Who is at Risk of TB?

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July 9, 2025

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Has the following disclosures to make:

- No conflict of interests
- No relevant financial relationships with any commercial companies pertaining to this activity

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Screening and Treating Tuberculosis (TB) Infection

July 09th, 2025

Heartland National TB Center,
Edinburg, TX

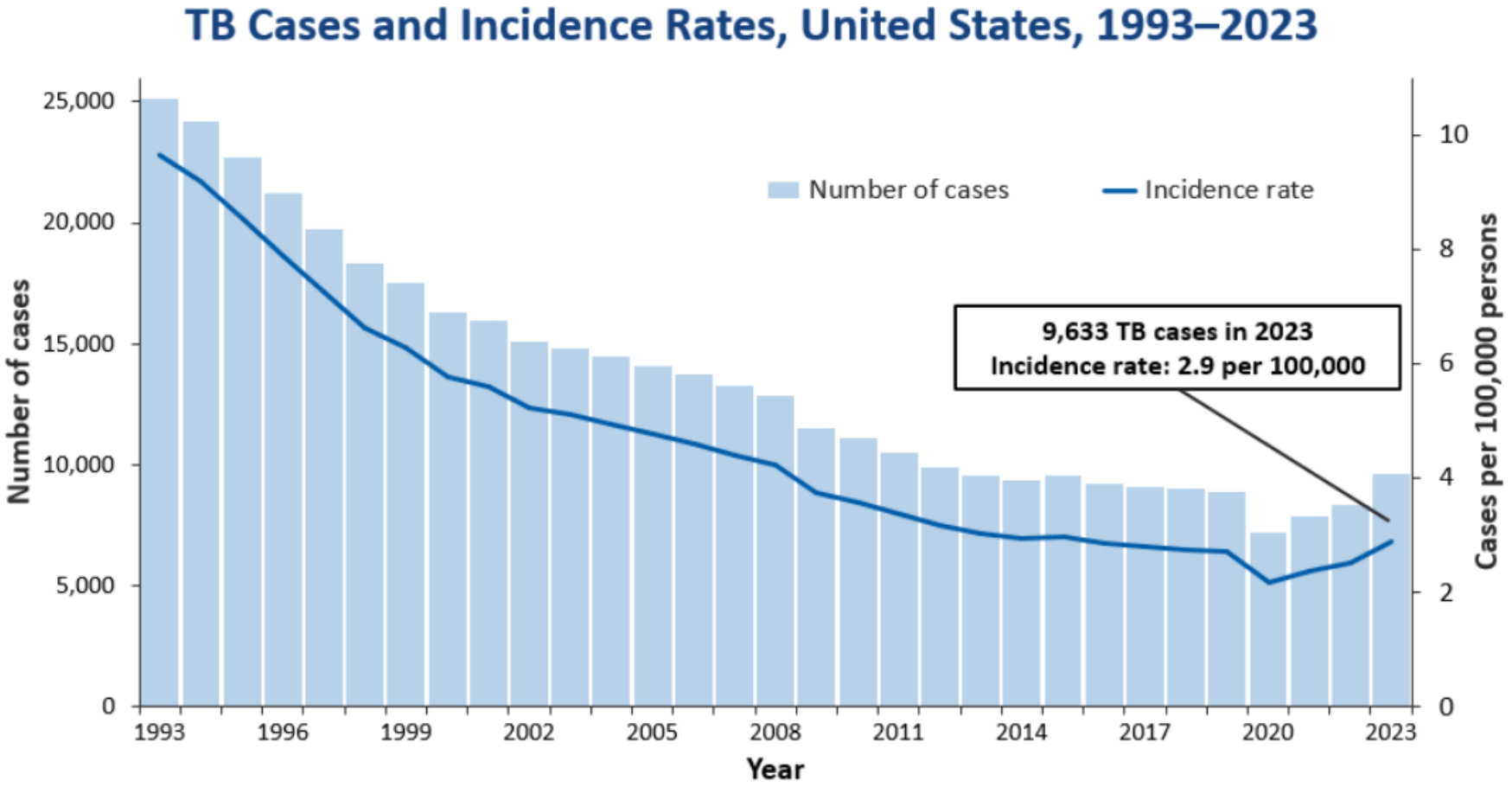
Disclosure

- I have no conflict of interests to disclose.
- Most of slides adapted from Dr. Annie Kizilbash.

Objectives

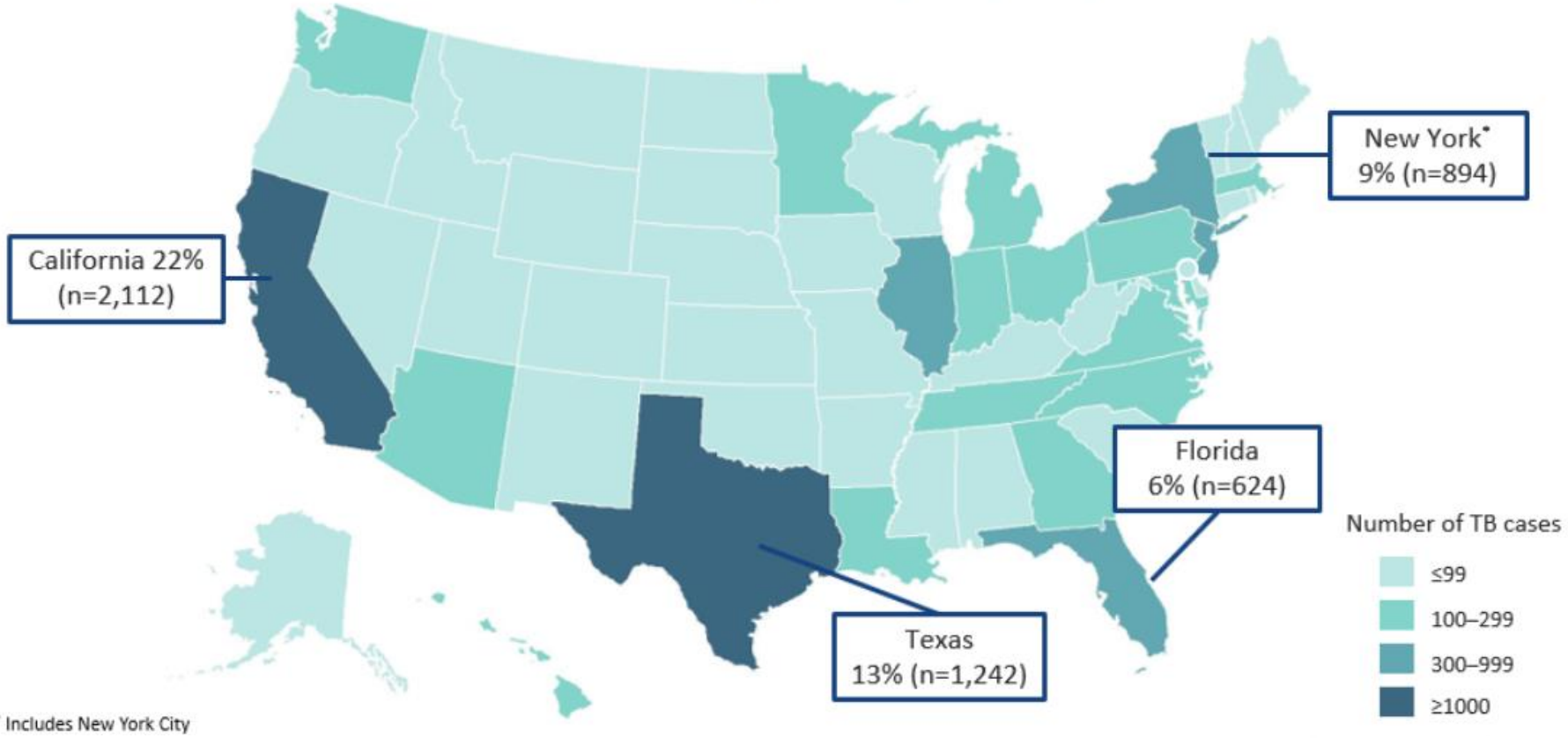
1. Describe the current epidemiology of TB
2. List the groups of people who are more likely to be exposed to or infected with *Mycobacterium tuberculosis*
3. List risk factors for progression to TB disease after infection with *M. tuberculosis*

What is the Current Epidemiology of TB in the US and along the US/Mexico Border?



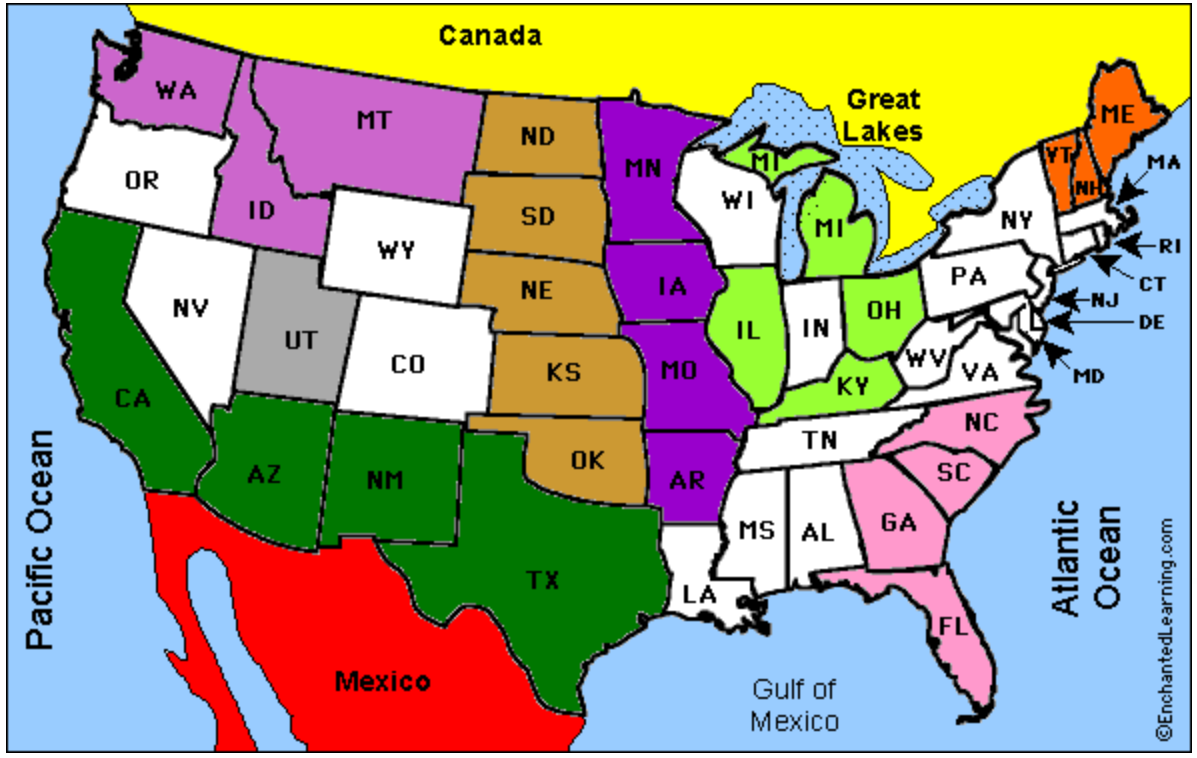
In 2023, 9,633 TB cases (2.9 per 100k), an increase of 1,295 cases (16%) compared with the 8,320 cases reported in 2022 (2.5 per 100k), the highest number of cases reported since 2013 (9,556).

TB Cases and Percentages by Reporting Area, United States, 2023 (N=9,633)

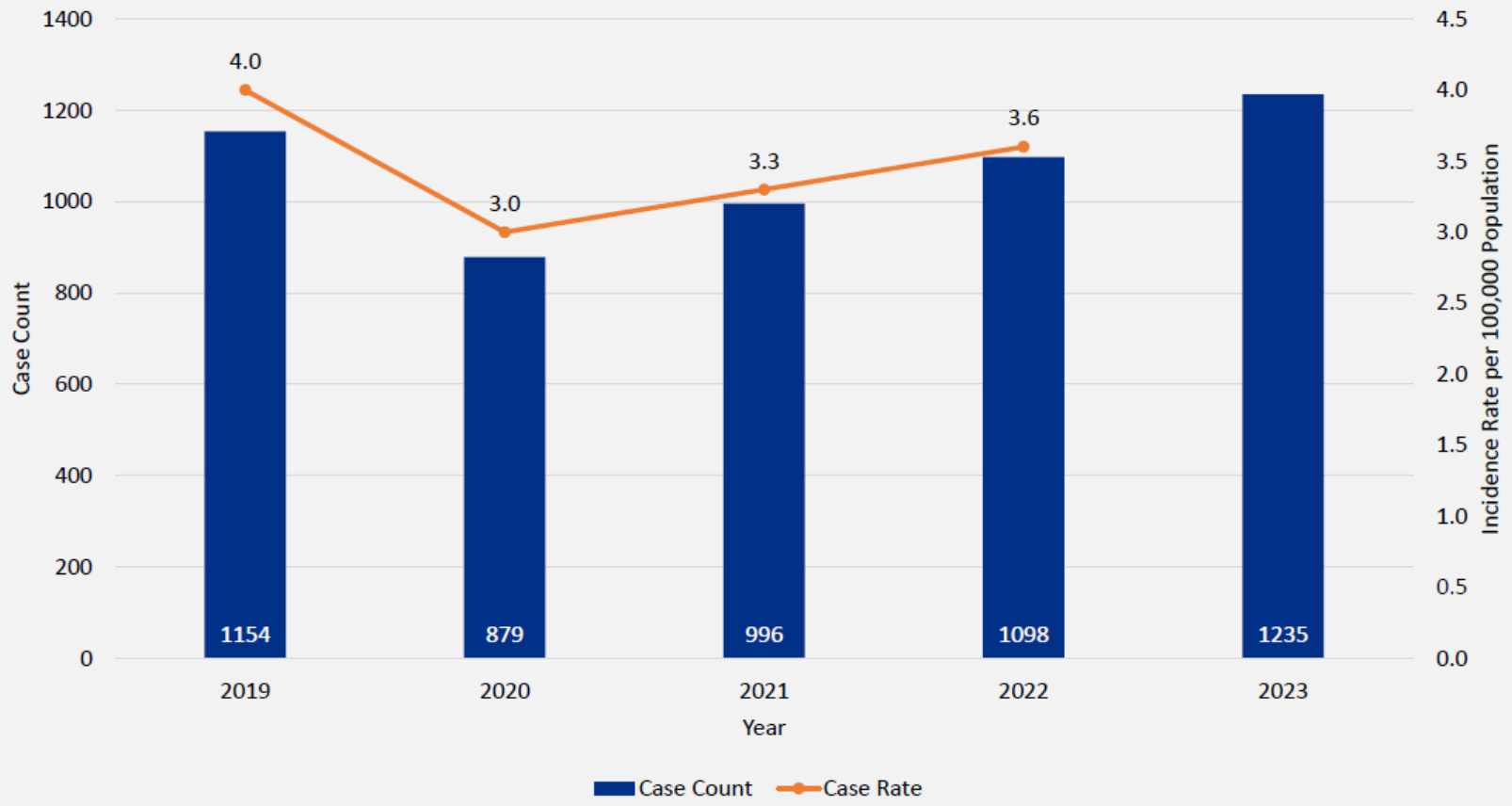


* Includes New York City

US/Mexico Border States



TB Case Counts and TB Case Rates, 2019-2023 Texas



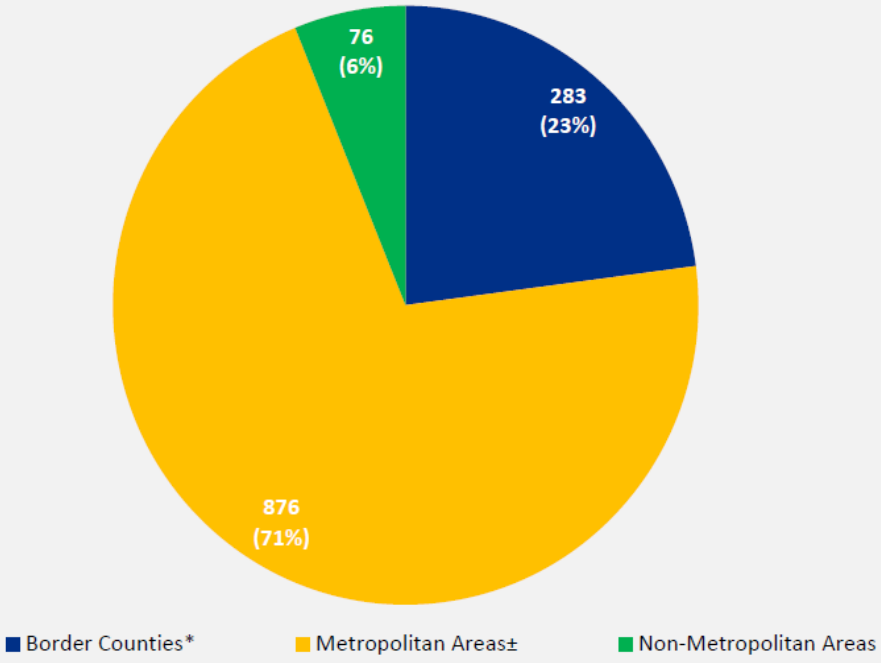
TEXAS
Health and Human Services

Texas Department of State Health Services

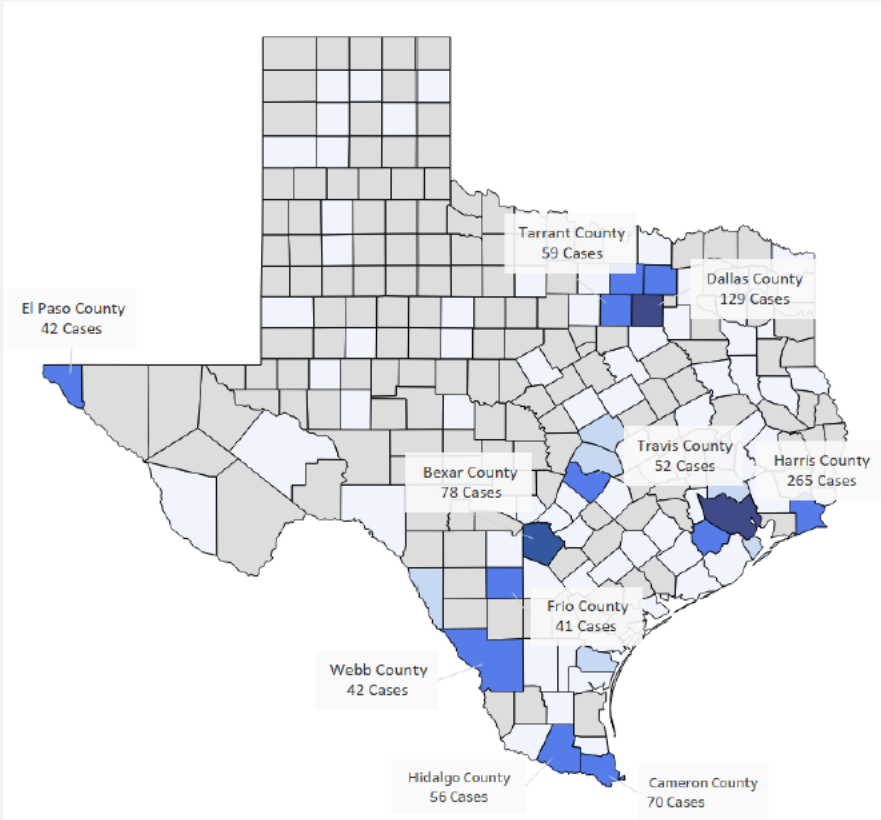
*2023 data are provisional and subject to change

Geographic Distribution of TB in Texas Communities, 2023*

- The majority of TB cases are reported from large metropolitan areas
- Border counties have the second highest number of cases



Distribution of TB in Texas, 2023



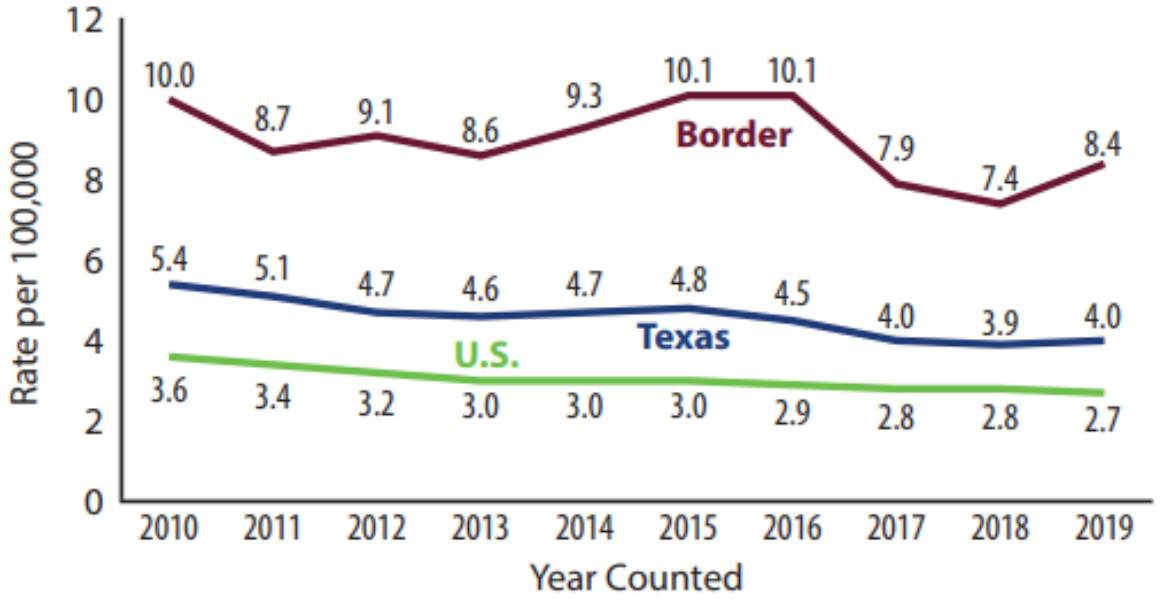
County	Reported Cases	Percent of All Cases
Harris	265	21.5%
Dallas	129	10.5%
Bexar	78	6.3%
Cameron	70	5.7%
Tarrant	59	4.8%
Hidalgo	56	4.5%
Travis	52	4.2%
El Paso	42	3.4%
Webb	42	3.4%
Frio	41	3.3%
Total	**834**	**67.5%**

TB in Border Counties*, 2023

- 13 of the 32 border counties reported at least one TB case
  - This region accounts for 23% of all TB cases
- Less than 10% of the Texas population lives in the border region

As defined by the La Paz Agreement

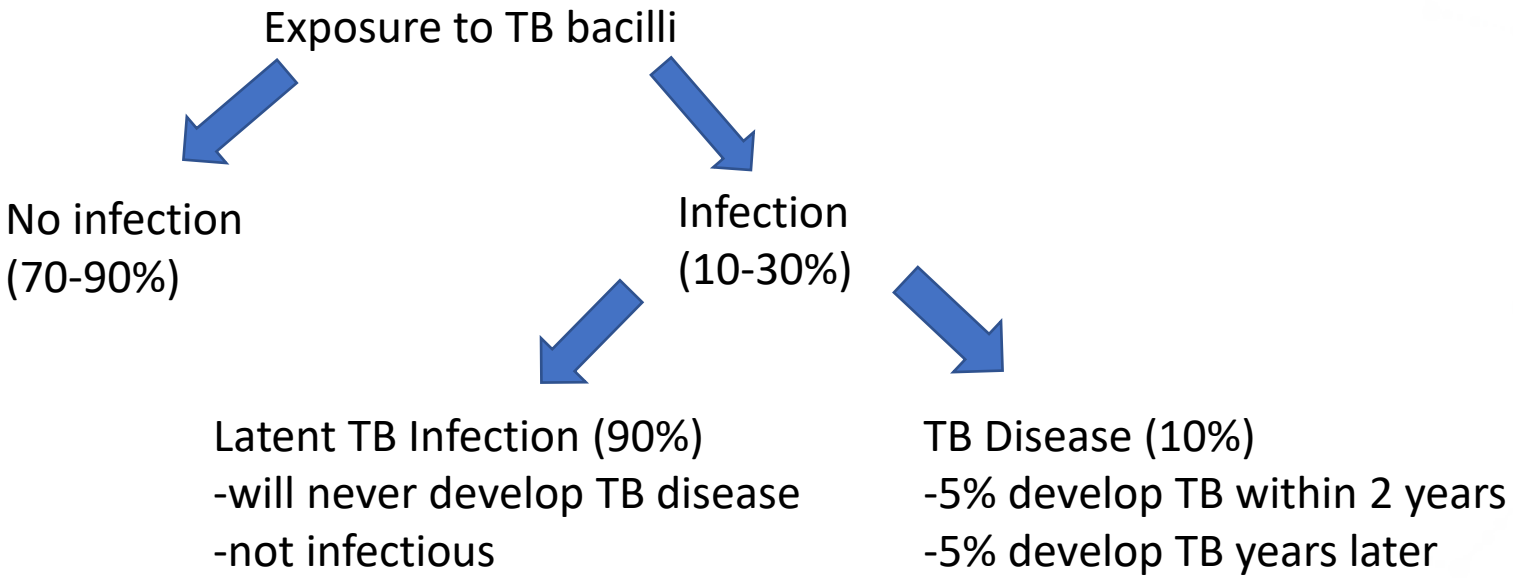
Figure 2: TB Incident Rate Comparison Among Texas, U.S., and Texas-Mexico Border Counties



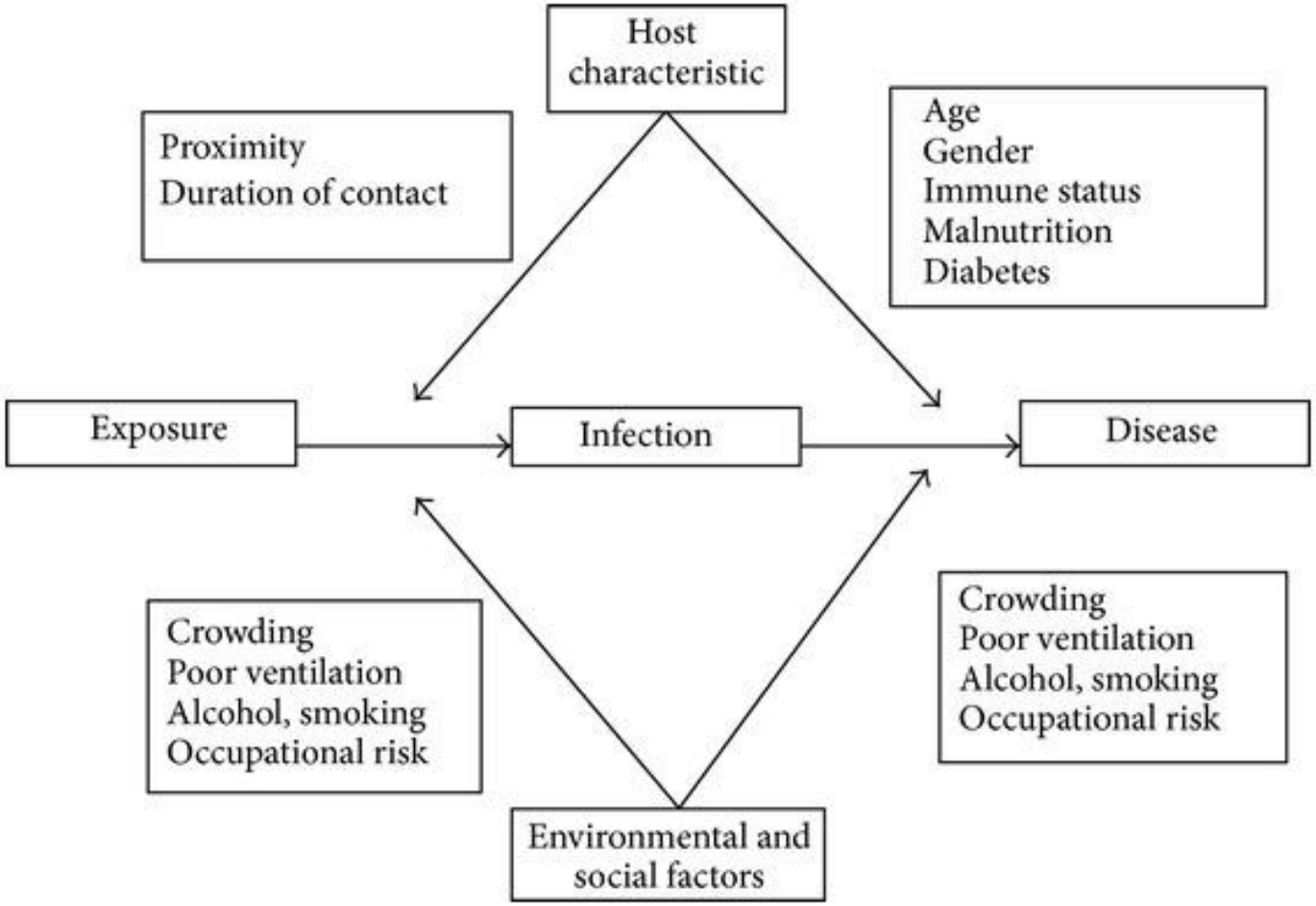
In 2019, the 32 border counties had an average TB incidence rate of 8.4/100,000, which was more than double the Texas TB rate of 4.0/100,000, and nearly triple the national rate 2.7/100,000.[1]

Who is more likely to be exposed or infected with *Mycobacterium tuberculosis* ?

Pathogenesis of Tuberculosis



Risk Factors for Tuberculosis



Who is more likely to be exposed to *M. tuberculosis*?

- Foreign born persons from countries with a high incidence of TB disease
- Residents and employees of high-risk congregate settings (e.g. correctional facilities, long term care facilities)
- Healthcare workers
- Contacts to persons with infectious TB disease
- Persons who spend time in shelters
- Persons who use illicit drugs

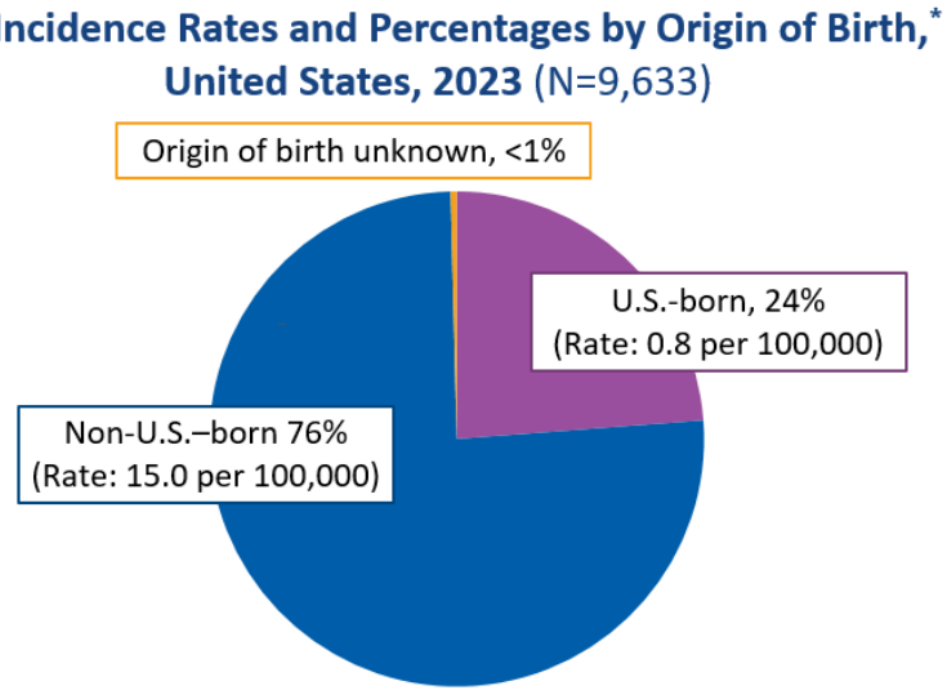
Incidence of TB Global vs. USA

- Globally: In 2023
  - 10.8 million estimated cases of TB disease
  - 134 per 100,000 population

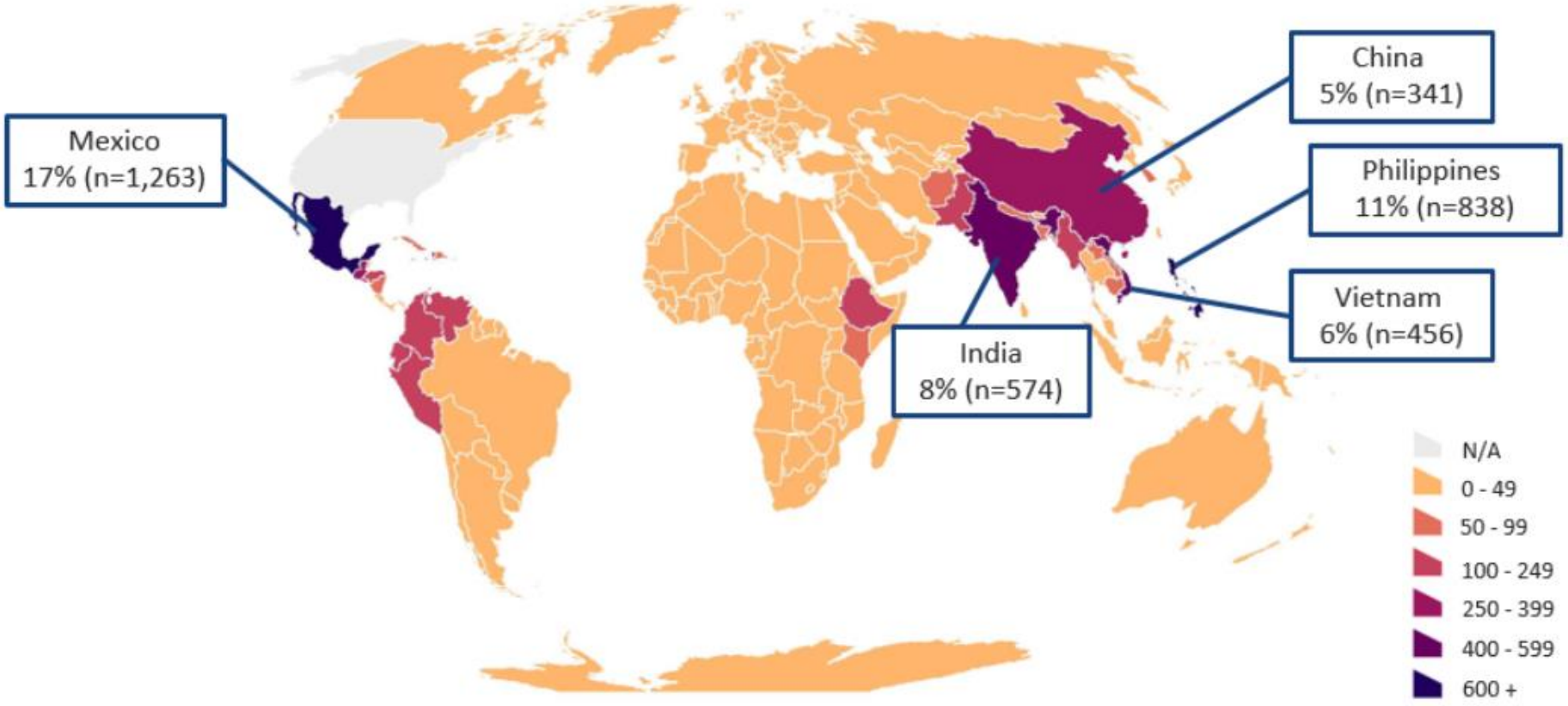
Global Tuberculosis Report WHO Report 2024

- USA: In 2023
  - **9,633** TB disease cases reported
  - **2.9** cases per 100,000 population

MMWR March 2023

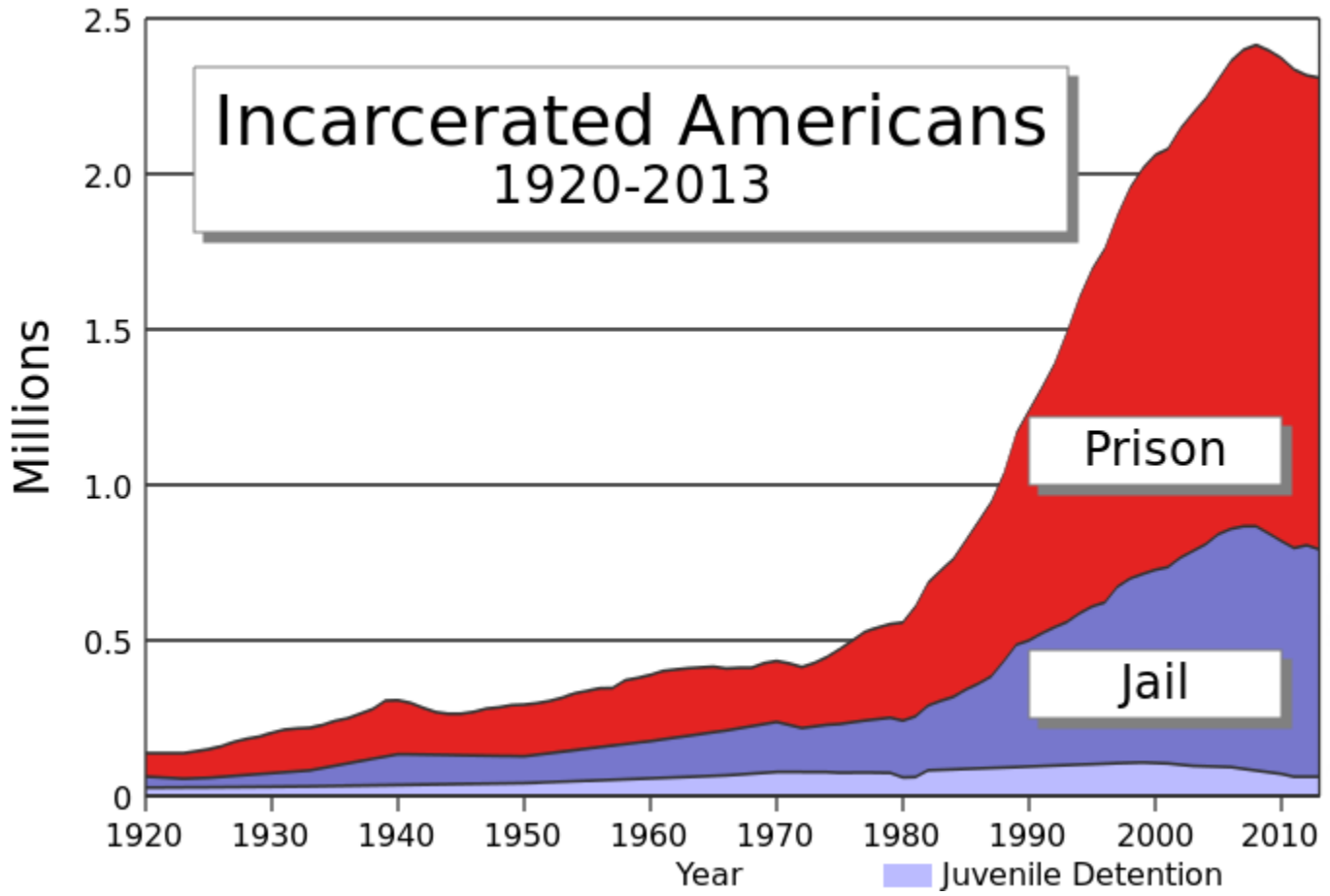


TB Cases by Countries of Birth Among Non-U.S.–Born* Persons, United States, 2023 (N=7,299)



*Persons born in the United States, certain U.S. territories, or elsewhere to at least one U.S. citizen parent are categorized as U.S.-born. All other persons are categorized as non-U.S.–born.

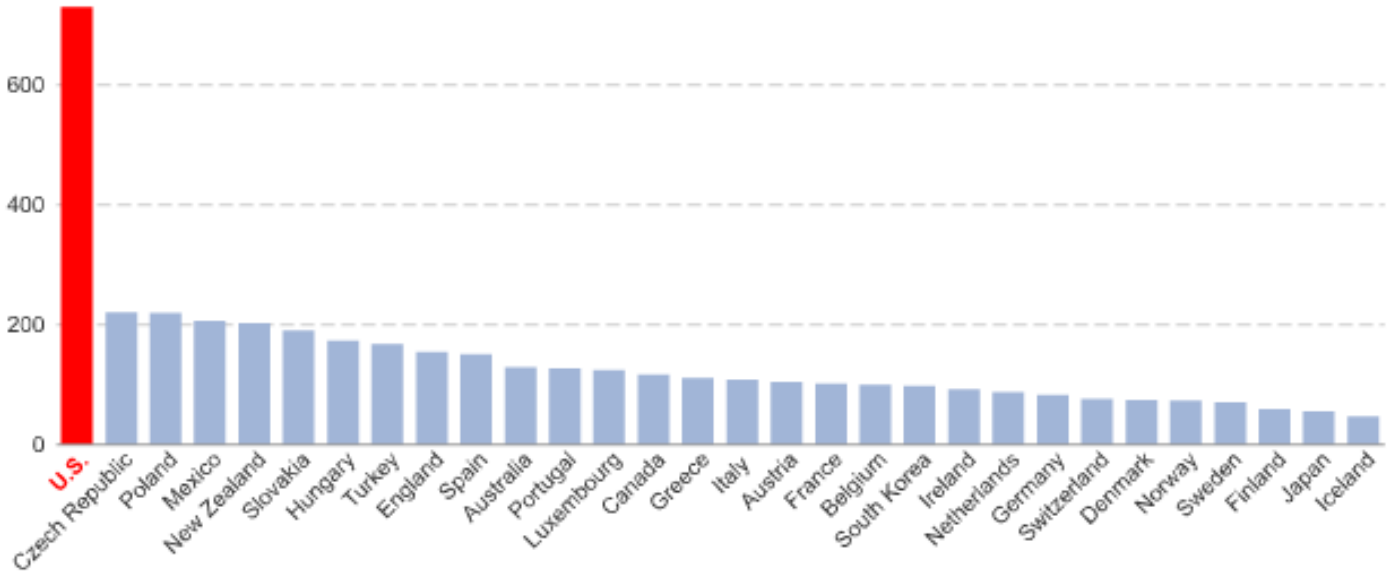
Correctional Facilities and Risk for TB



The U.S. has the highest incarceration rate of any country in the world, imprisoning about 730 out of every 100,000 citizens.

Incarceration Rates for Countries in the OECD

Source: International Centre for Prison Studies



Correctional facilities and Risk for TB

- Prevalence of LTBI among inmates high
  - 49 correctional facilities in 12 states, 198102 inmates , 17% TST positive
    - Treatment for latent TB in correctional facilities: a challenge for TB elimination; Loboto MN; Am J Prev Med. 2003; 24:249-53
- Correlation between length of incarceration and positive TST
  - 8% LTBI newly incarcerated, 5% increase with each year
    - Active and latent tuberculosis in Brazilian correctional facilities: cross sectional study; Carbone; BMC Infectious Diseases 2015
- Substantially higher TB disease cases rates in correctional populations
  - E.g. New Jersey (1994) - 91.2 cases per 100,000 (11 cases per 100,000 among all residents)

Prevention and Control of Tuberculosis in Correctional and Detention Facilities: Recommendations from CDC; MMWR: July 7, 2006

Why ?

- At least three factors:
  - Those incarcerated are at higher risk for TB
  - Physical structure of the facility – inadequate ventilation, overcrowding, close living quarters
  - Movement of inmates into and out of facilities

In 2023, 324 (3.6%) persons 15 years of age or older with TB disease were residents of a correctional facility at the time of TB diagnosis.

Tuberculosis among the Homeless

- TB outbreaks frequently originate in homeless shelters – high risk of recurrence
- Homeless – person without a fixed, regular adequate nighttime residence within 12 months preceding the diagnosis of TB

NATIONAL

Homelessness in the U.S. hit a record high last year as pandemic aid ran out

UPDATED DECEMBER 15, 2023 · 4:25 PM ET

HEARD ON ALL THINGS CONSIDERED

Jennifer Ludden

4-Minute Listen + PLAYLIST

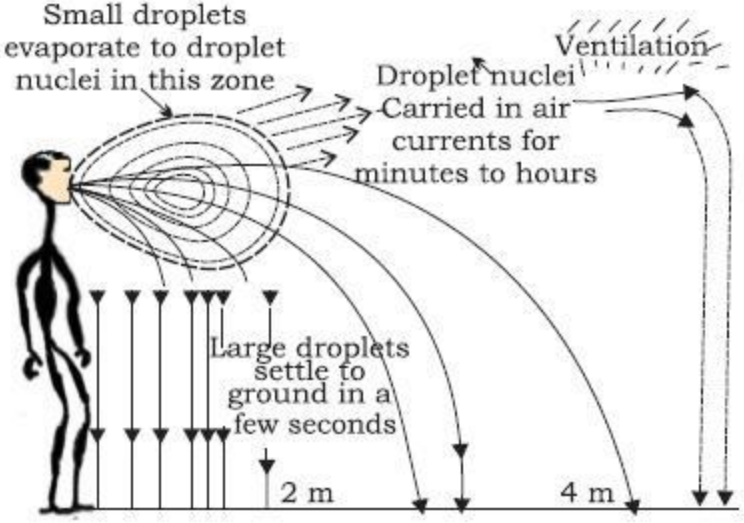
In 2023, among persons 15 years of age or older with TB disease:

695 (8.3%) persons reported ever experiencing homelessness during their lifetime, and

536 (5.9%) persons reported experiencing homelessness within 12 months prior to TB diagnosis.

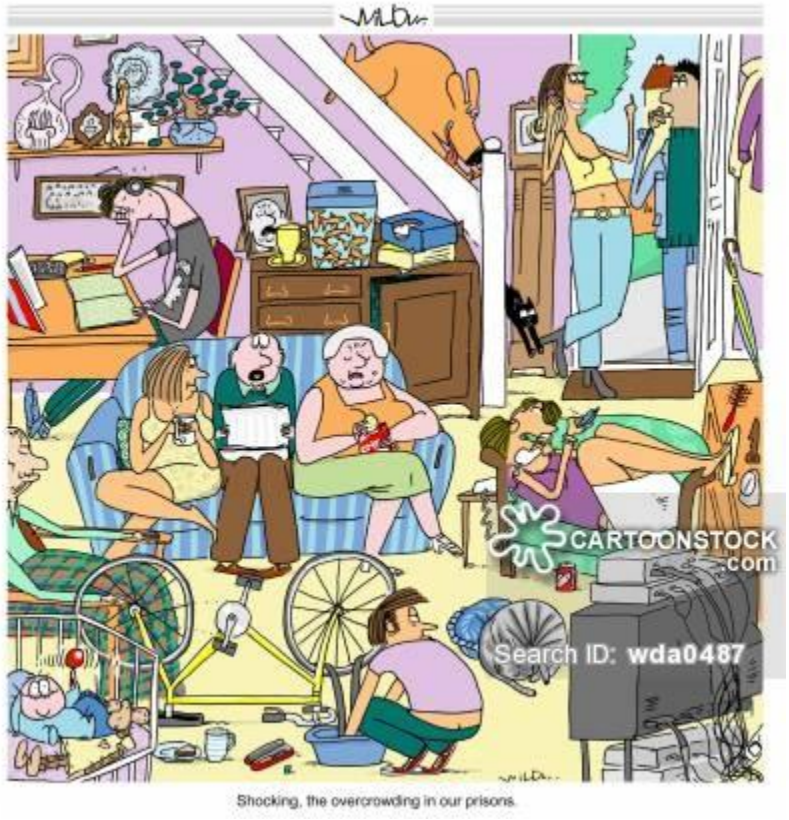
What are environmental factors which increase likelihood of TB transmission?

- Poorly ventilated settings
- Crowding



Crowding and Risk of TB Transmission

- Increases the likelihood of contact between an infectious TB case and a susceptible person and increases intimacy of exposure
  - PPD conversion in children living in houses of TB cases is associated with the number of cubic ft/person in house
    - Chapman JS. Social and other factors in intrafamilial transmission of tuberculosis. Am Rev Respir Dis 1964
  - The number of new TB cases was highly correlated with overcrowding.
    - Stein L. Glasgow tuberculosis and housing. Tubercle 1954:35; 195-203



Shocking, the overcrowding in our prisons.

Poor Ventilation and Risk of TB Transmission

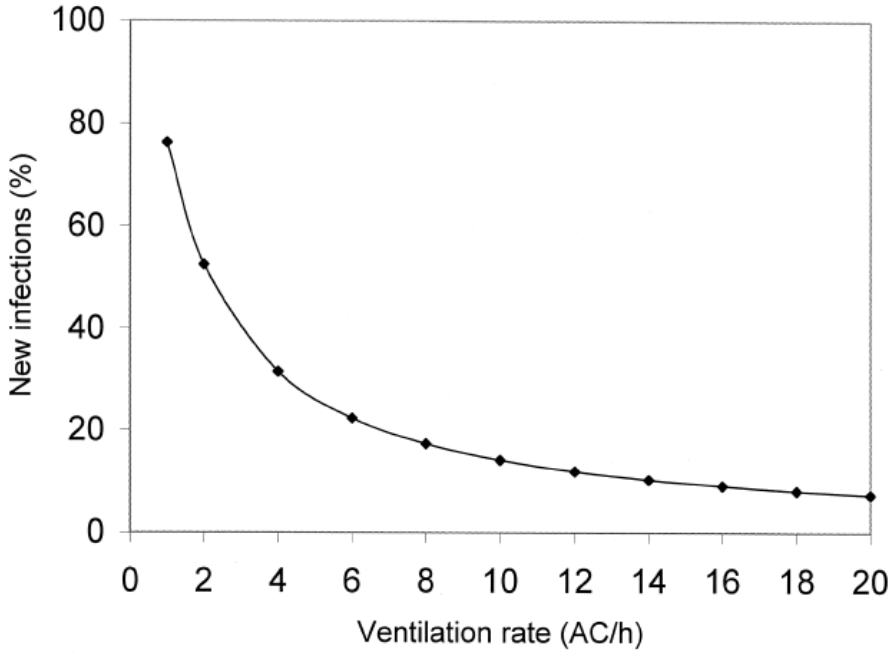


Figure 5 Effect of ventilation rate on new infections for base condition parameters with a total quanta production rate of 12 quanta/h and an exposure time of 16 h.

- Simplistic parametric model
- Depends on other factors such as room volume, occupancy density, infectious dose and susceptibility of host

The transmission of tuberculosis in confined spaces: an analytical review of alternative epidemiological models, Beggs C.B., Int J Tuberc Ling Dis 7(11): 1015-1026, 2003

TB among Healthcare Workers

- In low- and middle-income countries annual risk of TB infection in HCWs 3.9% to 14.3% (between 2.6% and 11.3% attributable to occupational exposure).

Joshi R, Reingold AL, Menzies D, Pai M. Tuberculosis among health-care workers in low- and middle-income countries: a systematic review. PLoS Med 2006;3(12):e494.

- Annual risk of developing TB disease was three times higher (95% CI:2.43–3.51) for HCWs compared to the general population.

Baussano I, Nunn P, Williams B, Pivetta E, Bugiani M, Scano F. Tuberculosis among health care workers. Emerg Infect Dis 2011;17(3):488–94.

Four occupational drug-resistant TB survivors unite behind ZERO TB and ZERO STIGMA on South African National Women's Day.

Contacts to persons with infectious TB disease

- Factors include:
  - Infectiousness of TB patient
  - Susceptibility of contact
  - Duration of contact
    - No safe exposure time has been established
  - Proximity of contact
    - Difficult to determine

Contact Investigation for Tuberculosis: a systematic review and meta-analysis; Fox G, Eur Respir J. 2013

Proximity and Duration of MTB Exposure

- 32 years old Korean lady MDR pulmonary TB
- Flight from Chicago to Honolulu
- Flight duration 8.75 hours
- 15 positive TST
  - 6 without TB risk factors

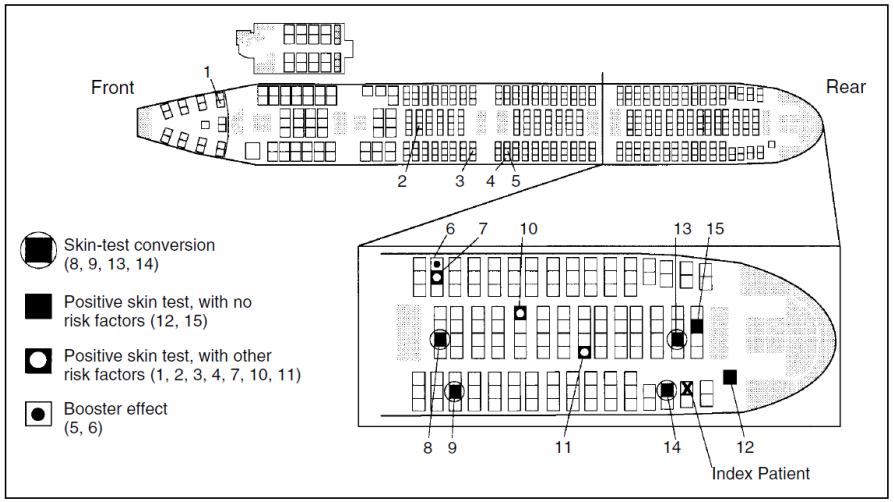


Figure 2. Diagram of the Boeing 747-100, with Seat Assignments of the Passengers and Flight Crew on Flight 4 Who Had Positive Tuberculin Skin Tests.
Numbers refer to the contacts listed in Table 2. Contact 12 was a member of the flight crew.

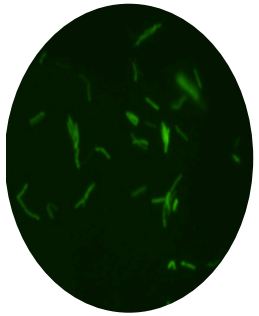
Table 3. Seat Locations in Aircraft and Results of Tuberculin Skin Tests of Passengers and Crew Members on Flight 4 Who Had No Risk Factors.*

Seat Location	No. with Positive Skin Tests/No. Tested (%)	Rate Ratio (95% CI)†	P Value
Not same cabin section as index patient	0/136	Reference value	—
Same cabin section as index patient	6/68 (8.8)	Undefined	0.001
Within 2 rows	4/13 (30.8)	8.5 (1.7–41.3)	0.01
Elsewhere in same section	2/55 (3.6)	Reference value	

Transmission of Multidrug Resistant Mycobacterium tuberculosis during a long airplane flight, NEJM 4/11/96

Chest X-ray of Index Patient 8 days after Flight

Sputum Bacteriology – AFB smear positive



one microscopic field

CAP	ATS	Interpretation	AFB/ml sputum	Infectiousness of patient
negative	negative	negative	<5,000	probably not infectious
1 or 2 per smear	1 or 2 per smear	weakly positive	~5,000	probably infectious
<1 per field	1+	moderately positive	~10,000	probably infectious
1-10 per field	2+	moderately positive	~100,000	probably infectious
>10 per field	3+	strongly positive	~1,000,000	probably very infectious
	4+	strongly positive	>1,000,000	probably very infectious

Illicit Drug Use and TB

- IDU often share risk factors which confer additional risk for exposure

  Tuberculosis and Illicit Drug Use: Review and Update; Deiss R.G.; CID 2009: 48 Jan 1

- During 2023, reported types of substance use among persons 15 years of age or older with TB disease were:
  - Excess alcohol use (7.9%)
  - Noninjecting drug use (7.8%)
  - Injecting drug use (1.1%)

A network informed approach to investigating a tuberculosis outbreak: implications for enhancing contact investigations. McElroy RD; Int J Tuberc Lung Dis 2003; 7 S486-93

The Effects of Smoking

- Smoking associated with RR 1.7 for TB Infection and RR 2.3-2.7 for TB disease
- Estimated RR for development. of TB disease in a TB infected population of 1.4-1.6

Risk of Tuberculosis From Exposure to Tobacco Smoke; Bates M.N.; Arch. Int. Med, Feb 2007

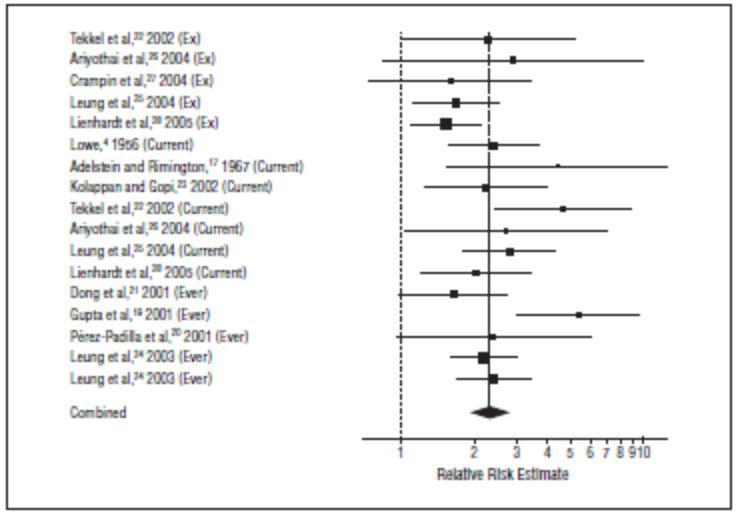


Figure 3. Forest plot of results for men only and for men and women combined in studies[4,17,19-28] that examined smoking and tuberculosis disease. The smoking type (ex-smokers [Ex], current smokers [Current], and ever smokers [Ever]) of the study population is shown on the y-axis.

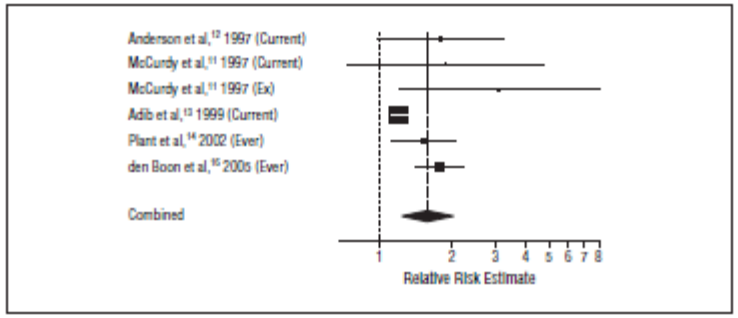
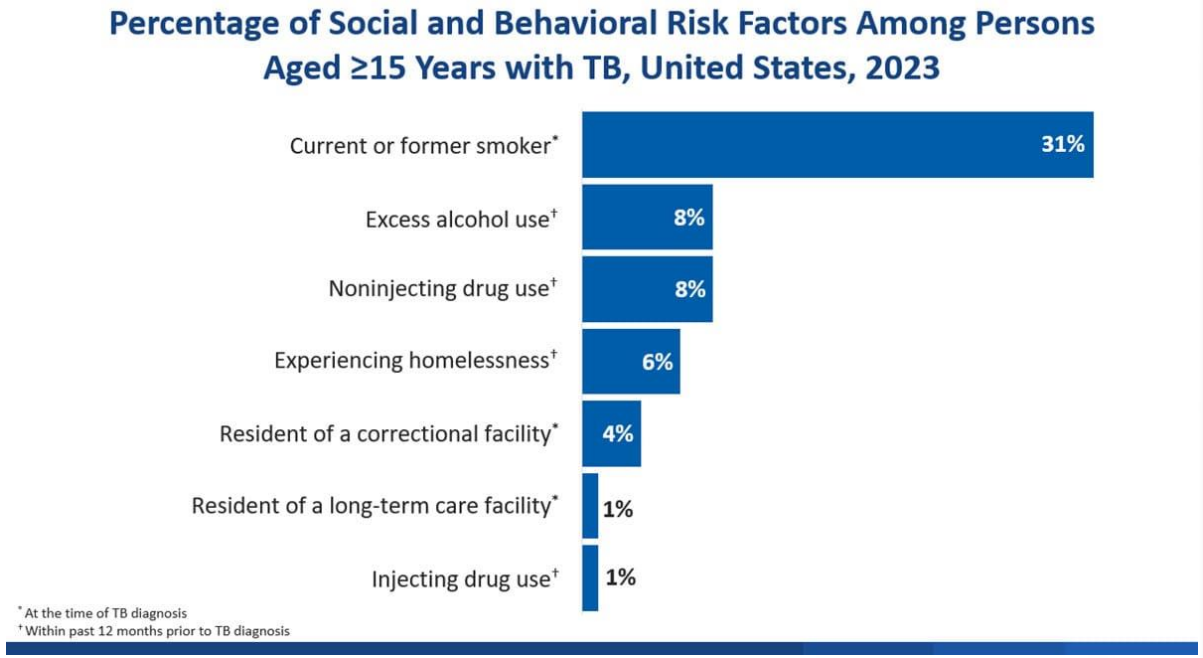


Figure 1. Forest plot of results of 5 studies[11-14,16] that examined smoking and tuberculosis infection. The smoking type (current smokers [Current], ex-smokers [Ex], and ever smokers [Ever]) of the study population is shown on the y-axis.

Smoking

- Smoking is associated with increased risk of TB disease. In the 2020 RVCT, the definition of "smoking" is consuming tobacco (or nicotine) through:
- Combustible tobacco products (e.g., cigarettes)
- Electronic nicotine delivery systems (e.g., vapes, e-cigarettes)
- In 2023, 2,834 (31.2%) persons 15 years of age or older with TB disease reported being a current or former smoker.



Who is likely to progress to TB disease after infection with *M. tuberculosis?*

Risk Factors for Progression to TB disease after infection with *M.tuberculosis*

- Infants and children aged ≤5 years

Percent Risk of Disease by Age

Age at Infection	Risk of Active TB
Birth – 1 year*	43%
1 – 5 years*	24%
6 – 10 years*	2%
11 – 15 years*	16%
Healthy Adults	5-10% lifetime risk
HIV Infected Adults+	30-50% lifetime

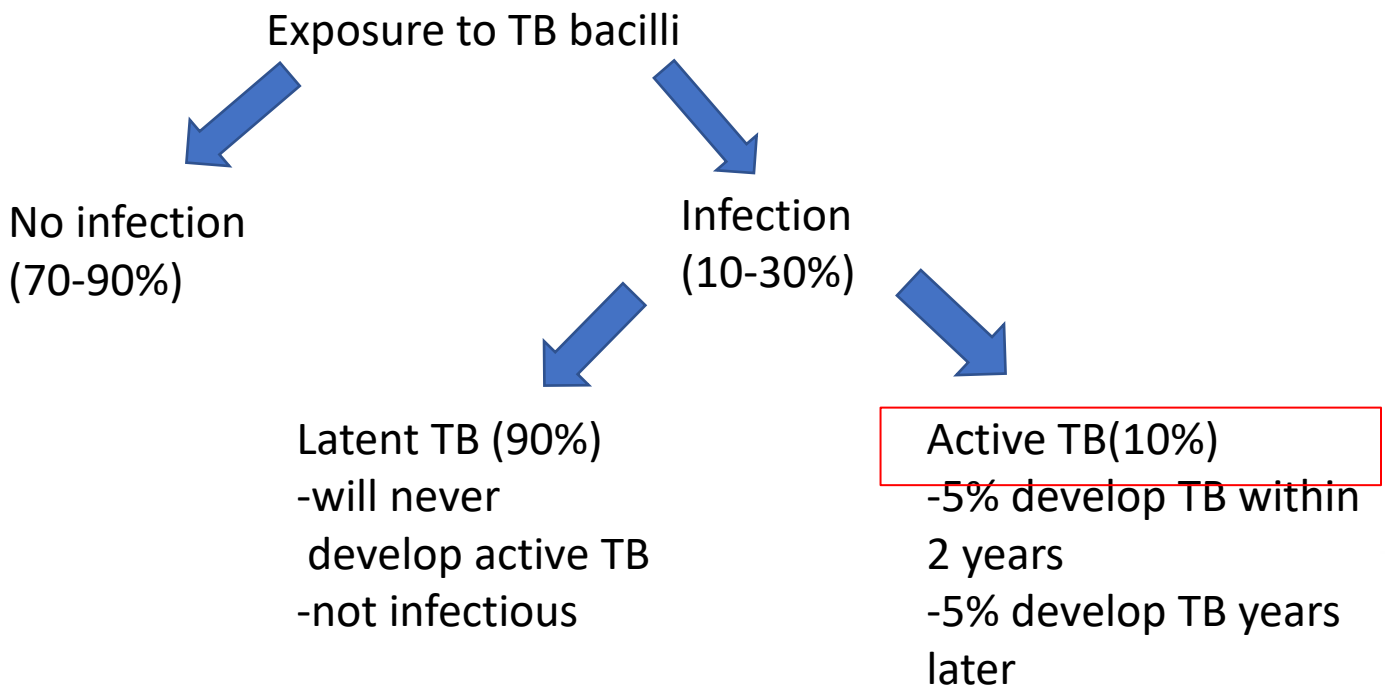
*Miller, Tuberculosis in Children Little Brown, Boston, 1963

+WHO, 2004

Risk Factors for Progression to TB disease after infection with *M.tuberculosis*

- Infants and children aged ≤5 years
- Infected with *M. tuberculosis* within the prior 2 years

Pathogenesis of Tuberculosis



Risk Factors for Progression to TB disease after infection with *M.tuberculosis*

- Infants and children aged ≤ 5 years
- Infected with *M.tuberculosis* within the prior 2 years
- HIV infection and other medical risk factors

Effect of HIV on Progression from Latent to TB Disease

Tuberculosis in the Homeless; A Prospective Study
Moss, A.; J Respir Crit Care Med Vol 162. pp 460–464, 2000

INCIDENCE OF REPORTABLE TUBERCULOSIS IN THE SAN FRANCISCO GENERAL HOSPITAL HOMELESS COHORT BY HIV AND TUBERCULIN SKIN TEST (TST) STATUS AT BASELINE

	n	Person-years	Cases	Rate per Person-Year	95% Confidence Interval
TST+, HIV+	40	134	6	4.46	(1.76–9.10)
TST+, HIV−	695	2,524	12	0.48	(0.25–0.80)
TST−, HIV+	155	559	3	0.56	(0.14–1.46)
TST−, HIV−	1,382	4,422	3	0.07	(0.02–0.18)
TST unknown, HIV+	49	185	1	0.54	(0.02–2.14)
TST unknown, HIV−	443	1,418	0	0	(0.0–0.21)
Total	2,764	9,221	25	0.27	(0.18–0.39)

HIV infected had about a 10 times higher risk of reactivation than those HIV uninfected

Effect of HIV on Latent TB Reactivation

*HIV infected with 25 times the rate of reactivation of latent TB compared to HIV uninfected

Table 5. Estimated Rate of Reactivation Tuberculosis Among HIV-infected and HIV-uninfected Tuberculosis Patients Aged 15–64 Years Not Residing in California, United States, 2006–2008

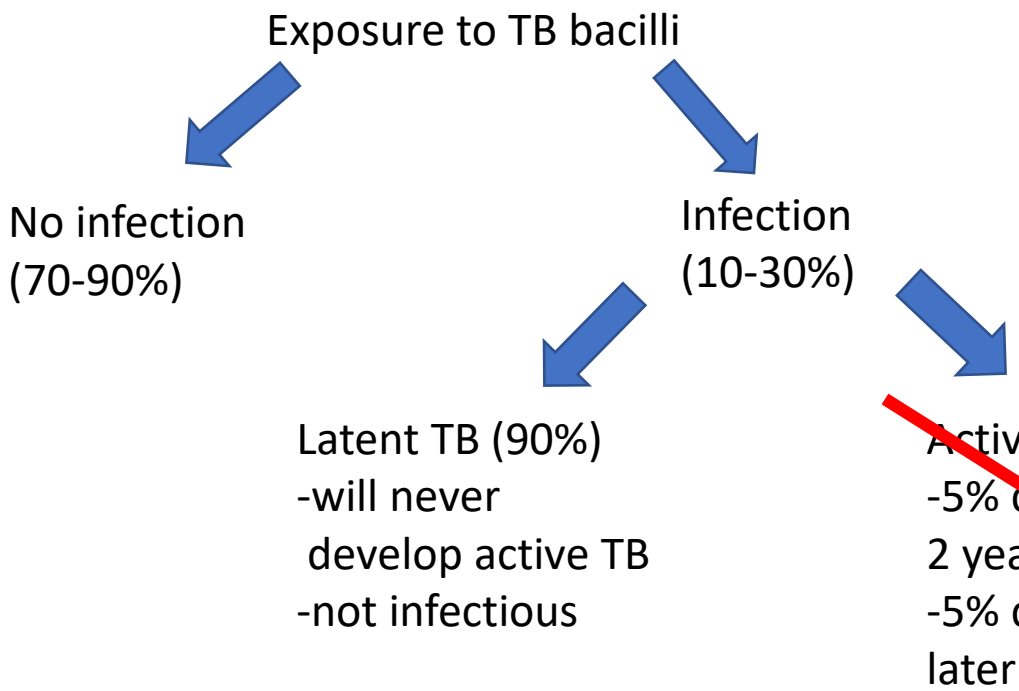
	Estimated No. of Reactivation TB Cases	Estimated % of US Population With Latent TB Infection	Estimated US Population	Estimated No. of PY at Risk for Reactivation TB	Estimated Rate of Reactivation TB per 100 PY	95% Confidence Interval
HIV-infected	2,198	4.2	961,000	121,100	1.82	1.74, 1.89
HIV-uninfected	16,568	4.2	182,243,000	22,850,000	0.073	0.070, 0.075

Abbreviations: HIV, human immunodeficiency virus; PY, person-years; TB, tuberculosis.

Estimated rate of reactivation of latent tuberculosis infection in the United States, overall and by population subgroup; Shea KM, Am J Epidemiol. 2014 Jan 15; 179(2):216-25

5.3% of TB patients with known HIV status in 2018 were coinfected with HIV, including 8.6% among persons aged 25–44 years. MMWR 2019

Pathogenesis of Tuberculosis



HIV infected – 10% reactivation **per year** of latent TB

Diabetes and TB

Richard Morton (1637-98) and his Phthisiologia

Tuberculosis and diabetes mellitus: convergence of two epidemics; Dooley K; *Lancet Infect Dis*. 2009 December; 9(12): 737–746.

- A link between diabetes and TB has been recognized for centuries
- Diabetics have increased risk of progression to disease, failure of therapy, relapse and mortality from TB

Chronic Kidney Disease and TB

TABLE 3—Adjusted[a] Odds Ratios (ORs) and 95% Confidence Intervals (CIs) for Tuberculosis among Patients Discharged from Civilian Hospitals in California during 1991, by Race/Ethnicity

Variable	Whites		Hispanics		Blacks	
	Adjusted OR	95% CI	Adjusted OR	95% CI	Adjusted OR	95% CI
Sex (male vs female)	1.51	1.42, 1.61	1.02	0.96, 1.10	1.87	1.68, 2.08
Age, y						
<25 (reference)						
25–54	4.98	4.35, 5.70	2.87	2.66, 3.10	5.92	5.02, 6.98
>54	12.71	11.02, 14.65	9.98	8.93, 11.15	4.90	4.00, 6.01
Foreign born[b]	1.18	1.15, 1.21	1.14	1.11, 1.19	0.94	0.90, 0.99
Poor education[b]	1.40	1.31, 1.50	0.96	0.88, 1.05	2.33	2.02, 2.68
Median income[c]	0.99	0.98, 0.99	1.00	0.99, 1.01	0.97	0.95, 0.99
Health insurance						
Other (reference)[d]						
Medicare	2.22	2.04, 2.42	1.78	1.54, 2.06	2.58	2.17, 3.07
Medicaid	5.87	5.33, 6.46	3.71	3.39, 4.05	5.21	4.50, 6.02
None	2.10	1.88, 2.36	2.51	2.29, 2.76	5.39	4.61, 6.29
Diabetes mellitus	1.31	1.19, 1.45	2.95	2.61, 3.33	0.93	0.78, 1.09
Type II, uncomplicated	0.99	0.87, 1.15	1.67	1.39, 2.01	0.63	0.49, 0.82
Type I, uncomplicated	1.49	1.17, 1.88	2.22	1.66, 3.00	0.80	0.56, 1.13
Poor control/complicated	1.93	1.64, 2.28	5.73	4.78, 6.87	1.52	1.18, 1.95
HIV-related conditions	54.26	47.66, 61.77	237.81	160.81, 351.56	79.37	52.64, 119.67
Chronic renal insufficiency	4.11	3.30, 5.11	10.92	7.50, 15.89	2.23	1.61, 3.09
Alcohol-related conditions	10.19	8.87, 11.70	24.49	18.95, 31.64	9.29	6.92, 12.47
Drug use	4.63	3.26, 6.58	9.51	6.36, 14.20	9.26	6.26, 13.70

[a]Race stratified models containing all the variables listed in the table. The odds ratios for all variables, except drug use, were statistically different across race/ethnicity ($P < .01$ for each two-way interaction term).
[b]Risk associated with a 10% increase in the prevalence of foreign-born people or the proportion not completing high school in the zip code area where patients resided.
[c]Risk associated with a $1000 decrease in the mean income per capita in the zip code area where patients resided.
[d]Health insurance other than Medicare or Medicaid.

The role of diabetes mellitus in the higher prevalence of tuberculosis among Hispanics;
Pablos M.A.; Am J Public Health 1997; 87:574-9

Malnutrition and Progression from Latent to Active TB

- Ecologic Study
  - Prisoners of War
    - British soldiers given food supplements – TB incidence 1.2%
    - Russian soliders not given food supplements – TB incidence 15-19%
      - Leyton G B. Effects of slow starvation. Lancet 1946; 2: 253–255

TNF alpha Antagonists

- TNF alpha activity is required for granuloma formation and control of MTB infection

- Used for rheumatoid arthritis, Crohn's disease, psoriasis and a variety of other immune mediated diseases

- Remicaid (inflixamab)
- Embril (entanercept)
- Humira (adalimubab)
- Cimzia (certolizumab)

Warning: Risk Of Infections Infliximab

- Tuberculosis (frequently disseminated or extrapulmonary at clinical presentation), …and other opportunistic infections have been observed in patients receiving Remicade some of these infections have been fatal.
- Patients should be evaluated for LTBI with a TST.
- Treatment of LTBI should be initiated prior to therapy with Remicade.
- SEE WARNINGS

PDR 2004

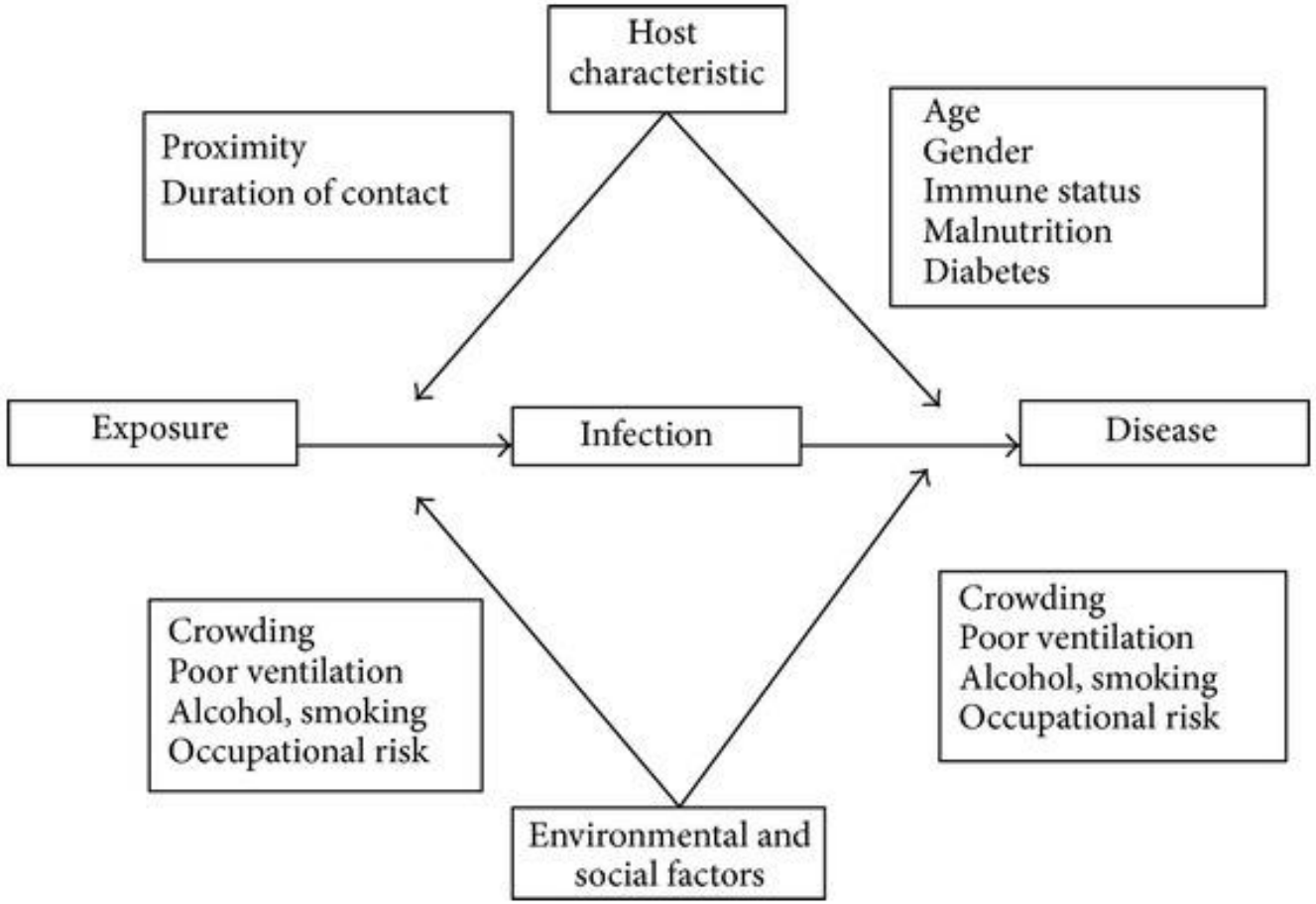
TABLE 1 Risk factors for the development of active TB among persons infected with *Mycobacterium tuberculosis* (28)[a]

Risk factor	Estimated risk for TB relative to persons with no known risk factor
High risk (testing and treatment for LTBI recommended for all ages)	
AIDS (not on anti-HIV therapy)	110–170
HIV (not on anti-HIV therapy)	50–110
Transplantation (related to immunosuppressive therapy)	20–74
Silicosis	30
Chronic renal failure requiring hemodialysis	10–25
Carcinoma of head and neck	16
Recent TB infection (<2 yrs)	15
Abnormal chest X ray—with upper lobe fibronodular disease typical of healed TB infection	6–19
TNF-α inhibitors	2–9
Moderate risk (testing and treatment for LTBI recommended if age < 65 yrs)	
Treatment with glucocorticoids	5
Diabetes mellitus (all types)	2–4
Young age when infected (0–4 yrs)	2–5
Slightly increased risk (testing and treatment for LTBI recommended if age < 50 yrs)	
Underweight (<90% ideal body weight; for most persons, this is a BMI of 20)	2–3
Cigarette smoker (1 pack/day)	2–3
Abnormal chest X ray—granuloma	2
Low risk (testing and treatment for LTBI recommended if age < 35 yrs)	
Infected person, no known risk factor, normal chest X ray ("low-risk reactor")	1
Very low risk (treatment of LTBI not usually recommended)	
Person with positive two-step ("boosting"), no other known risk factor, and normal chest X ray	0.5

[a]Modified from the work of Lobue and Menzies (140) and the CDC.

Haley, CA, Treatment of LTBI, Microbiol. Spect. 2017, April 5(2).

Risk Factors for Tuberculosis



Thank you!