CDC National Notifiable Disease Surveillance System (NNDSS) on Childhood Vaccine Preventable Diseases in the U.S.

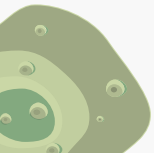
By Katherine Thao

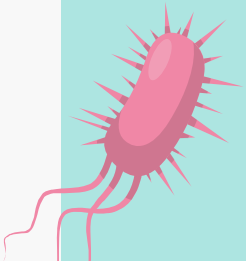
November 20th, 2025

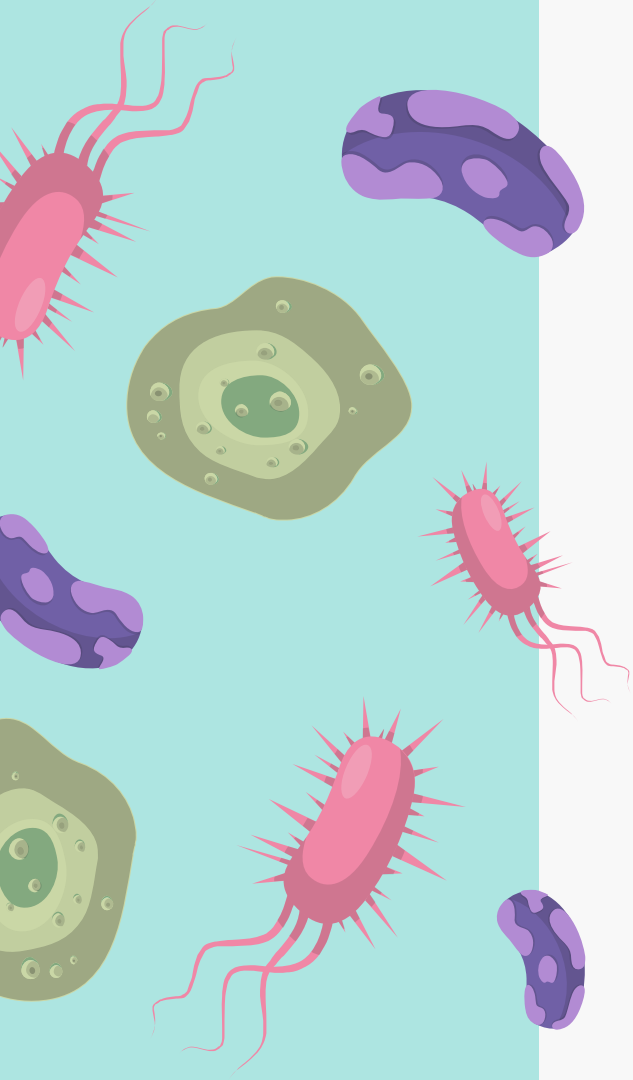
About me

- BA in Biology at Gustavus Adolphus College
- Current MPH student at Saint Catherine University and data analyst trainee
- Experience in state level governmental public health in refugee health programing, rural health equity qualitative research, and clinical patient care.
- Interest in infectious disease and aspirations to be an epidemiologist in global health serving marginalized communities.

Overview







Background

Childhood Vaccine Preventable Diseases and Vaccine Hesitancy

Why vaccines matter?

Immune system

- The body's defense system that fights harmful germs.
- Remembers germs it has seen before by making antibodies.
- These help the body respond faster if the same germ appears again.

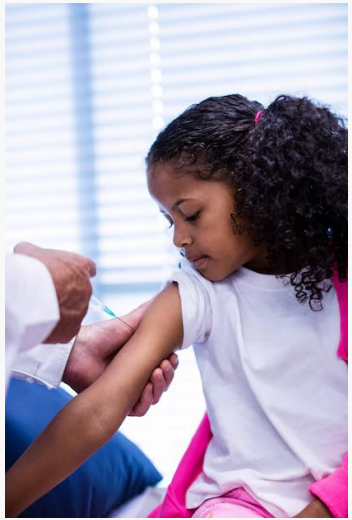
Vaccines

- Contain safe parts of a germ that help the body create antibodies.
- They train and strengthen the immune system so it can quickly recognize and fight the real germ.

References
https://www.cdc.gov/vaccines-children/reasons/index.html

Childhood vaccine preventable diseases (CVPDs)

- Children's developing immune systems put them at risk for serious illnesses
- Some of these illnesses can be prevented with routine childhood vaccines
- Vaccines help protect children by teaching their bodies recognize and fight germs before they cause serious harm



References
https://www.cdc.gov/vaccines-children/reasons/index.html

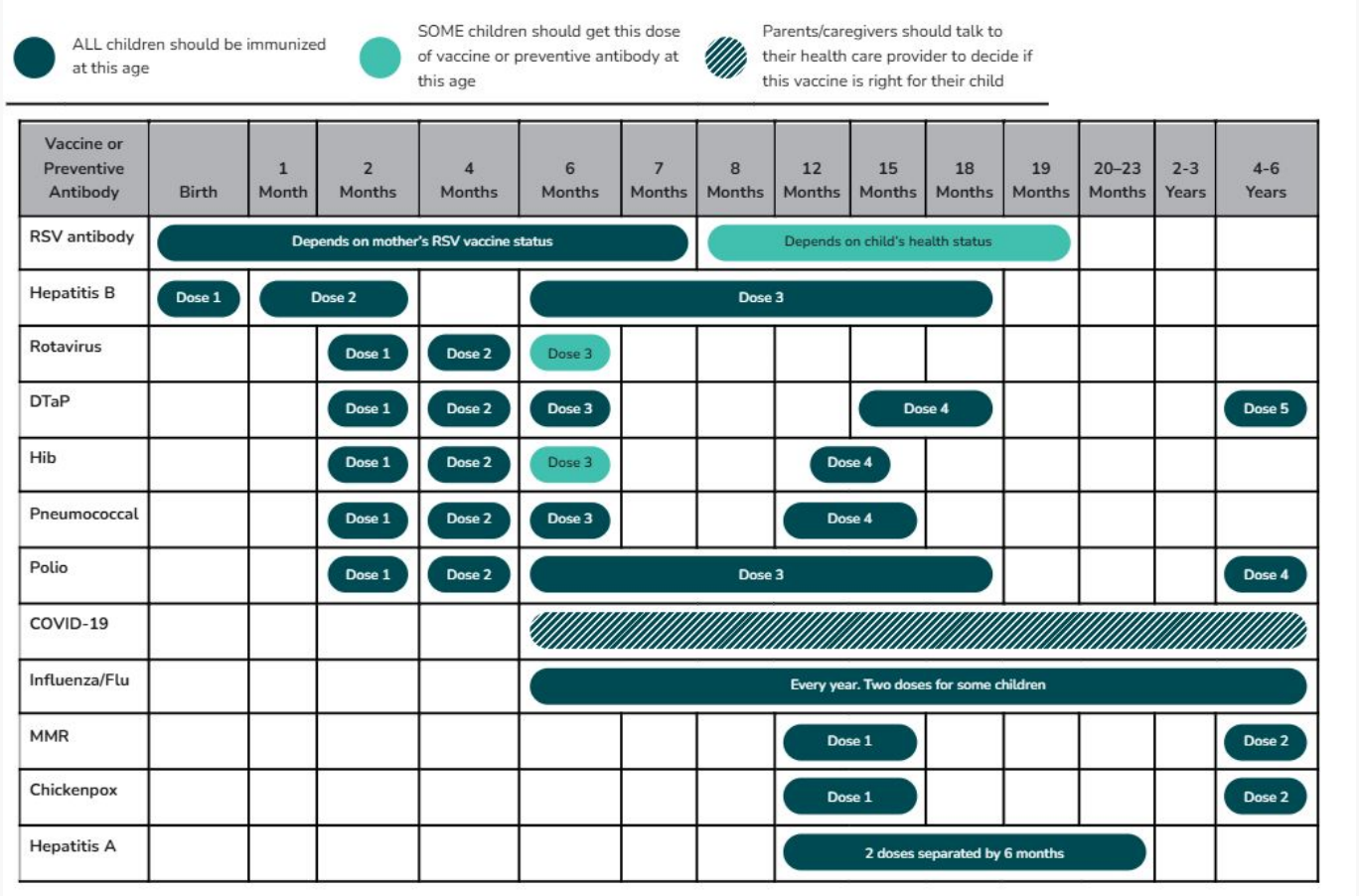
Childhood vaccine preventable diseases (CVPDs)

As of 2025, the CDC recognizes 17 diseases that can be prevented by routine childhood vaccines.

RSV (Respiratory syncytial virus) Contagious viral infection of the nose, throat, and sometimes lungs; spread through air and direct contact	Hib (*Haemophilus influenzae* type b) Contagious bacterial infection of the lungs, brain and spinal cord, or bloodstream; spread through air and direct contact	Measles (Rubeola)† Contagious viral infection that causes high fever, cough, red eyes, runny nose, and rash; spread through air and direct contact
Hepatitis B Contagious viral infection of the liver; spread through contact with infected body fluids such as blood or semen	Pneumococcal Bacterial infections of ears, sinuses, lungs, or bloodstream; spread through direct contact with respiratory droplets like saliva or mucus	Mumps† Contagious viral infection that causes fever, tiredness, swollen cheeks, and tender swollen jaw; spread through air and direct contact
Rotavirus Contagious viral infection of the gut; spread through the mouth from hands and food contaminated with stool	Polio Contagious viral infection of nerves and brain; spread through the mouth from stool on contaminated hands, food or liquid, and by air and direct contact	Rubella (German Measles)† Contagious viral infection that causes low-grade fever, sore throat, and rash; spread through air and direct contact
Diphtheria* Illness caused by a toxin produced by bacteria that infects the nose, throat, and sometimes skin.	COVID-19 Contagious viral infection of the nose, throat, or lungs; may feel like a cold or flu. Spread through air and direct contact	Chickenpox (Varicella) Contagious viral infection that causes fever, headache, and an itchy, blistering rash; spread through air and direct contact
Pertussis (Whooping Cough)* Contagious bacterial infection of the lungs and airway; spread through air and direct contact	Influenza (Flu) Contagious viral infection of the nose, throat, and sometimes lungs; spread through air and direct contact	Hepatitis A Contagious viral infection of the liver; spread by contaminated food or drink or close contact with an infected person
Tetanus (Lockjaw)* Bacterial infection of brain and nerves caused by spores found in soil and dust everywhere; spores enter the body through wounds or broken skin		

Reference: *https://www.cdc.gov/vaccines/imz-schedules/child-easyread.html.*

Table 1. *CDC Recommended Vaccine Schedule: Birth to 6 Years (U.S.)*



***DTaP** protects against tetanus, diphtheria, and pertussis

†MMR protects against measles, mumps, and rubella

Reference: *https://www.cdc.gov/vaccines/imz-schedules/child-easyread.html.*

Vaccine hesitancy in the U.S.

- Vaccine hesitancy has existed for centuries, often due to religious or personal beliefs.
- Growth of internet and social media access → increased exposure to vaccine misinformation → heightened concerns about vaccine safety and, in some cases, distrust in the healthcare system
- These factors contributed to a stronger and more visible anti-vaccine movement, particularly during the 2000s–2020s

REPORT JAN 8, 2025

Childhood Vaccination Has Saved Millions of Lives, but Rising Hesitancy Could Reverse Decades of Progress

Growing vaccine hesitancy, driven by misinformation and disinformation, threatens the health of American children and communities.

AUTHORS

Steven Woolf Jill Rosenthal

Strengthening Health, COVID-19, Health, +3 More

Patients with polio are seen in iron lungs during the 1950s at the Rancho Los Amigos Respiratory

News Source:
https://www.americanprogress.org/article/childhood-vaccination-has-saved-millions-of-lives-but-rising-hesitancy-could-reverse-decades-of-progress/

Reference: *https://www.cdc.gov/vaccines-children/reasons/index.html*

Destabilization of vaccine health infrastructure

RFK Jr. allies declared 'God is an anti-vaxxer' at Texas conference

Story by Brendan Rascius • 1w • 3 min read Summarize

RFK Jr. suggests vaccines linked to peanut allergies. What the science says.

Adrianna Rodriguez
USA TODAY

Nov. 18, 2025, 11:06 a.m. ET

Florida plans to become first state to eliminate all childhood vaccine mandates

By | September 3, 2025

SHOTS - HEALTH NEWS

Under RFK Jr., the CDC is scrutinizing the childhood vaccine schedule

NOVEMBER 7, 2025 · 7:00 AM ET

HEARD ON ALL THINGS CONSIDERED

Rob Stein

4-Minute Listen + PLAYLIST TRANSCRIPT ···

CDC panel to review childhood vaccine schedules

(The Hill) –The vaccine advisory panel for the Centers for Disease Control and Prevention (CDC) is planning to look into the timing of other childhood vaccine schedules, soon after it voted to delay the measles, mumps, rubella and chickenpox vaccine.

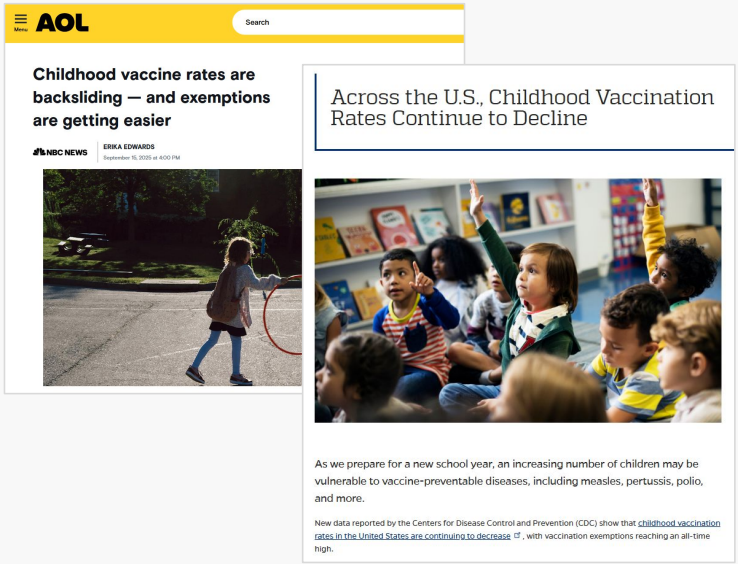
San Angelo couple pleads guilty to child endangerment and death case

The CDC's Advisory Committee on Immunization Practices (ACIP) shared it would be establishing a Childhood and Adolescent Immunization Schedule Workgroup in documents updated on Wednesday.

News Source:
https://www.independent.co.uk/news/world/americas/us-politics/rfk-jr-god-anti-vaxxer-texas-b2862191.html
https://www.npr.org/sections/shots-health-news/2025/11/07/nx-s1-5576321/childhood-vaccine-schedule-rfk-cdc
https://www.usatoday.com/story/life/health-wellness/2025/11/18/rfk-jr-peanut-allergies-vaccines-aluminum/87333853007/
https://wgno.com/news/nmw/cdc-panel-to-review-childhood-vaccine-schedules/
https://www.wptv.com/news/state/floridas-plan-to-eliminate-vaccine-requirements-remains-unclear-nearly-a-month-after-announcement

Decline in U.S. childhood vaccine coverage

- U.S. vaccine rates now lag behind many other high-income countries.
- Vaccines work so well that people often forget the diseases they prevent.
- Vaccines aren't 100% effective, but they greatly reduce illness and spread.
- Lower vaccination makes it easier for germs to spread and cause outbreaks.



References:
https://publichealth.jhu.edu/ivac/2025/across-the-us-childhood-vaccination-rates-continue-to-decline

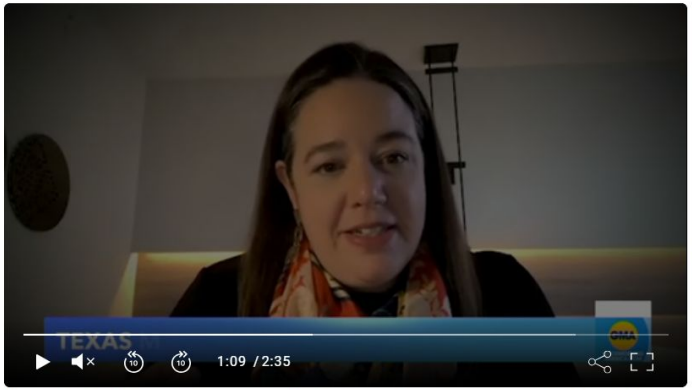
Recent rise of measles in the U.S.

abc NEWS Live Video Shows Shop

Measles death of unvaccinated child in Texas outbreak is 1st fatality in US in a decade

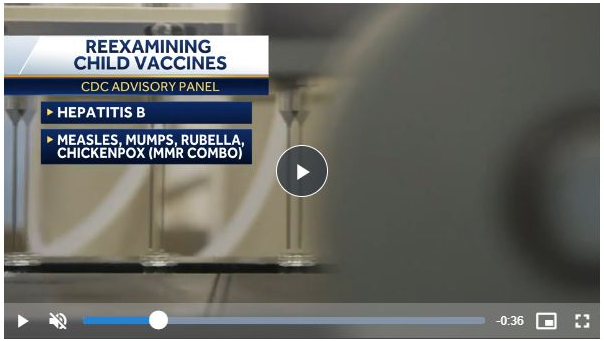
The majority of cases have occurred among unvaccinated people.

By Mary Kekatos
February 26, 2025, 3:30 PM



Unvaccinated child dies of measles amid Texas outbreak An unvaccinated school-aged child in Texas has died of measles in what the CDC says is the first fatality of the disease in the U.S. in a decade.

Measles outbreaks across the US continue to add to record case count



CNN Updated: 6:54 AM CDT Oct 10, 2025 | Editorial Standards

By Deidre McPhillips, CNN

A deadly measles outbreak in Texas ended in August, but outbreaks in other parts of the United States continue to add hundreds of new measles cases to this year's record national total.

There have been an average of 27 new measles cases reported each week since the end of August, according to data from the Centers for Disease Control and Prevention. The annual total – now up to 1,563 cases since January – is the highest by a significant margin since measles was declared eliminated in the US a quarter-century ago.

News Sources
https://abcnews.go.com/Health/1st-measles-death-linked-outbreak-texas-confirmed-child/story?id=119208967
https://www.ketv.com/article/measles-outbreak-us-record-cases-2025/68997567

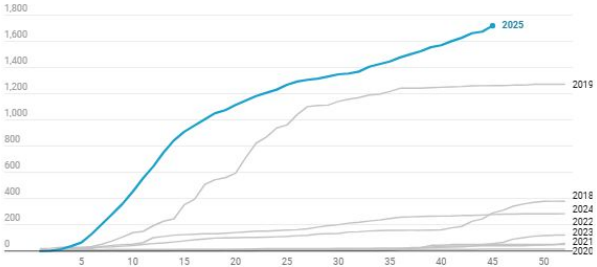
Recent rise of measles in the U.S.

U.S. Measles Cases Hit Highest Level Since Declared Eliminated in 2000

The United States surpassed a milestone in reported measles cases, with 2025 now having the most cases since the disease was declared eliminated in the U.S. in 2000 and the most cases in more than three decades.

As of July 7, 2025, 1,281 cases have been reported, more than the 1,274 measles cases reported in all of 2019, according to a U.S. Measles Tracker hosted by the International Vaccine Access Center (IVAC) at the Johns Hopkins Bloomberg School of Public Health and developed in collaboration with the Center for Systems Science and Engineering (CSSE) at the Whiting School of Engineering.

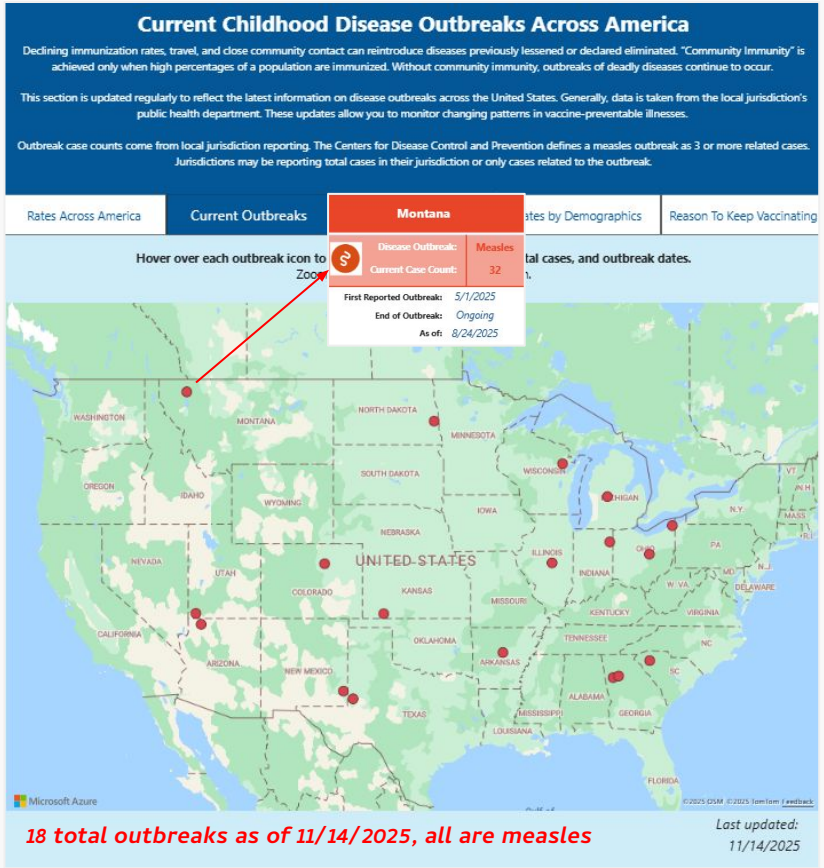
Cumulative measles cases reported in the United States by year



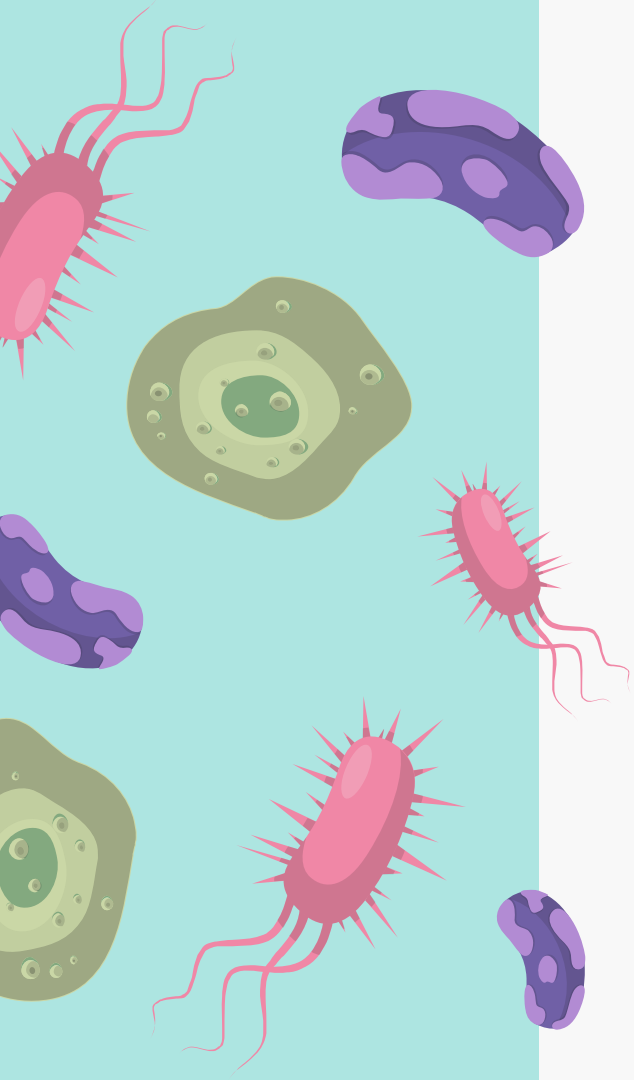
Source: Johns Hopkins University • Get the data • Download image

This interactive dashboard maps the total (in 2025) and recent (in the past two weeks) number of reported measles cases at the county level to provide real-time data. The data are made freely available for use by health officials, researchers, and the public in a **Github repository**.

Reference:
https://publichealth.jhu.edu/ivac/2025/us-measles-cases-hit-highest-level-since-declared-eliminated-in-2000



***Reference**: https://www.aap.org/en/patient-care/immunizations/immunizations-across-america/*

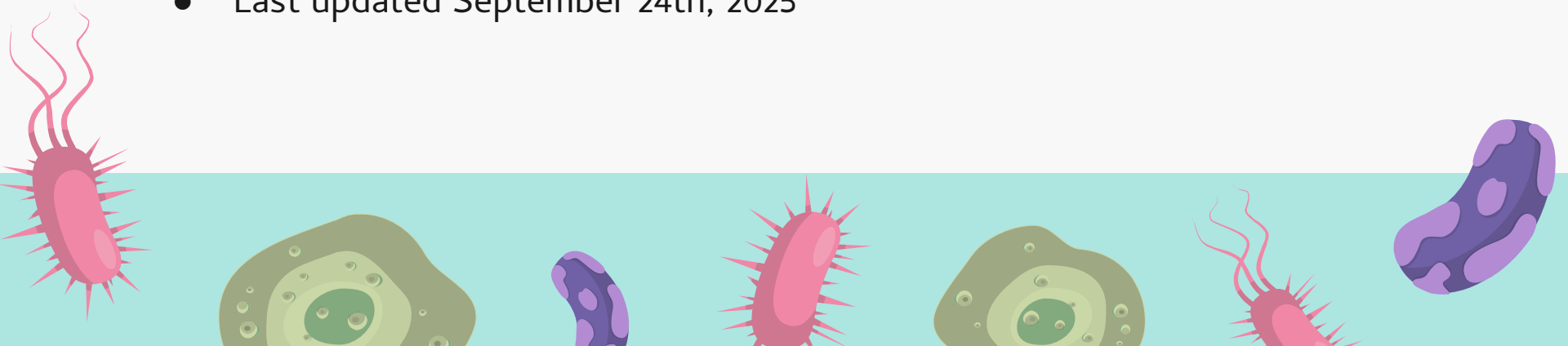


Data Source

CDC National Notifiable Diseases Surveillance System (NNDSS) and US Population Data

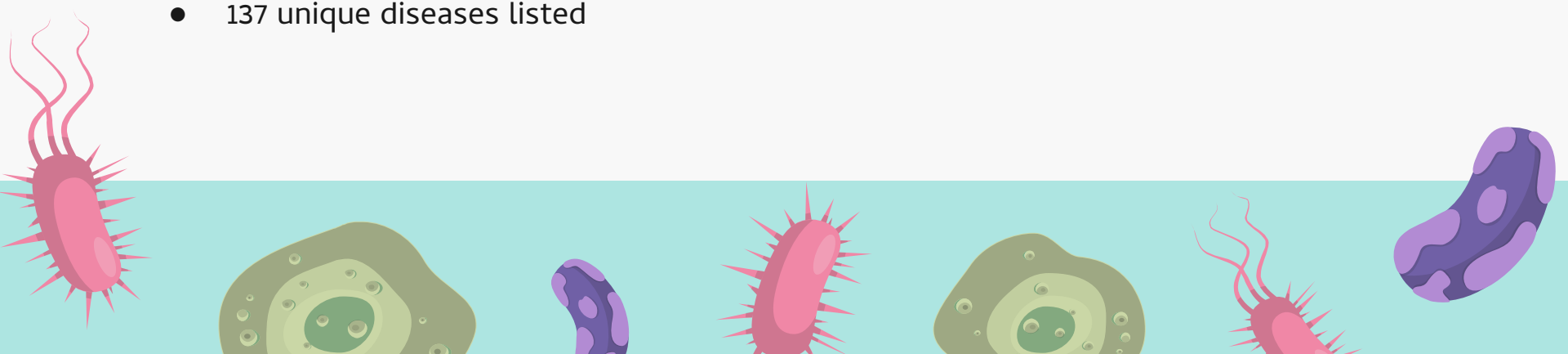
CDC National Notifiable Disease Surveillance System (NNDSS) Dataset

- *“A weekly case dataset of selected infectious national notifiable diseases reported by the all US states, New York City, the District of Columbia, and the U.S. territories.”*
- Cases are voluntarily reported by state health departments to CDC for weekly publication.
- Last updated September 24th, 2025



NNDSS Dataset characteristics

- Reporting dates between 2022 - 2025. ***NOTE: Case counts for reporting years 2024 and 2025 are provisional.***
- *Morbidity and Mortality Weekly Reporting (MMWR)* calendar, 52 total weeks = one fiscal disease reporting year
- Long data format
- 16 total columns
- 1,546,980 total rows
- 137 unique diseases listed



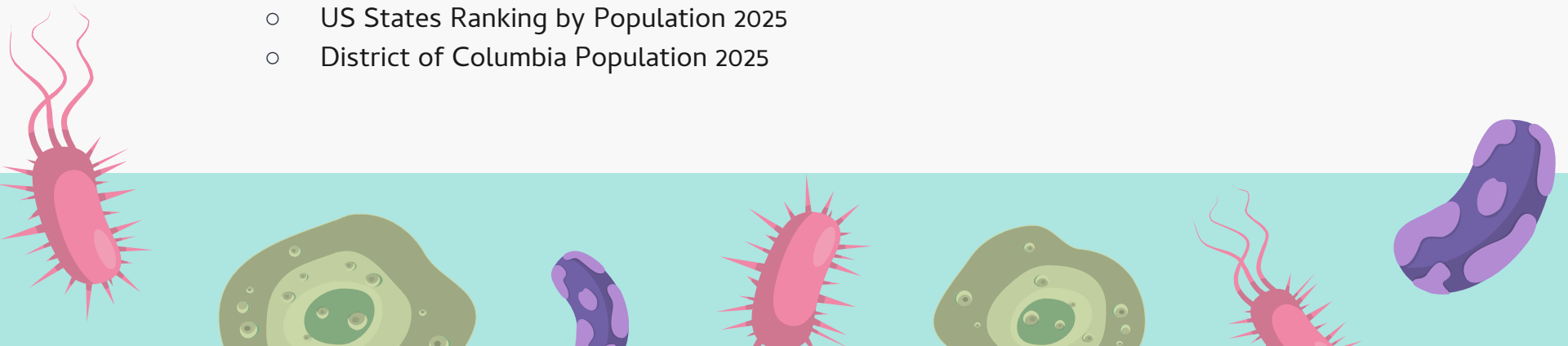
NNDSS Dataset

Reporting	Current MI	MMWR WE	Label	Current we	Current we	Previous 5	Previous 5	Cumulativ	Cumulativ	Cumulativ	Cumulativ	LOCATION1	LOCATION2	sort_order	geocode
US RESIDE	2022	1	Anthrax		-	0	-		-		-		US RESIDENTS	20220100001	
NEW ENGL	2022	1	Anthrax		-	0	-		-		-		NEW ENGLAND	20220100002	
CONNECT	2022	1	Anthrax		-	0	-		-		-	CONNECTICUT		20220100003	POINT (-72.738288 41.575155)
MAINE	2022	1	Anthrax		-	0	-		-		-	MAINE		20220100004	POINT (-69.06137 45.117911)
MASSACH	2022	1	Anthrax		-	0	-		-		-	MASSACHUSETTS		20220100005	POINT (-71.481104 42.151077)
NEW HAMI	2022	1	Anthrax		-	0	-		-		-	NEW HAMPSHIRE		20220100006	POINT (-71.57139 43.680429)
RHODE ISI	2022	1	Anthrax		-	0	-		-		-	RHODE ISLAND		20220100007	POINT (-71.534637 41.572574)
VERMONT	2022	1	Anthrax		-	0	-		-		-	VERMONT		20220100008	POINT (-72.662695 44.075252)
MIDDLE AT	2022	1	Anthrax		-	0	-		-		-		MIDDLE ATLANTI	20220100009	
NEW JERS	2022	1	Anthrax		-	0	-		-		-	NEW JERSEY		20220100010	POINT (-74.655514 40.110253)
NEW YORK	2022	1	Anthrax		-	0	-		-		-	NEW YORK		20220100011	POINT (-75.59655 42.921241)
NEW YORK	2022	1	Anthrax		-	0	-		-		-	NEW YORK CITY		20220100012	
PENNSYLV	2022	1	Anthrax		-	0	-		-		-	PENNSYLVANIA		20220100013	POINT (-77.838886 40.896694)
EAST NOR	2022	1	Anthrax		-	0	-		-		-		EAST NORTH CE	20220100014	
ILLINOIS	2022	1	Anthrax		-	0	-		-		-	ILLINOIS		20220100015	POINT (-89.148632 40.124144)
INDIANA	2022	1	Anthrax		-	0	-		-		-	INDIANA		20220100016	POINT (-86.2818 39.919991)
MICHIGAN	2022	1	Anthrax		-	0	-		-		-	MICHIGAN		20220100017	POINT (-85.730977 44.874798)
OHIO	2022	1	Anthrax		-	0	-		-		-	OHIO		20220100018	POINT (-82.70936 40.415534)
WISCONSI	2022	1	Anthrax		-	0	-		-		-	WISCONSIN		20220100019	POINT (-89.732969 44.639954)
WEST NOR	2022	1	Anthrax		-	0	-		-		-		WEST NORTH CE	20220100020	
IOWA	2022	1	Anthrax		-	0	-		-		-	IOWA		20220100021	POINT (-93.500061 42.074659)
KANSAS	2022	1	Anthrax		-	0	-		-		-	KANSAS		20220100022	POINT (-98.38018 38.484729)
MINNESOT	2022	1	Anthrax		-	0	-		-		-	MINNESOTA		20220100023	POINT (-94.198308 46.349153)
MISSOURI	2022	1	Anthrax		-	0	-		-		-	MISSOURI		20220100024	POINT (-92.477244 38.3675)

U.S. Population Datasets

Created a state and national U.S. population dataset between 2022-2025, includes data from

- **U.S. Census Bureau**
  - *Annual Population Estimates, Estimated Components of Resident Population Change, and Rates of the Components of Resident Population Change for the United States, States, District of Columbia, and Puerto Rico: April 1, 2020 to July 1, 2024 (NST-EST2024-ALLDATA)*
  - U.S. and World Population Clock, for a 2025 National US population data point
- **World Population Review**
  - US States Ranking by Population 2025
  - District of Columbia Population 2025

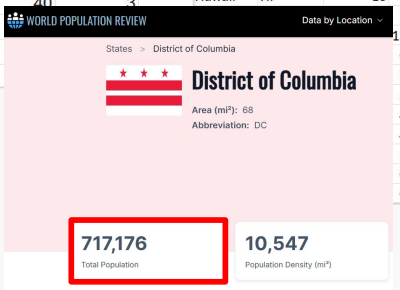


U.S. Population by State Dataset

U.S. Census Bureau, NST-EST2024-ALLDATA

SUMLEV	REGION	DIVISION	STATE	NAME	ESTIMATES	POPESTIM	POPESTIN	POPESTIM	POPESTIM	POPESTIM
10	0	0	0	United Sta	3.32E+08	3.32E+08	3.32E+08	3.34E+08	3.37E+08	3.4E+08
20	1	0	0	Northeast	57617706	57431458	57252533	57159597	57398303	57832935
30	1	1	0	New Engla	15122011	15057350	15118145	15175633	15263573	15386085
30	1	2	0	Middle Atl	42495695	42374108	42134388	41983964	42134730	42446850
20	2	0	0	Midwest R	68998970	68984258	68872831	68903297	69186401	69596584
30	2	3	0	East North	47381362	47358568	47206851	47199092	47360185	47619171
30	2	4	0	West Nort	21617608	21625690	21665980	21704205	21826216	21977413
20	3	0	0	South Regi	1.26E+08	1.26E+08	1.27E+08	1.29E+08	1.31E+08	1.33E+08
30	3									
30	3									
30	3									
20	4									
30	4									
30	4									
40	3									
40	4									
40	4									
40	3									

state	code	fips	pop2020	pop2024	pop2025	population	growthRat	growthRat	densityMi	rank	percent
Alabama	AL	1	5033090	5157700	5197720	5197720	0.00776	0.00654	102.6305	24	0.015167
Alaska	AK	2	733017	740133	743756	743756	0.0049	0.00293	1.30337	48	0.00217
Arizona	AZ	4	7187140	7582380	7691740	7691740	0.01442	0.01404	67.71256	14	0.022445
Arkansas	AR	5	3014550	3088350	3107240	3107240	0.00612	0.00615	59.71442	33	0.009067
California	CA	6	39522000	39431300	39663800	39663800	0.0059	0.00072	254.6158	1	0.11574
Colorado	CO	8	5787130	5957490	6013650	6013650	0.00943	0.00783	58.02329	20	0.017548
Connectic	CT	9	3579920	3675070	3707120	3707120	0.00872	0.00711	765.6175	29	0.010817
Delaware	DE	10	991928	1051920	1067410	1067410	0.01473	0.01522	547.6706	45	0.003115
Florida	FL	12	21592000	23372200	23839600	23839600	0.02	0.02082	444.5613	3	0.069564
Georgia	GA	13	10732900	11180900	11297300	11297300	0.01041	0.01052	196.4304	8	0.032966
Hawaii	HI	15	1451250	1446150	1450900	1450900	0.00328	-0.00005	225.8913	40	0.004234
			1849420	2001620	2032120	2032120	0.01524	0.01976	24.58914	37	0.00593
			12799100	12710200	12778100	12778100	0.00534	-0.00033	230.1572	6	0.037287
			6790500	6924280	6968420	6968420	0.00637	0.00524	194.5073	17	0.020334
			3191140	3241490	3264560	3264560	0.00712	0.0046	58.44496	32	0.009526
			2938170	2970610	2989710	2989710	0.00643	0.00351	36.56735	34	0.008724
			4508320	4588370	4626150	4626150	0.00823	0.00523	117.1593	25	0.013499
			4652300	4597740	4607410	4607410	0.0021	-0.00193	106.6431	26	0.013444
			1364570	1405010	1410380	1410380	0.00382	0.00671	45.72772	42	0.004116
			6177940	6263220	6309380	6309380	0.00737	0.00426	649.9825	18	0.018411
			6994600	7136170	7205770	7205770	0.00975	0.00604	923.8167	16	0.021027



World Review Population, District of Columbia Population 2025

Worlds Review Population, U.S. States Ranking by Population 2025

U.S. State Population Dataset

Reporting Area	Current MMWR Year	Population
Alabama	2022	5076181
Alaska	2022	734442
Arizona	2022	7377566
Arkansas	2022	3047704
California	2022	39142414
Colorado	2022	5850935
Connecticut	2022	3617925
Delaware	2022	1020625
District of Columbia	2022	676725
Florida	2022	22379312
Georgia	2022	10931805
Hawaii	2022	1440359
Idaho	2022	1944299
Illinois	2022	12621821
Indiana	2022	6844545
Iowa	2022	3202820
Kansas	2022	2937324
Kentucky	2022	4519233
Louisiana	2022	4593687
Maine	2022	1390922
Maryland	2022	6192440

**2025 U.S. population estimates are provisional and reflects data as of Nov. 17, 2025.*

Dataset characteristics:

Year 2022-2025, long data format, 3 columns total, and 205 total rows

National U.S. Population Dataset

U.S. Census Bureau, NST-EST2024-ALLDATA

SUMLEV	REGION	DIVISION	STATE	NAME	ESTIMATES	POPESTIM	POPESTIM	POPESTIM	POPESTIM	POPESTIM
10	0	0	0	United Sta	3.32E+08	3.32E+08	3.32E+08	3.34E+08	3.37E+08	3.4E+08
20	1	0	0	Northeast	57617706	57431458	57252533	57159597	57398303	57832935
30	1	1	0	New Engla	15122011	15057350	15118145	15175633	15263573	15386085
30	1	2	0	Middle Atl	42495695	42374108	42134388	41983964	42134730	42446850
20	2	0	0	Midwest R	68998970	68984258	68872831	68903297	69186401	69596584
30	2	3	0	East North	47381362	47358568	47206851	47199092	47360185	47619171
30	2	4	0	West Nort	21617608	21625690	21665980	21704205	21826216	21977413
20	3	0	0	South Regi	1.26E+08	1.26E+08	1.27E+08	1.29E+08	1.31E+08	1.33E+08
30	3	5	0	South Atla	66097951	66176865	66680852	67657171	68684308	69676509
30										
30										
20										
30										
30										
40										
40										
40										
40										
40										
40										
40										

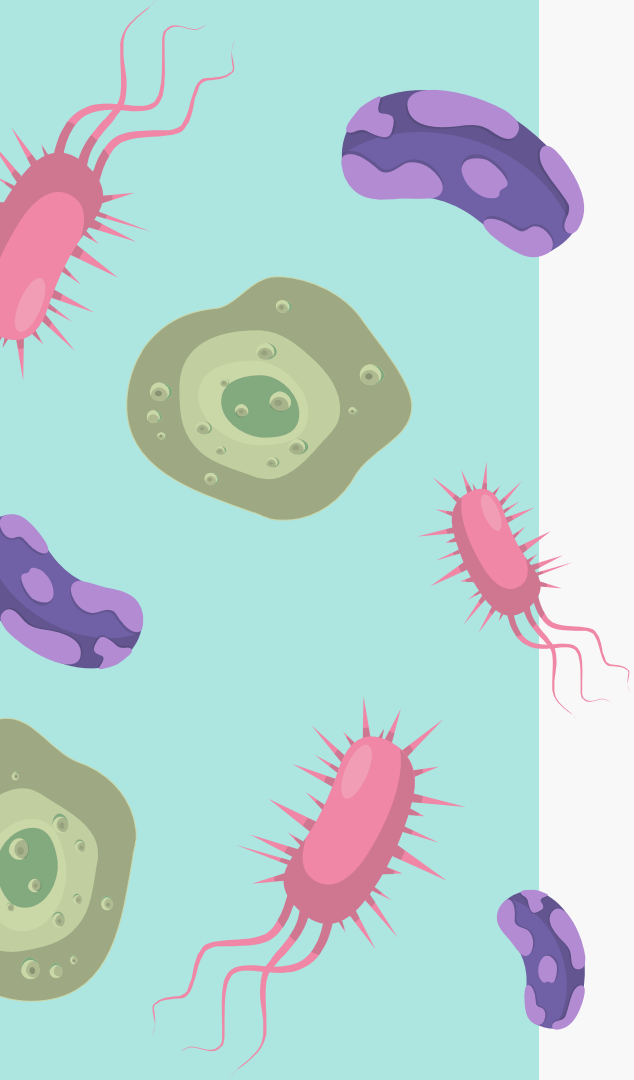
U.S Census Bureau, US. and World Population Clock

National U.S. Population Dataset

```
uspopulation <- data.frame(
  `Reporting Area` = c("US Residents",
                       "US Residents",
                       "US Residents",
                       "US Residents"),
  `Current MMWR Year` = c(2022, 2023, 2024, 2025),
  Population = c(334017321, 336806231, 340110988, 347956170)
)
```

	Reporting Area	Current MMWR Year	Population
1	US Residents	2022	334017321
2	US Residents	2023	336806231
3	US Residents	2024	340110988
4	US Residents	2025	347956170

**2025 U.S. population estimates are provisional and reflects data as of Nov. 17, 2025.*



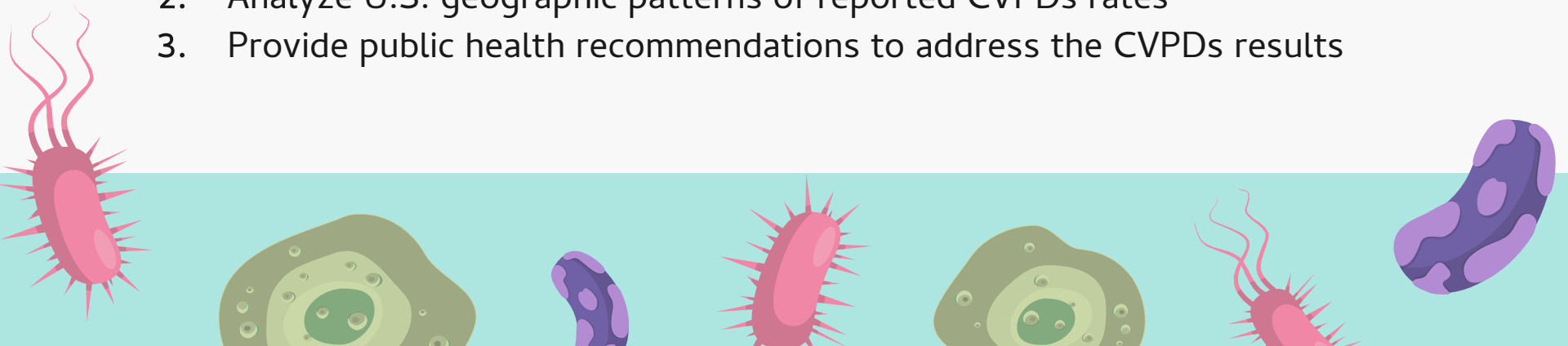
Objectives and Goals

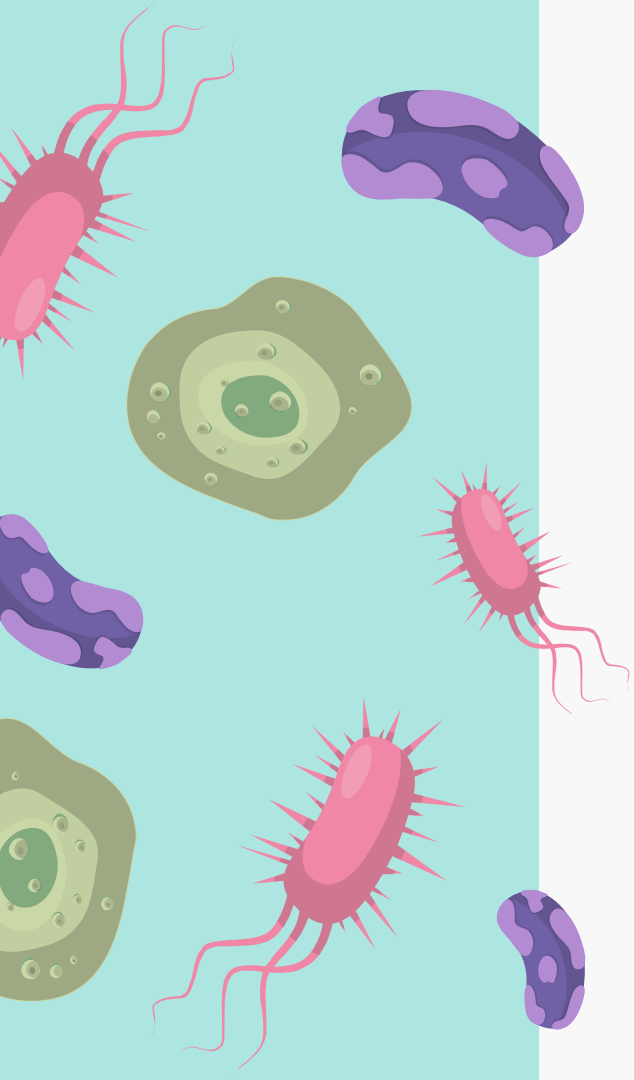
Objective and goals

Objective: To determine whether there has been an increase in CVPD cases in the U.S. from 2022–2025, in relation to the rise of vaccine hesitancy.

Goals:

1. Describe temporal trends in reported CVPDs cases and disease incident rates in the U.S.
2. Analyze U.S. geographic patterns of reported CVPDs rates
3. Provide public health recommendations to address the CVPDs results





Data cleaning and manipulation

R-studio

Data cleaning and manipulation

1. Installing R Packages & Importing Datasets

```r
#Installing R packages
library(tidyverse)
library(dplyr)
library(janitor)
library(stringr)
```

```r
#Importing Datasets
##CDC Disease Reporting
rawdata_disease_reports <- read_csv(
  "C:\\Users\\kaths\\Downloads\\NNDSS_Weekly_Data_20251030.csv")

disease_reports <- read_csv(
  "C:\\Users\\kaths\\Downloads\\NNDSS_Weekly_Data_20251030.csv")
head(disease_reports) #Short summary of the data

##U.S. State Populations
statepopulation <- read_csv(
  "C:\\Users\\kaths\\Downloads\\population_dataset.csv") #Raw dat
head(uspopulation) #Short summary of the data
```

```r
##Creating a National US Population data frame
uspopulation <- data.frame(
  `Reporting Area` = c("US Residents",
                       "US Residents",
                       "US Residents",
                       "US Residents"),
  `Current MMWR Year` = c(2022, 2023, 2024, 2025),
  Population = c(334017321, 336806231, 340110988, 347956170)
)
```

2. Understanding the NNDSS Dataset

```
> glimpse(rawdata_disease_reports)
Rows: 1,547,980
Columns: 16
$ `Reporting Area`                      <chr> "US RESIDENTS", "NEW ENGLAN…
$ `Current MMWR Year`                   <dbl> 2022, 2022, 2022, 2022, 202…
$ `MMWR WEEK`                           <dbl> 1, 1, 1, 1, 1, 1, 1, 1, 1, …
$ Label                                 <chr> "Anthrax", "Anthrax", "Anth…
$ `Current week`                        <dbl> NA, NA, NA, NA, NA, NA, NA,…
$ `Current week, flag`                  <chr> "-", "-", "-", "-", "-", "-…
$ `Previous 52 week Max`                <dbl> 0, 0, 0, 0, 0, 0, 0, 0, 0, …
$ `Previous 52 weeks Max, flag`         <chr> "-", "-", "-", "-", "-", "-…
$ `Cumulative YTD Current MMWR Year`    <dbl> NA, NA, NA, NA, NA, NA, NA,…
$ `Cumulative YTD Current MMWR Year, flag` <chr> "-", "-", "-", "-", "-", "-…
$ `Cumulative YTD Previous MMWR Year`   <dbl> NA, NA, NA, NA, NA, NA, NA,…
$ `Cumulative YTD Previous MMWR Year, flag` <chr> "-", "-", "-", "-", "-", "-…
$ LOCATION1                             <chr> NA, NA, "CONNECTICUT", "MAI…
$ LOCATION2                             <chr> "US RESIDENTS", "NEW ENGLAN…
$ sort_order                            <dbl> 20220100001, 20220100002, 2…
$ geocode                               <chr> NA, NA, "POINT (-72.738288 …
```

Identifying unique values in each column, especially qualitative values

```r
##Disease list
rawdata_diseaseslist <- sort(unique(rawdata_disease_reports$Label))
length(rawdata_diseaseslist) #Total count of all unique reported di
```

```r
##Temporal lists
year <- sort(unique(disease_reports$`Current MMWR Year`)) #List
week <- sort(unique(disease_reports$`MMWR WEEK`)) #List of all
```

```r
##Reporting location list
raw_reportlocations <- sort(unique(rawdata_disease_reports$`Reporting Area`)
```

Data cleaning and manipulation

3. Combine all CVPDs into one group

80	Meningococcal disease, All serogroups
81	Meningococcal disease, Other serogroups
82	Meningococcal disease, Serogroup B
83	Meningococcal disease, Serogroups ACWY
84	Meningococcal disease, Unknown serogroup
85	Mpox
86	Mumps
87	Novel Influenza A virus infections
88	Novel Influenza A virus infections, Confirmed
89	Novel Influenza A virus infections, Probable
90	Novel Influenza A virus infections, Total
91	Pertussis
92	Plague
93	Poliomyelitis, paralytic
94	Poliovirus infection, nonparalytic
95	Psittacosis

**Identify all CVPDs from 137 diseases list,*
***Some diseases multiple labels that specify the age range individuals infected, disease severity (acute or chronic), disease variants, etc.*

```
###Subgrouping diseases together; NOTE: Some disease listed are distinct b
hepatitisB <- c("Hepatitis B, acute, Confirmed",
                "Hepatitis B, acute, Probable",
                "Hepatitis B, chronic, Confirmed",
                "Hepatitis B, chronic, Probable",
                "Hepatitis B, perinatal infection",
                "Hepatitis B, perinatal, Confirmed") #Group all Hepatitis

measles <- c("Measles, Imported",
             "Measles, Indigenous") #Group all measles

pneumococcal <- c("Invasive pneumococcal disease, all ages, Confirmed",
                  "Invasive pneumococcal disease, all ages, Probable") #Gr

polio <- c("Poliomyelitis, paralytic",
           "Poliovirus infection, nonparalytic") #Group all polio cases

rubella <- c("Rubella",
             "Rubella, congenital syndrome") #Group all rubellas

varicella <- c("Varicella disease",
               "Varicella morbidity") #Group all v

influenza <- c("Haemophilus influenzae, invasive d
               "Influenza-associated pediatric mor
```

7 total disease subgroups created

```
###Group all the Childhood Vaccine Preventable Disease (C
CVPD_list <- c(hepatitisB,
               measles,
               pneumococcal,
               polio,
               rubella,
               varicella,
               influenza,
               "Hepatitis A, Confirmed",
               "Meningococcal disease, All serogroups",
               "Mumps",
               "Pertussis")
```

**Finalised 22 total CVPDs*

Data cleaning and manipulation

4. Group all U.S states from the reporting area column

	x
1	Alabama
2	ALABAMA
3	Alaska
4	ALASKA
5	American Samoa
6	AMERICAN SAMOA
7	Arizona
8	ARIZONA
9	Arkansas
10	ARKANSAS
11	California
12	CALIFORNIA
117	U.S. Residents
118	U.S. Territories
119	U.S. Virgin Islands
120	U.S. VIRGIN ISLANDS
121	US RESIDENTS
122	US TERRITORIES

```
disease_reports <- disease_reports %>%    #Standardizing va
  mutate(`Reporting Area` = `Reporting Area` %>%
           str_trim() %>%
           str_replace_all("(?i)u\\.?\\s*s\\.?", "US") %>%
           str_to_title() %>%
           str_replace_all("\\bUs\\b", "US"))  #Fix title-ca
```

	x
1	Alabama
2	Alaska
3	Arizona
4	Arkansas
5	California
6	Colorado
7	Connecticut
8	Delaware
9	Florida
10	Georgia
11	Hawaii
12	Idaho

ving 1 to 12 of 51 entries,

```
US_states <- c(state.name, "District Of Columbia")
```

All U.S states & District of Columbia List

	x
1	Alabama
2	Alaska
3	American Samoa
4	Arizona
5	Arkansas
6	California
7	Colorado
8	Commonwealth Of Northern Mariana Islands
9	Connecticut
10	Delaware
11	District Of Columbia

Condensed to 71 locations

Data cleaning and manipulation

5. Create national and state U.S. CPVDs tables

```
#Filtering and sorting
disease_reports <- disease_reports %>% #Filter
  select(`Reporting Area`,
         `Current MMWR Year`,
         `MMWR WEEK`,
         `Yearly Quarter`,
         `Season`,
         `Label`,
         `Current week`,
         `Cumulative YTD Current MMWR Year`,
         `sort_order`)
```

```
##ONLY US States and CVPDs
CVPD_data <- disease_reports %>%
  filter(`Reporting Area` %in% US_states,
         `Label` %in% CVPD_list,
         `MMWR WEEK` == 52)
```

```
##National US cases
CVPD_USresident <- disease_reports %>% #Filter
  filter(`Reporting Area` == "US Residents",
         `Label` %in% CVPD_list,
         `MMWR WEEK` == 52)
```

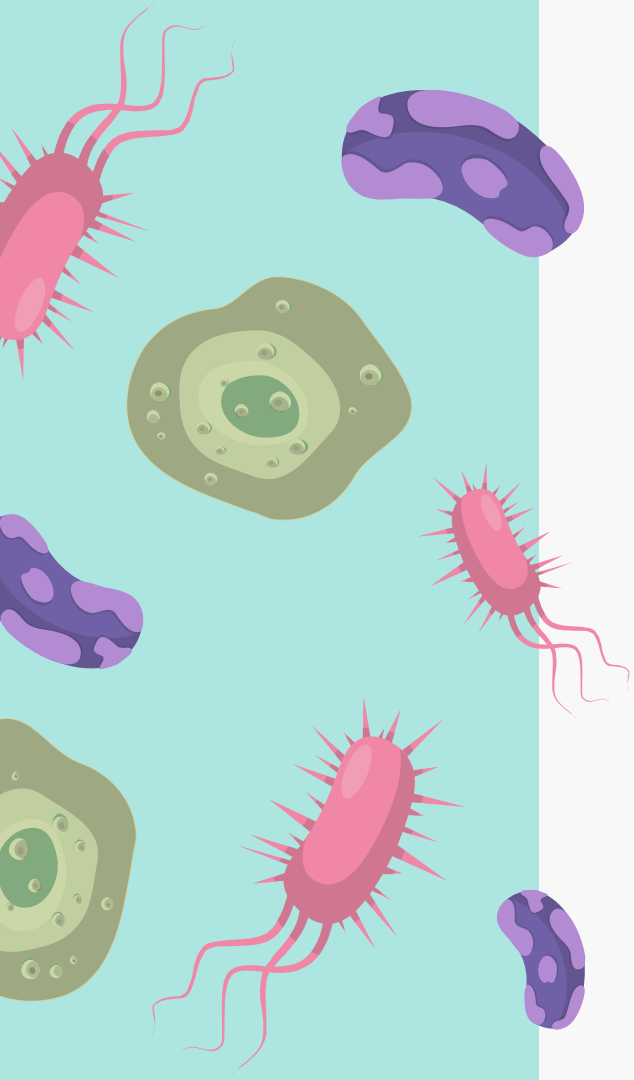
6. Adding disease category to U.S. CPVDs tables

```
CVPD_data <- CVPD_data %>% #Add disease category column
  mutate(
    Disease_Category = case_when(
      Label %in% hepatitisB ~ "Hepatitis B",
      Label %in% measles ~ "Measles",
      Label %in% pneumococcal ~ "Pneumococcal",
      Label %in% polio ~ "Polio",
      Label %in% rubella ~ "Rubella",
      Label %in% varicella ~ "Varicella",
      Label %in% influenza ~ "Influenza",
      Label == "Mumps" ~ "Mumps",
      Label == "Pertussis" ~ "Pertussis",
      Label == "Hepatitis A, Confirmed" ~ "Hepatitis A",
      Label == "Meningococcal disease, All serogroups" ~ "Meningococcal"))
```

Data cleaning and manipulation

7. Calculating national and state disease incident rates

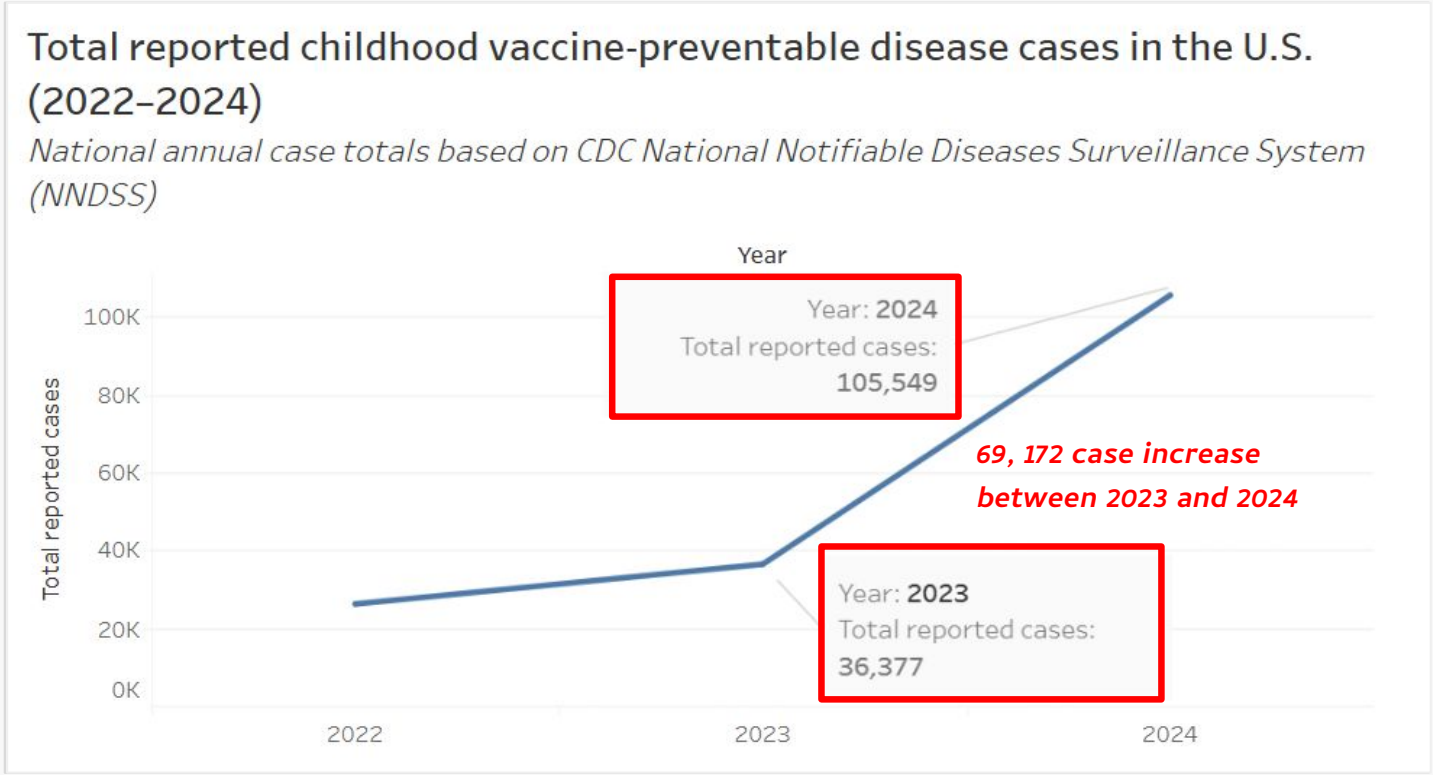
```
##State Disease Incidents Prevalence
CVPD_staterates <- CVPD_data %>% #Sum all total cases by Disease Category
  group_by(`Reporting Area`,`Current MMWR Year`, Disease_Category) %>%
  summarise(total_cases = sum(`Cumulative YTD Current MMWR Year`, na.rm =
  ungroup()

CVPD_staterates <- CVPD_staterates %>% #Merge in the U.S. population by St
  left_join(
   statepopulation,by = c("Reporting Area",
      "Current MMWR Year"))

CVPD_staterates <- CVPD_staterates %>%
  mutate(incidence_rate = (total_cases / Population) * 100000) #Calculatio

CVPD_staterates <- CVPD_staterates %>%
  mutate(incidence_rate = round(incidence_rate, 2)) #Round the state incid
```



Data Analysis

R-studio and Tableau

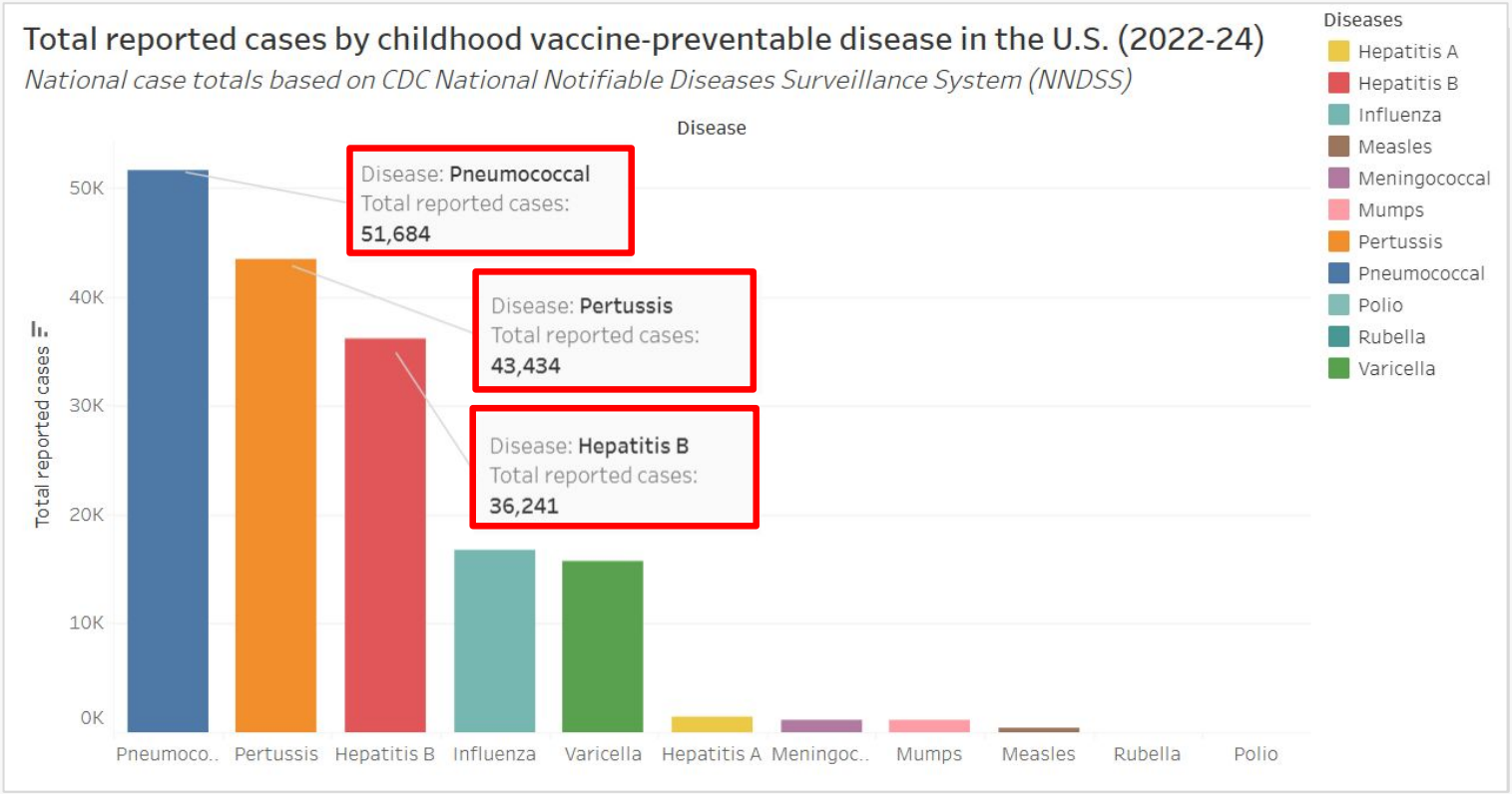
What are the total number of reported CVPD cases by year in the U.S.?



*2024 data are provisional and subjected to change

168,086 total reported cases

What CVPDs make up most of the cases in the U.S.?



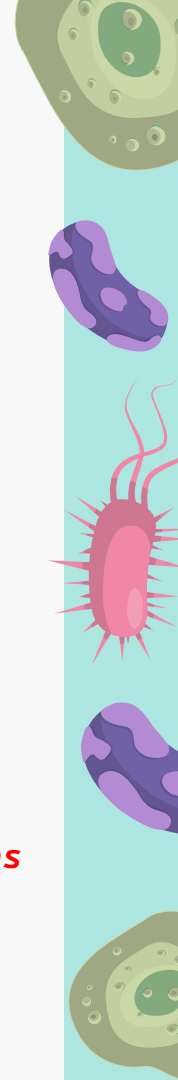
**2024 data are provisional and subjected to change*

168,086 total reported cases

Total case counts can be misleading

- Populations size differences across states and years.
- Case counts do not measure risk or how common a disease is.
- Reporting varies by disease and U.S. state.
- Higher case totals can reflect better reporting, not higher disease burden
- Diseases have different characteristics and baseline levels
    - Some diseases naturally produce high (e.g., varicella) or low (e.g., measles, meningococcal) case numbers.
    - Case totals alone can make severe but rare diseases look unimportant.
- Outbreaks distort totals. Sudden spikes can inflate raw counts.

Use disease incidence rates (new cases per 100,000 people) to standardize disease comparisons

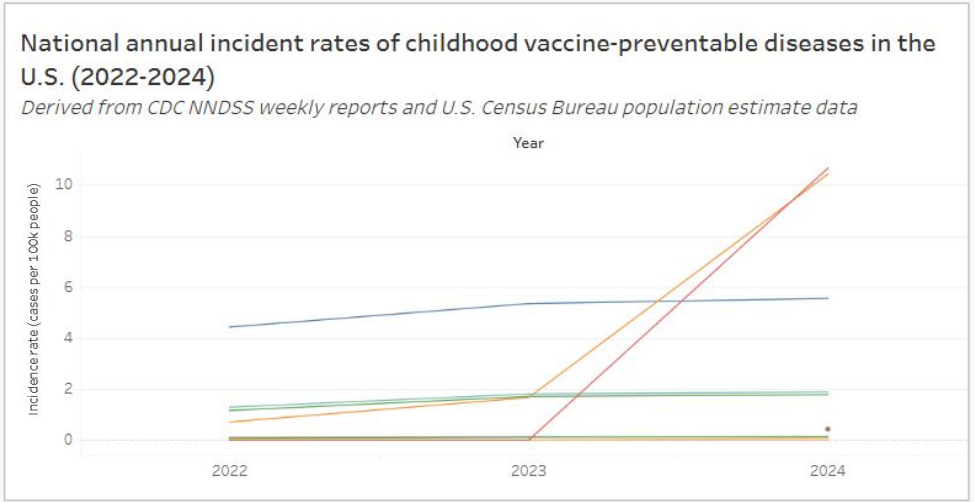


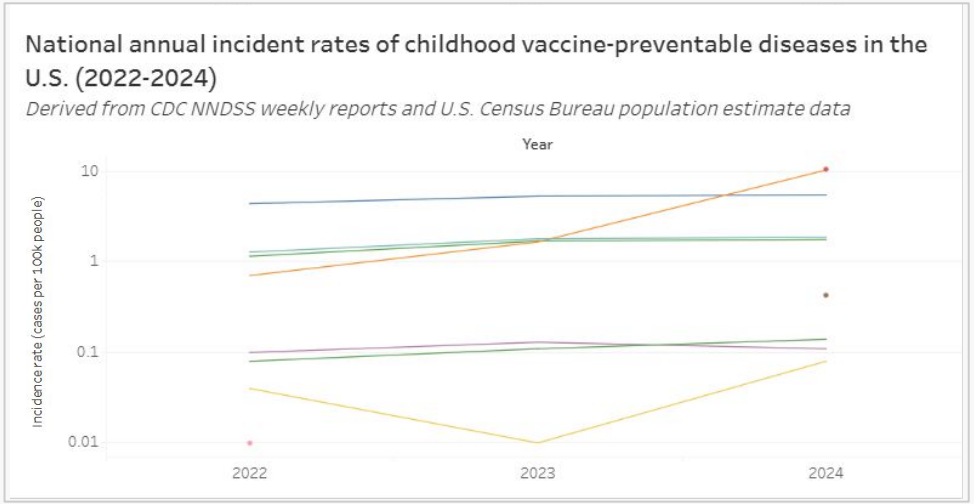
What is the annual incidence rate of each CPVDs in the U.S.?

- **Top visual:** Clustered and **ONLY** displays incident rates **> 1 case per 100k people**
- **Bottom visual:** Adjusted y-axis to logarithmic values to displays incident rates **< 1 case per 100k people**

	Disease_Category	2022	2023	2024
2	Hepatitis B	0.00	0.00	10.65
7	Pertussis	0.71	1.67	10.42
8	Pneumococcal	4.43	5.35	5.55
3	Influenza	1.29	1.81	1.88
11	Varicella	1.16	1.71	1.78
1	Hepatitis A	*NA*	*NA*	0.43
5	Meningococcal	0.08	0.11	0.14
6	Mumps	0.10	0.13	0.11
4	Measles	0.04	0.01	0.08
9	Polio	0.00	0.00	0.00
10	Rubella	0.01	0.00	0.00

Table 3. *National annual incident rates of childhood vaccine-preventable diseases in the U.S. (2022-2024)*





****2024 data are provisional and subjected to change***

What is the annual incidence rate of each CPVDs in the U.S.?

Notable Outliers: ***Single points for Hepatitis A (2024) and Rubella (2022)***

Compared to other national databases:

- Hepatitis A (2024) rate is typically lower than expected.
- Rubella rate aligns with the normal expected disease incidence.

There are under-reporting in cases and very low disease incidence can appear as zero when rates are rounded.

	Disease_Category	2022	2023	2024
2	Hepatitis B	0.00	0.00	10.65
7	Pertussis	0.71	1.67	10.42
8	Pneumococcal	4.43	5.35	5.55
3	Influenza	1.29	1.81	1.88
11	Varicella	1.16	1.71	1.78
1	Hepatitis A	*NA*	*NA*	0.43
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4	Measles	0.04	0.01	0.08
9	Polio	0.00	0.00	0.00
10	Rubella	0.01	0.00	0.00

Table 3. *National annual incident rates of childhood vaccine-preventable diseases in the U.S. (2022-2024)*

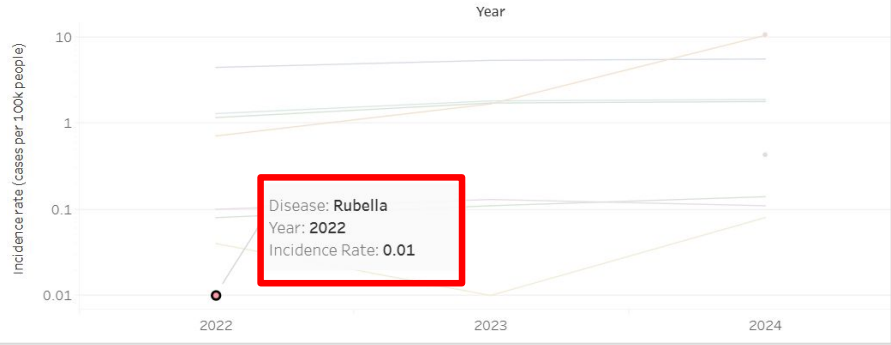
References
https://www.cdc.gov/hepatitis-surveillance-2023/hepatitis-a/table-1-1.html
https://www.cdc.gov/hepatitis-surveillance-2023/about/index.html
https://ourworldindata.org/grapher/rubella-cases-in-the-united-states

National annual incident rates of childhood vaccine-preventable diseases in the U.S. (2022-2024)

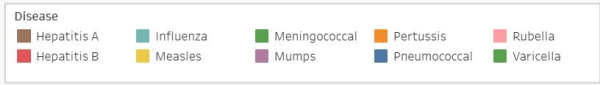
Derived from CDC NNDSS weekly reports and U.S. Census Bureau population estimate data

National annual incident rates of childhood vaccine-preventable diseases in the U.S. (2022-2024)

Derived from CDC NNDSS weekly reports and U.S. Census Bureau population estimate data



****2024 data are provisional and subjected to change***



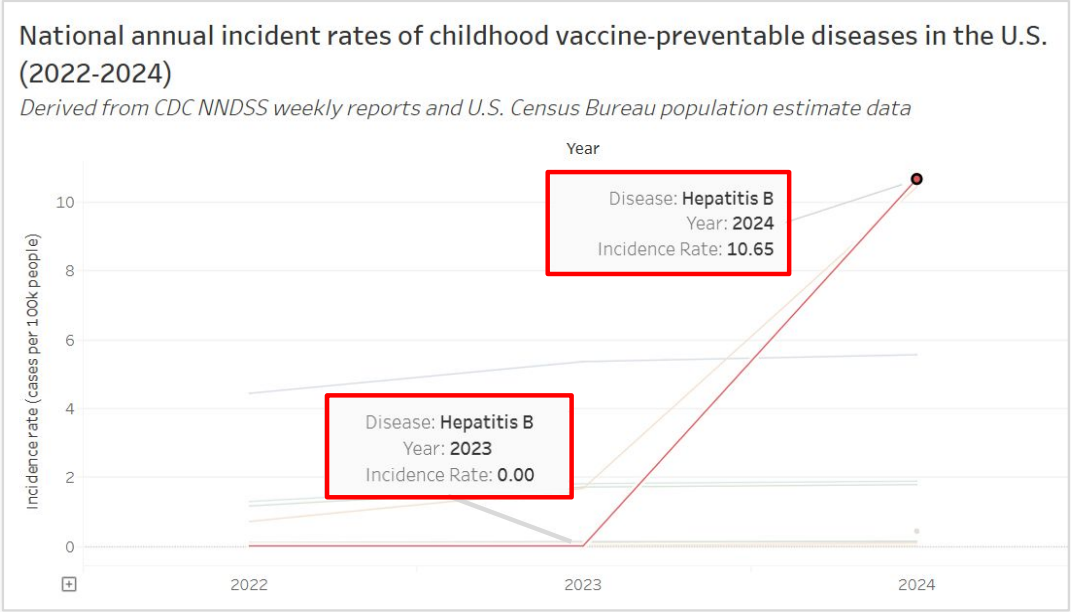
What is the annual incidence rate of each CPVDs in the U.S.?

Notable Outliers: ***Hepatitis B rate significantly increased between 2023 and 2024*** *(NOTE: Hepatitis B rate includes both acute and chronic conditions).*

- Reporting numbers are low and inconsistent in comparison to other national databases. Overall baseline rate is expected for the disease.
- There is an under-reporting in cases and very low disease incidence can appear as zero when rates are rounded.

	Disease_Category	2022	2023	2024
2	Hepatitis B	0.00	0.00	10.65
7	Pertussis	0.71	1.67	10.42
8	Pneumococcal	4.43	5.35	5.55
3	Influenza	1.29	1.81	1.88
11	Varicella	1.16	1.71	1.78
1	Hepatitis A	*NA*	*NA*	0.43
5	Meningococcal	0.08	0.11	0.14
6	Mumps	0.10	0.13	0.11
4	Measles	0.04	0.01	0.08
9	Polio	0.00	0.00	0.00
10	Rubella	0.01	0.00	0.00

Table 3. *National annual incident rates of childhood vaccine-preventable diseases in the U.S. (2022-2024)*



2024 data are provisional and subjected to change

References

https://www.cdc.gov/hepatitis-surveillance-2023/about/index.html
https://www.cdc.gov/hepatitis-surveillance-2023/hepatitis-b/index.html

What is the annual incidence rate of each CPVDs in the U.S.?

Significant increase in pertussis between 2023 and 2024.

- Above the expected baseline rate for the disease
- Reporting numbers are mostly consistent with other national databases

	Disease_Category	2022	2023	2024
2	Hepatitis B	0.00	0.00	10.65
7	Pertussis	0.71	1.67	10.42
8	Pneumococcal	4.43	5.35	5.55
3	Influenza	1.29	1.81	1.88
11	Varicella	1.16	1.71	1.78
1	Hepatitis A	*NA*	*NA*	0.43
5	Meningococcal	0.08	0.11	0.14
6	Mumps	0.10	0.13	0.11
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9	Polio	0.00	0.00	0.00
10	Rubella	0.01	0.00	0.00

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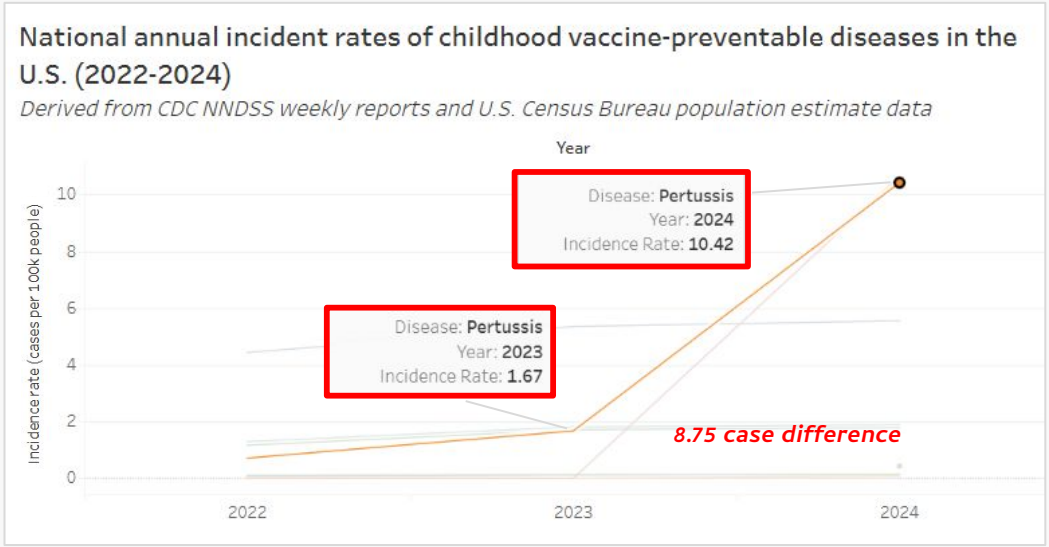

2024 data are provisional and subjected to change

References

https://www.cdc.gov/pertussis/media/pdfs/2025/01/pertuss-surv-report-2024_PROVISIONAL-508.pdf

What is the annual incidence rate of each CPVDs in the U.S.?

Significant increase in measles between 2023 and 2024.

- Above the expected baseline rate for the disease
- Reporting numbers are consistent with other national databases

	Disease_Category	2022	2023	2024
2	Hepatitis B	0.00	0.00	10.65
7	Pertussis	0.71	1.67	10.42
8	Pneumococcal	4.43	5.35	5.55
3	Influenza	1.29	1.81	1.88
11	Varicella	1.16	1.71	1.78
1	Hepatitis A	*NA*	*NA*	0.43
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9	Polio	0.00	0.00	0.00
10	Rubella	0.01	0.00	0.00

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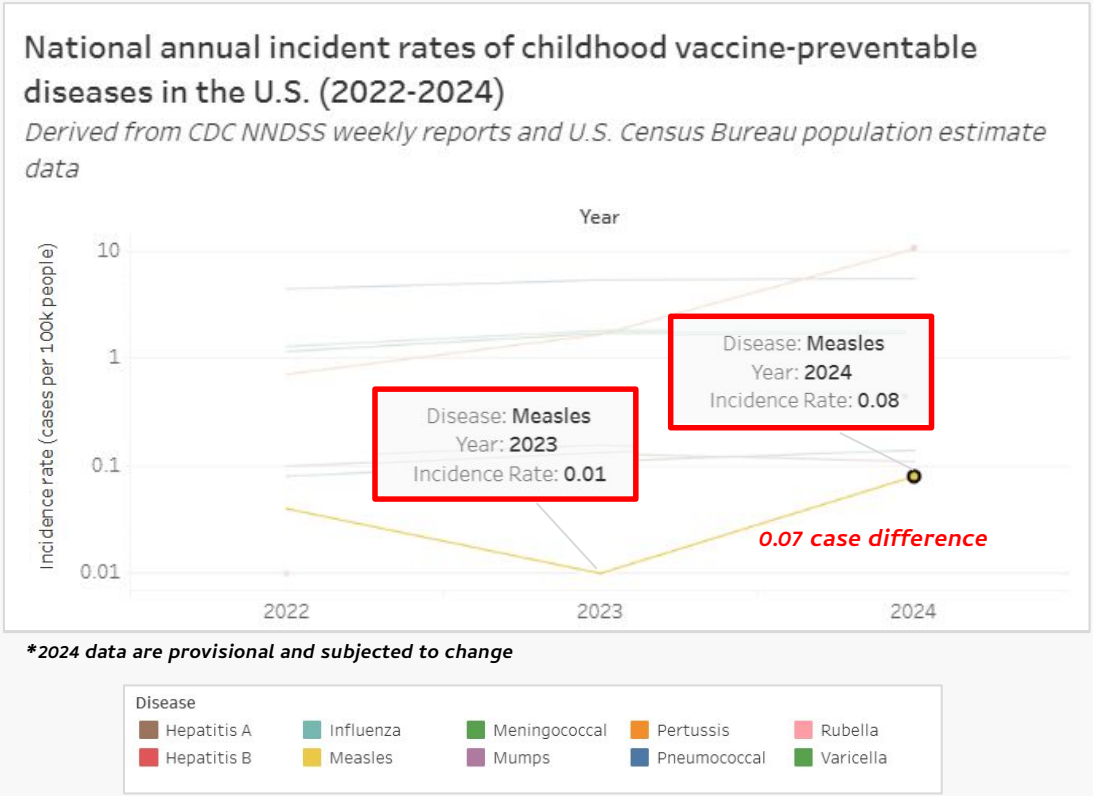


References: *https://www.cdc.gov/measles/data-research/index.html*

Analyze U.S. geographic patterns of reported CVPDs cases, Measles 2023-2024

	Reporting Area	Current MMWR Year	Disease_Category	incidence_rate
1	Idaho	2023	Measles	0.41
2	Hawaii	2023	Measles	0.14
3	Oregon	2023	Measles	0.05
4	Pennsylvania	2023	Measles	0.05
5	Illinois	2023	Measles	0.04

Table 4. *Top five U.S. states with the highest annual measles incidence rates in 2023*

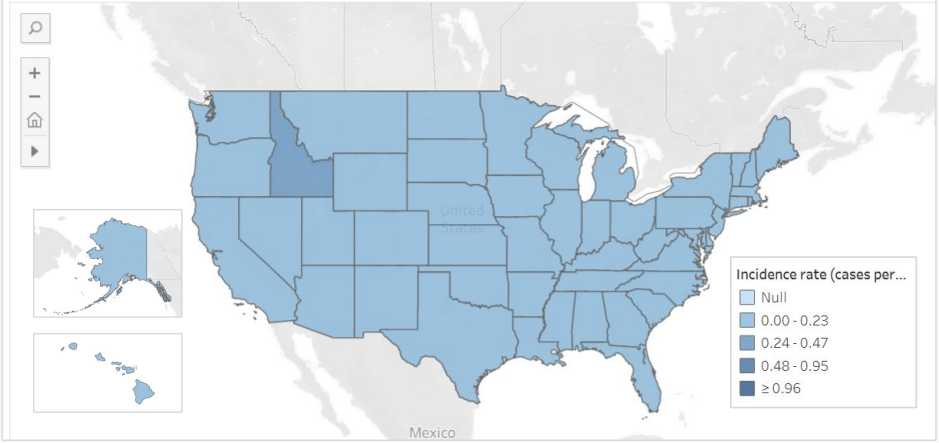
	Reporting Area	Current MMWR Year	Disease_Category	incidence_rate
1	Minnesota	2024	Measles	1.17
2	Oregon	2024	Measles	0.70
3	Illinois	2024	Measles	0.53
4	Vermont	2024	Measles	0.31
5	New Hampshire	2024	Measles	0.14

Table 5. *Top five U.S. states with the highest annual measles incidence rates in 2024*

References
https://www.cdc.gov/measles/data-research/index.html

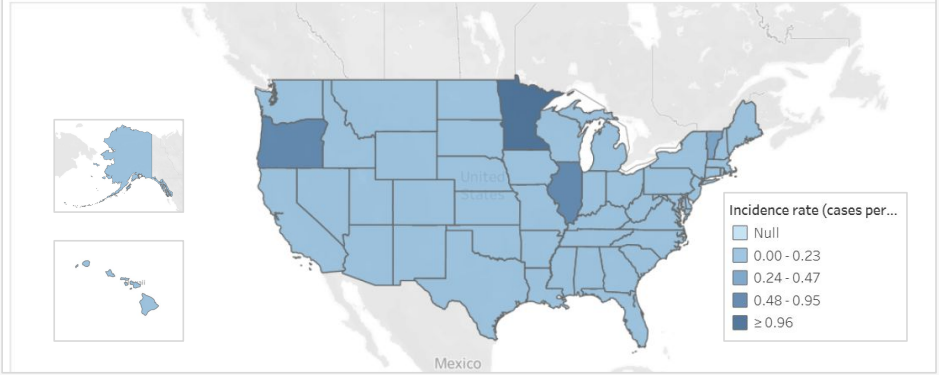
Geographic Distribution of Measles Incidence in the U.S (2023)

Annual state incidence rates per 100,000 population



Geographic Distribution of Measles Incidence in the U.S (2024)

Annual state incidence rates per 100,000 population



****2024 data are provisional and subjected to change***

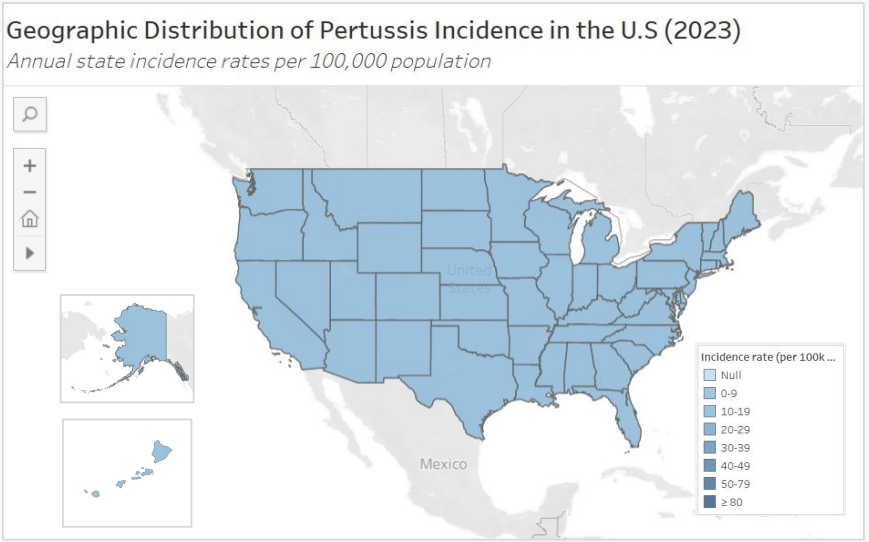
Analyze U.S. geographic patterns of reported CVPDs cases, Pertussis 2023-2024

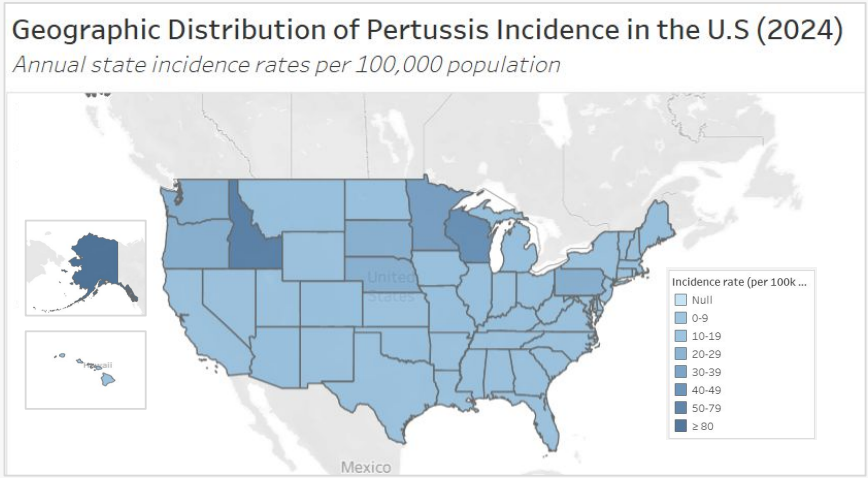
	Reporting Area	Current MMWR Year	Disease_Category	incidence_rate
1	Ohio	2023	Pertussis	6.85
2	Utah	2023	Pertussis	5.95
3	Illinois	2023	Pertussis	4.80
4	Maine	2023	Pertussis	4.79
5	Arizona	2023	Pertussis	4.51
6	South Dakota	2023	Pertussis	4.46

Table 6. *Top six U.S. states with the highest annual pertussis incidence rates in 2023*

	Reporting Area	Current MMWR Year	Disease_Category	incidence_rate
1	Alaska	2024	Pertussis	80.39
2	Idaho	2024	Pertussis	52.41
3	Wisconsin	2024	Pertussis	44.41
4	Minnesota	2024	Pertussis	32.71
5	South Dakota	2024	Pertussis	28.98
6	Washington	2024	Pertussis	25.50

Table 7. *Top six U.S. states with the highest annual pertussis incidence rates in 2024*





****2024 data are provisional and subjected to change***

Reference
https://www.cdc.gov/pertussis/php/surveillance/index.html

Limitations

- Limited demographic detail
- Differences in surveillance infrastructure, sensitivity, reporting protocols, and case definitions across U.S. States vs. CDC
- Reporting delays, underreporting, passive reporting processes, or provisional counts makes current analysis unreliable.
- Possible overestimation and lack of representation in unique cases

Summary of key findings

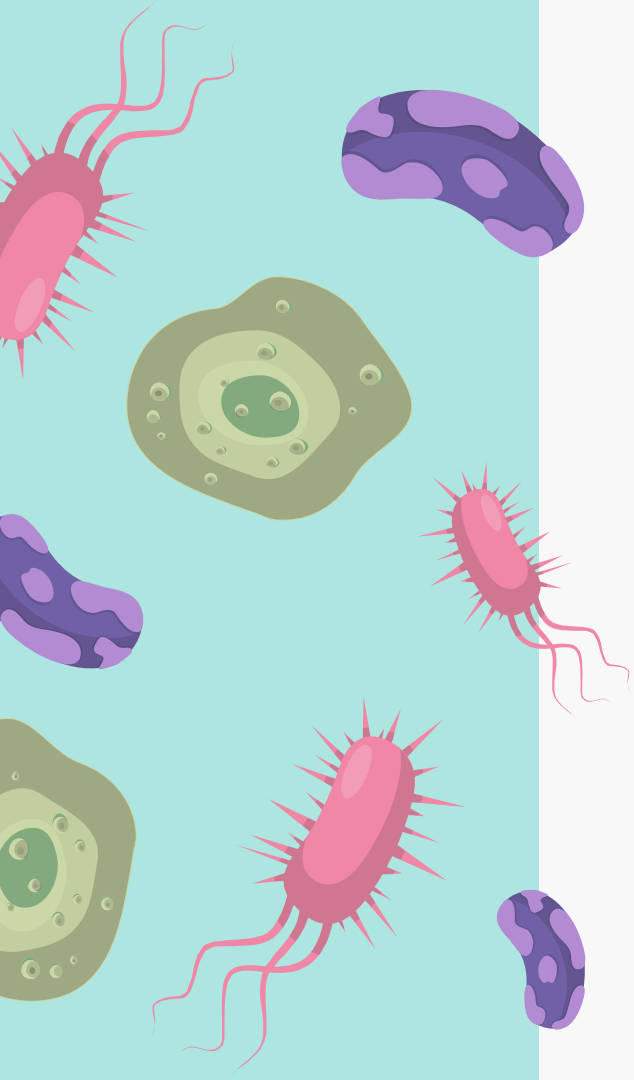
Objective: To determine whether there has been an increase in CVPD cases in the U.S. from 2022–2025, in relation to the rise of vaccine hesitancy.

Goal 1: Describe temporal trends in reported CVPDs cases and disease incident rates in the U.S.

- A notable rise in CVPD cases occurred between **2022 and 2024**.
- The most significant and resurging increases in incidence rates were seen in **measles** and **pertussis** between **2023 and 2024**.

Goal 2: Analyze U.S. geographic patterns of reported CVPDs disease incidence rates

- Several states experienced increases in measles and pertussis incidence rates.
- Geographic patterns were not uniformly strong across all states, need for 2025 data
- Additional research using disease-specific CDC program data or state-level surveillance systems is recommended for more accurate interpretation.



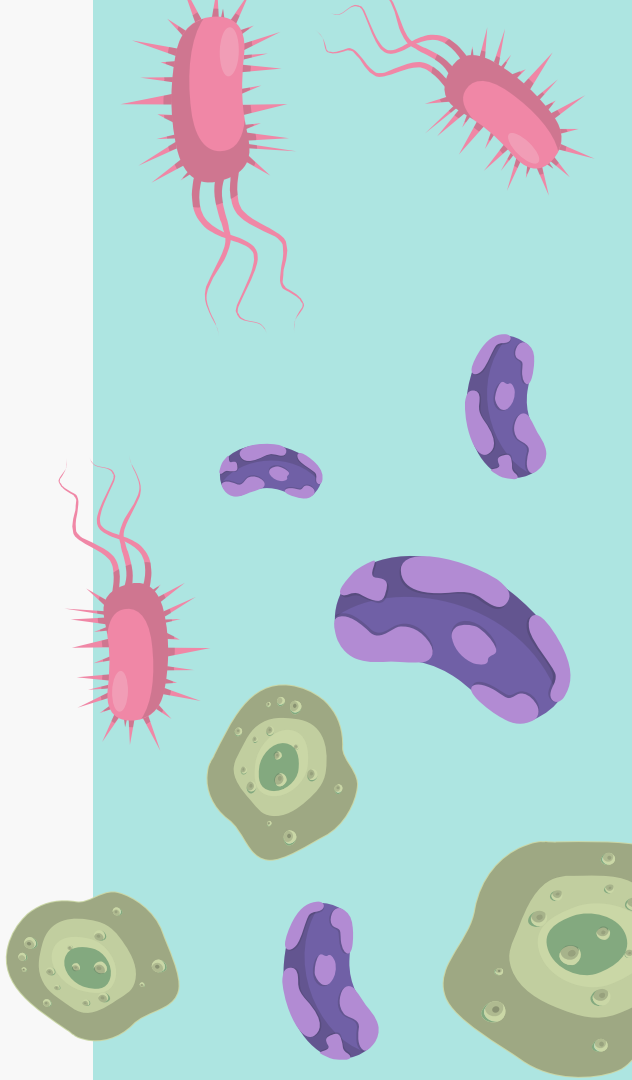
Conclusion

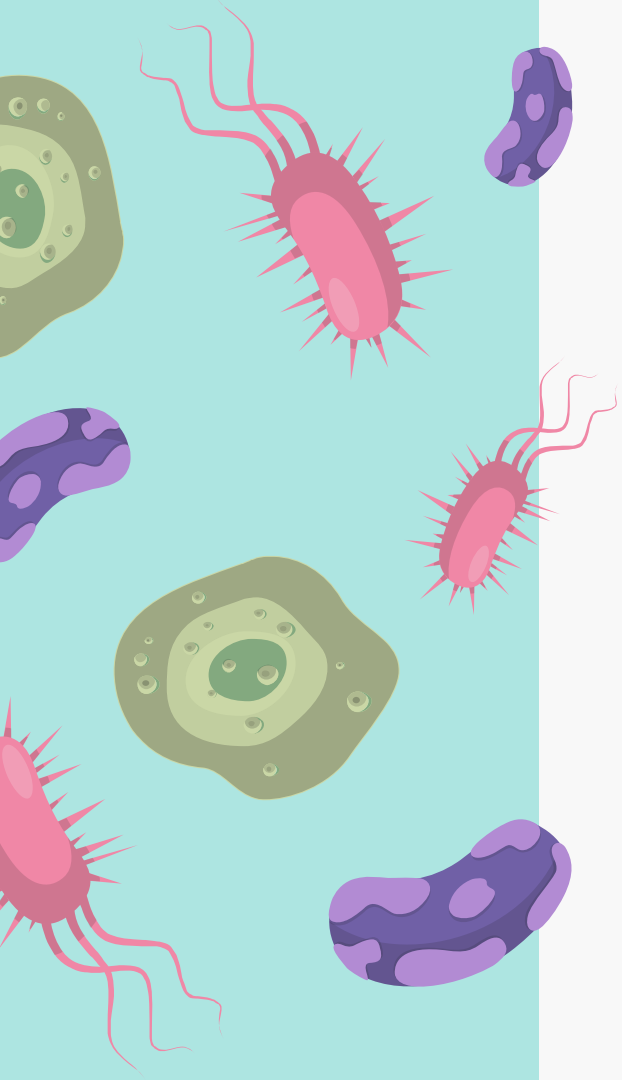
Recommendations

Recommendations

Goal 3: *Provide public health recommendations to address CVPDs numbers.*

- **Prioritize community-focused initiatives:** Target areas with low vaccination coverage or high vulnerability.
- **Expand health education efforts:** Provide culturally relevant vaccine education through campaigns and community workshops.
- **Increase access to vaccination services:** Use mobile clinics and school-based programs to reduce barriers.
- **Address health disparities:** Focus outreach and resources on marginalized and underserved populations
- **Support policy and advocacy efforts:** Encourage engagement with local lawmakers and promote evidence-based vaccination policies.





Thank You!