia, or cancer of the head, neck, or lung
- Persons who have had a gastrectomy or jejunoileal bypass
- Low body weight
- Cigarette smokers and person who abuse drugs or alcohol
- Populations defined locally as having an increased incidence of disease due to *M. tuberculosis*

High-Risk Groups for TB Disease Study Question 2.13

What is the strongest known risk factor for the development of TB disease?

HIV infection is the strongest known risk factor for developing TB disease. HIV infection weakens the body's immune system, making it more likely for a person who has TB infection to develop TB disease.

High-Risk Groups for TB Disease Study Question 2.14

If a person is infected with both *M. tuberculosis* and HIV, what are his or her chances of developing TB disease? How does this compare to the risk for people who are infected only with *M. tuberculosis*?

- **Risk is 7% to 10% <u>each year</u> if person is infected with both *M. tuberculosis* and HIV and the HIV is not treated**
- **Risk is 10% <u>over a lifetime</u> if person is only infected with *M. tuberculosis***

Case Studies

Module 2: 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 TB

Person	Factors
a) Mr. Petrov	✓ Works at a nursing home ____ Rides the subway every day ✓ Emigrated from Russia
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

Module 2: Case Study 2.2

For each of the following people, indicate the factor(s) known to increase the risk of developing TB disease once infected

Person	Factors
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