# Measles After 50 Years

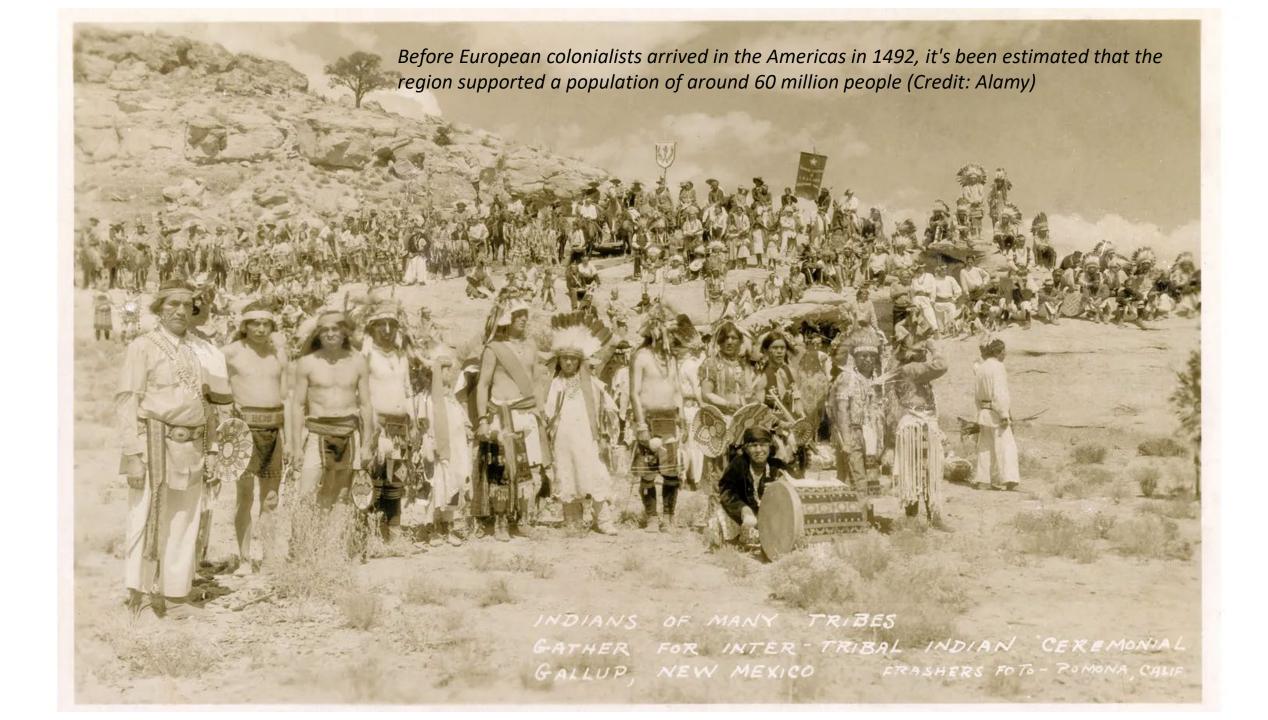
#### **Health Watch USAsm**

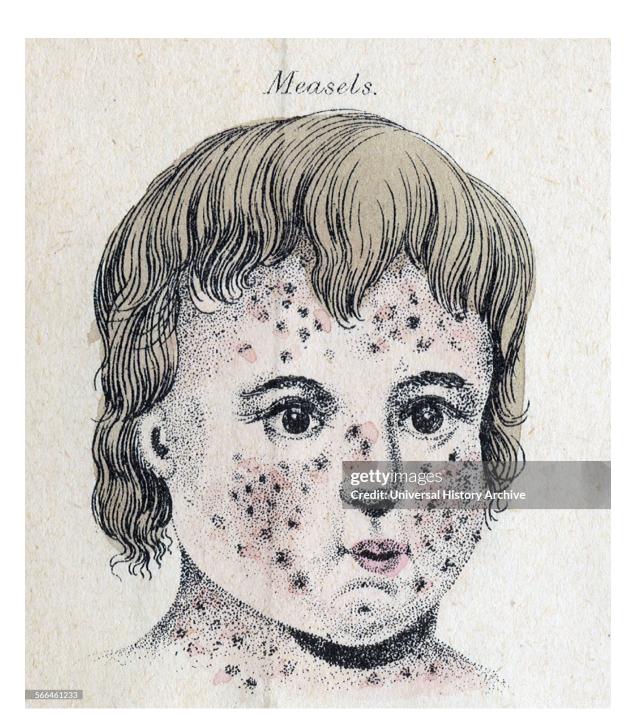
**Combating Infectious Diseases** 

Wilmore Webley, PhD
Professor of Microbiology
University of Massachusetts Amherst
August 29, 2025





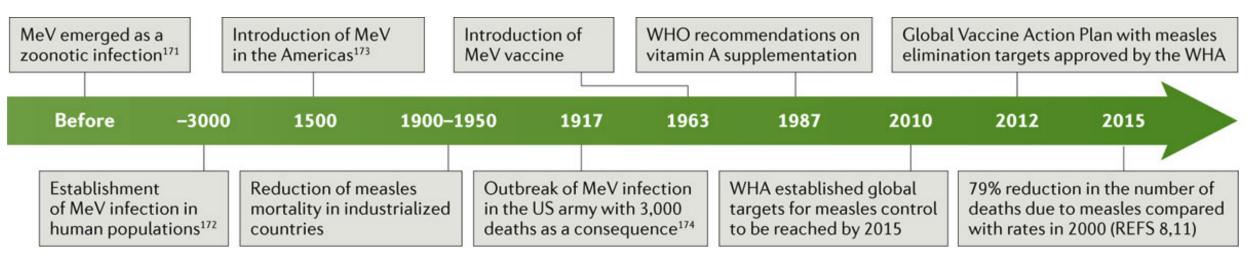




A young child infected with measles.

A young child with measles from the frontispiece of 'Domestic Medicine' by William Buchan, 1782. (Photo by: Universal History Archive/Universal Images Group via Getty Images)

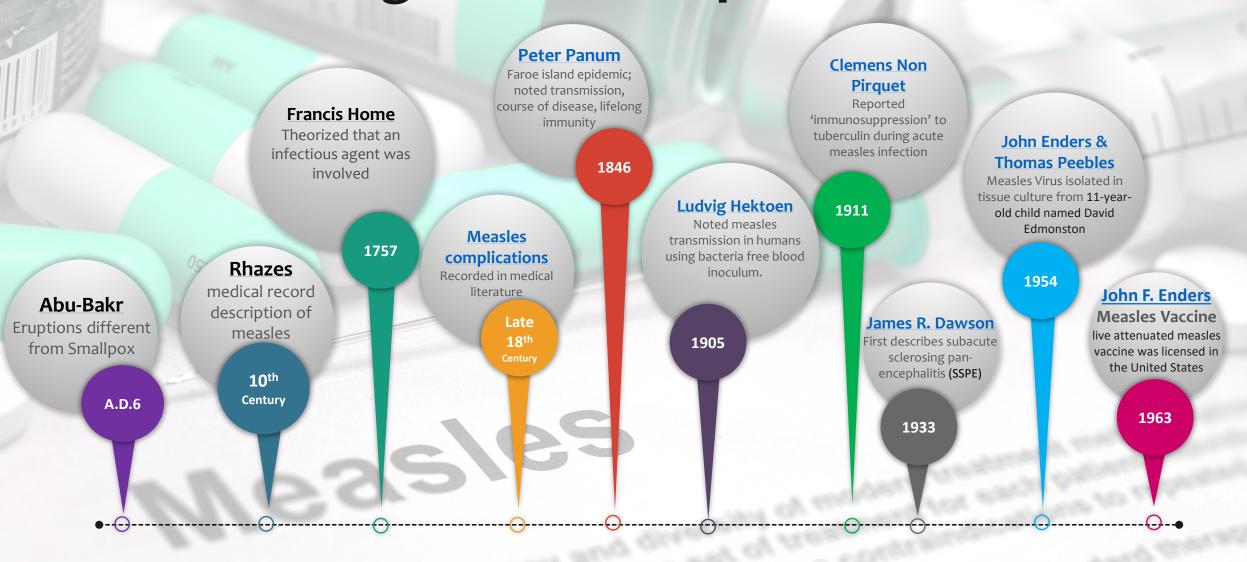
# History of measles virus infection and elimination programs

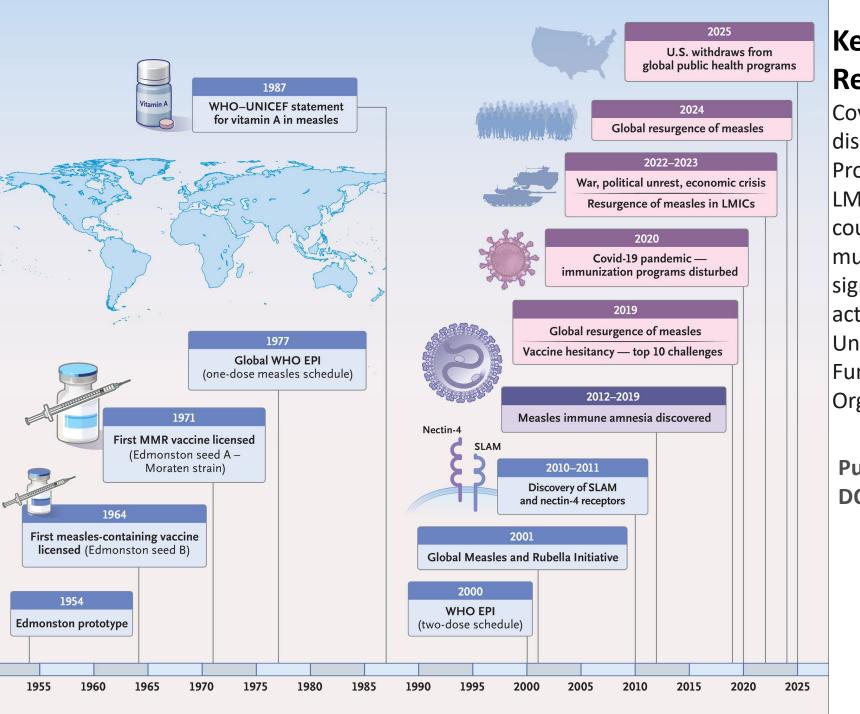


Nature Reviews | Disease Primers

Closely related to the recently eradicated cattle **virus rinderpest**<sup>170</sup>, measles virus (MeV) probably evolved from an ancestral virus and emerged as a zoonotic infection in communities in which cattle and humans lived in close proximity<sup>171</sup>. MeV most **likely became established in humans about 5,000 years ago** when human populations achieved sufficient size in Middle Eastern agrarian civilizations to maintain virus transmission<sup>172</sup>. Measles did not always have a global distribution and probably first entered the Americas in the fifteenth century with the immigration of Europeans. MeV and smallpox infections probably facilitated the European conquest of Native American civilizations by causing large numbers of deaths among the fully susceptible Native Americans<sup>173</sup>. The outbreak of measles in the US Army from 1917 to 1918 that resulted in >95,000 cases of measles and 3,000 deaths provided a striking example of the devastating effect of measles and associated bacterial co-infections that occurred before the introduction of antibiotics or measles vaccines<sup>174</sup>. Increasing measles vaccine coverage prevented an estimated 17.1 million deaths between 2000 and 2014 (Ref. 8). WHA, World Health Assembly.

# Measles Emergence and Important Milestonee



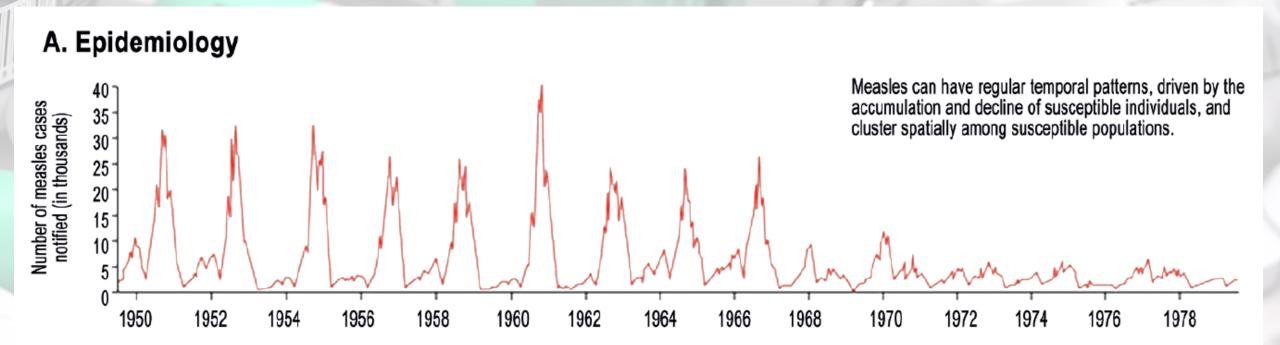


# **Key Events in Measles Research**

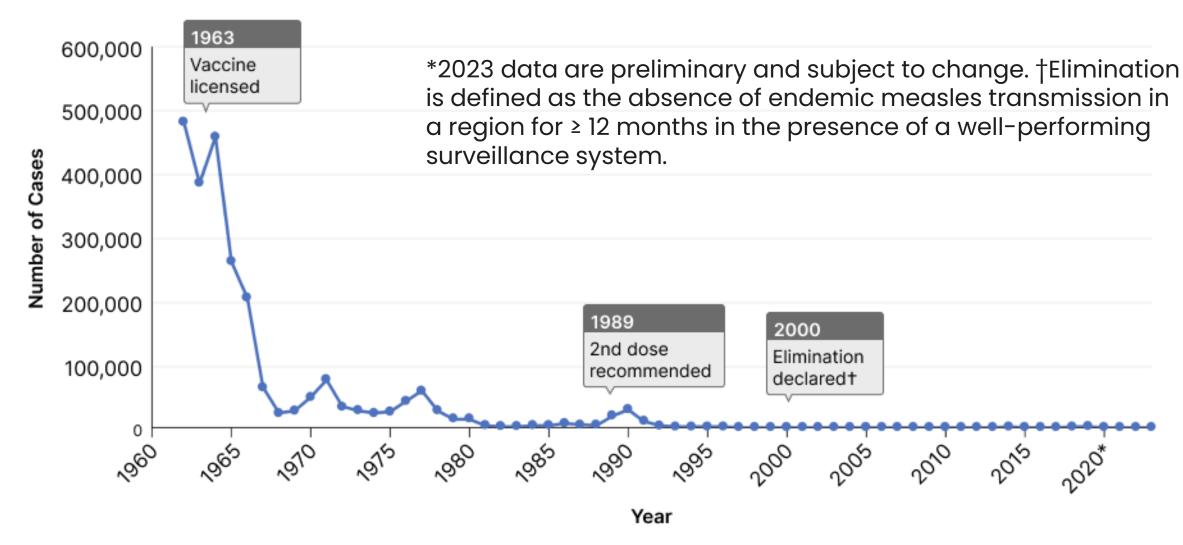
Covid-19 denotes coronavirus disease 2019, EPI Expanded Programme on Immunization, LMICs low- and middle-income countries, MMR measles—mumps—rubella, SLAM signaling lymphocytic activation molecule, UNICEF United Nations Children's Fund, and WHO World Health Organization.

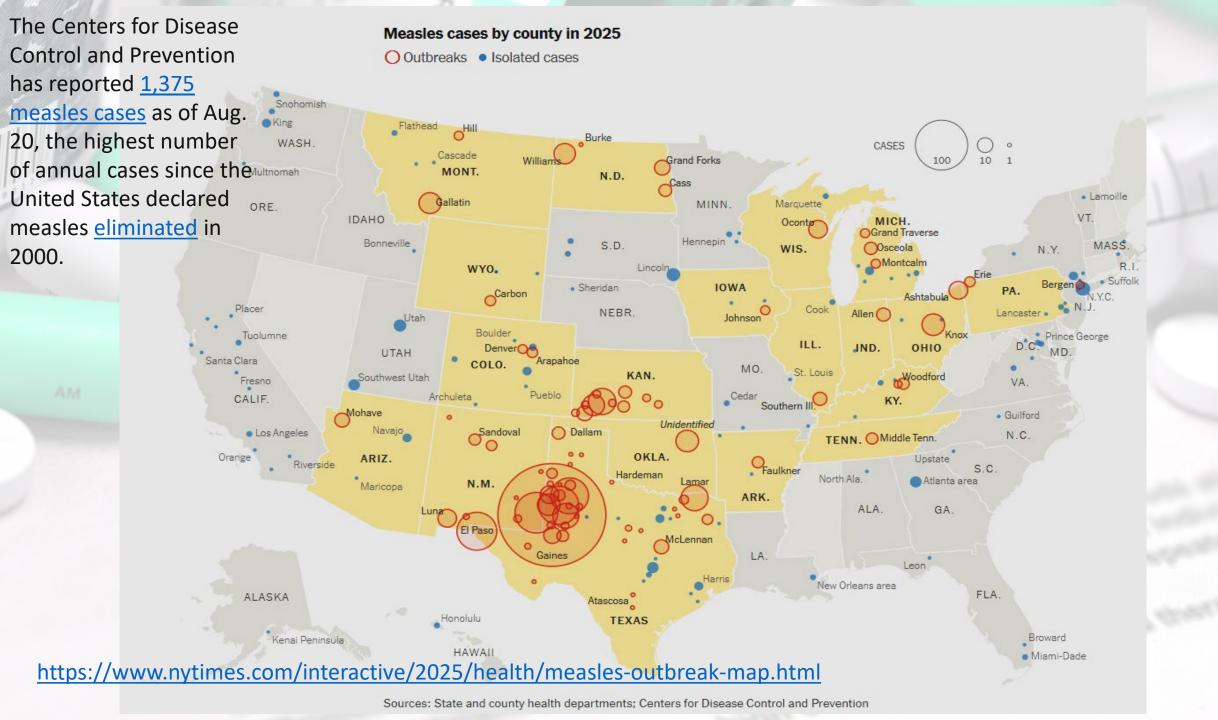
Published June 25, 2025 DOI: 10.1056/NEJMra2504516

# **Measles Epidemiology**

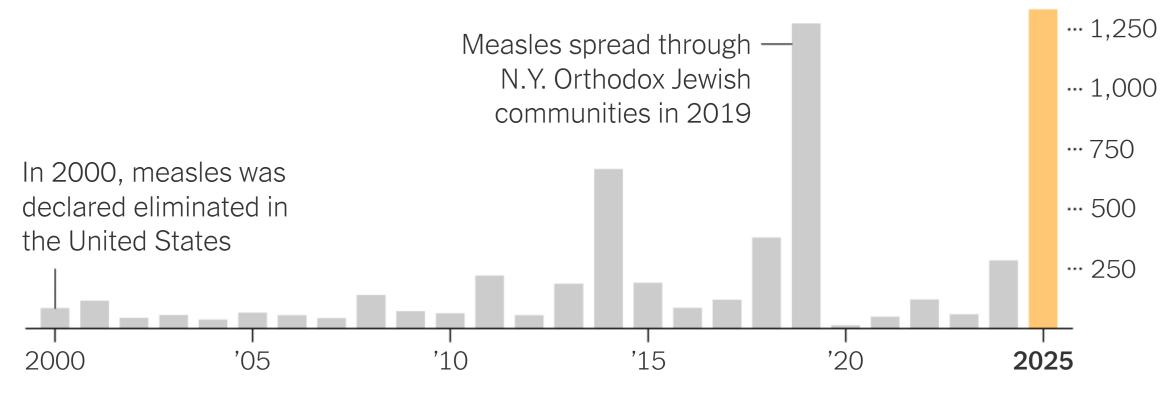


#### Reported Measles Cases in the United States from 1962 – 2023\*





#### **Confirmed measles cases since 2000**



Source: C.D.C. confirmed cases through July 30





By <u>Teddy Rosenbluth</u> and <u>Jonathan Corum</u>

© 2025 The New York Times Company

**Highly Contagious** 

#### **HOW CONTAGIOUS IS MEASLES?**

Measles is one of the most contagious viruses. It can linger in the air, infecting non-immune people even two hours after an infected person leaves the room. How the average infection rate compares with other diseases:

#### **MEASLES**

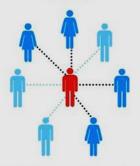
Each measles patient infects

12 to 18 people



#### **MUMPS**

Each mumps patient infects

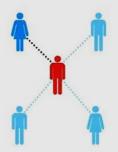


SOURCES Centers for Disease Control and Prevention; Reuters

Janet Loehrke, USA TODAY

#### **INFLUENZA**

Each influenza patient infects



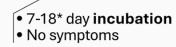
#### **EBOLA**

Each Ebola patient infects





#### Measles: virus, symptoms and immune blood cells an infection timeline in the unvaccinated Contagious period MEASLES VIRUS Level in blood Inhaled infectious • • measles 🧶 🛔 VIRAL RNA virus dose 28 days 1 day 7 days 14 days 21 days Months



4-7\* day rashRising immunity

against measles

2-4\* day prodrome
 Fever, cough, malaise cough, conjunctivitis

lan M Mackay, PhD virologydownunder.com \*approximate times only-full range shown using a bar; → -average time

Symptoms

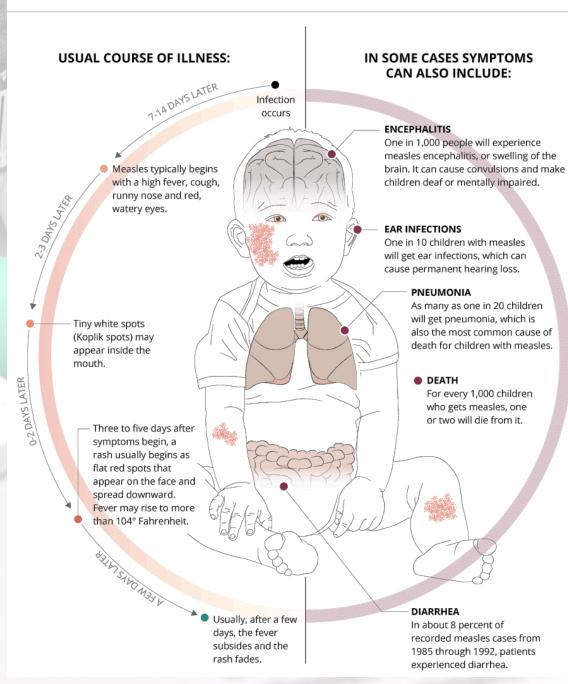
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update: 27MAR2025 AEST

Measles virus

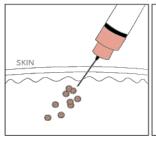
RNA lingers

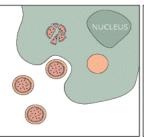
#### **How Measles Affects Your Body**

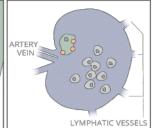


#### **How Vaccines Provide Protection**

A live but weakened measles virus enters the body, where it attracts the attention of immune cells called macrophages. These macrophages swallow up the virus to kill it and then carry the virus's antigens (think of them as a virus's uniform) back to the lymph nodes to teach other other immune cells how to recognize and defeat the virus in the future.





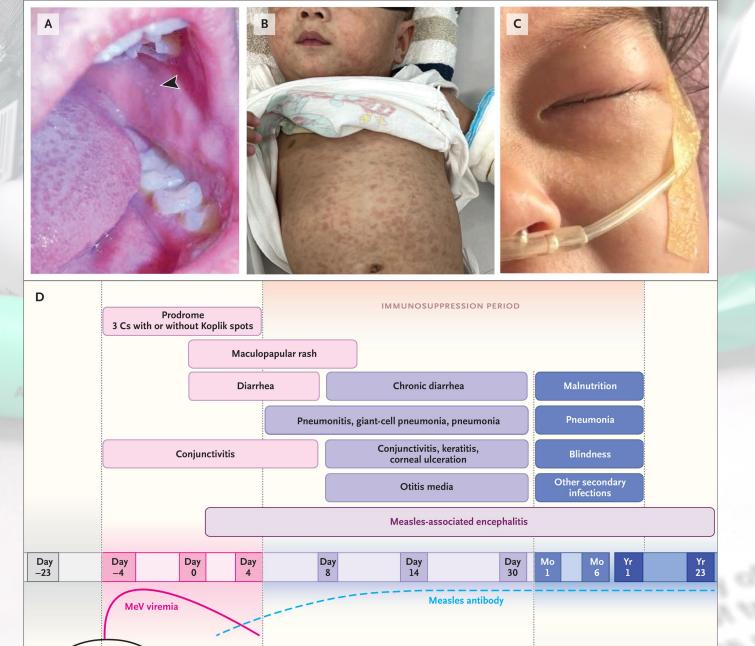


Sources: CDC, Mayo Clinic, National Institutes of Health

THE HUFFINGTON POST

https://www.huffpost.com/entry/measles-symptomscomplications n 6615222





Preexisting CD150+ lymphocytes

**ACUTE DISEASE PERIOD** 

LATE COMPLICATIONS

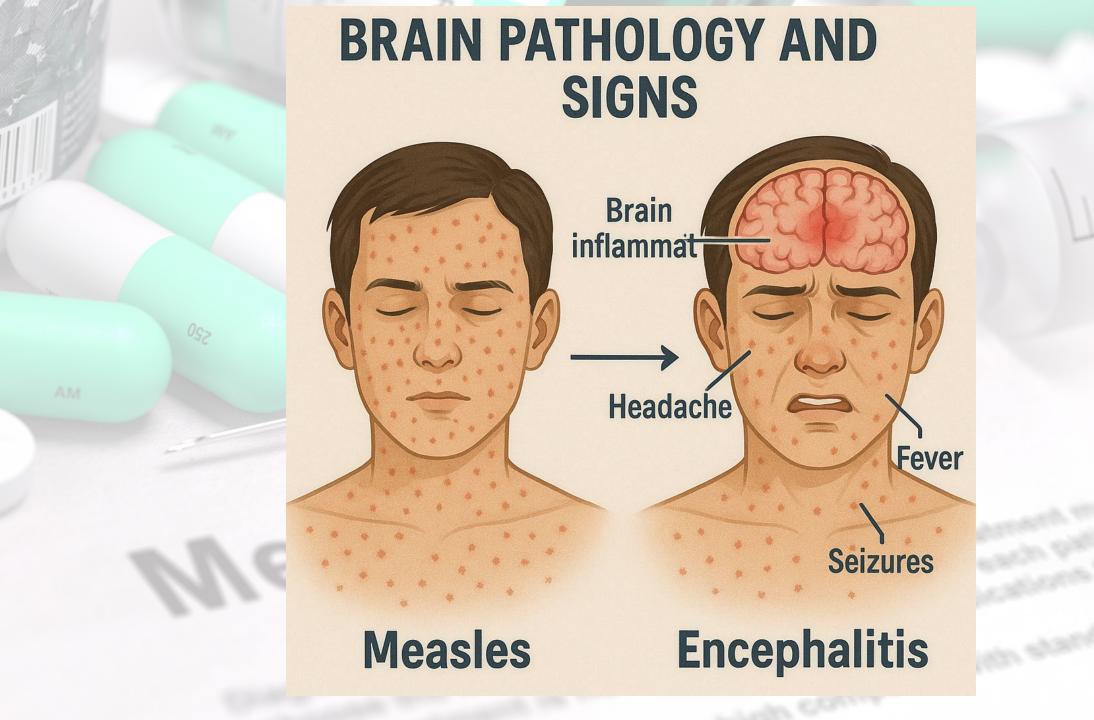
INCUBATION

**CONTAGIOUS PERIOD** 

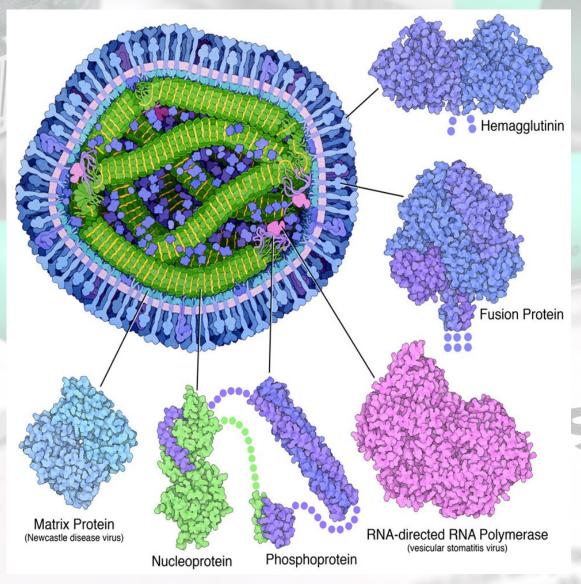
Clinical Features and Pathogenesis of Measles.

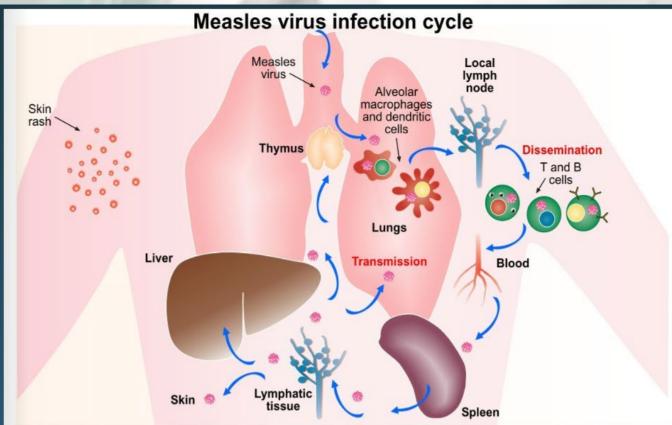
Features of measles include Koplik spots on the buccal mucosa (Panel A); rash on the trunk, spreading to the face, head, arms, and legs (Panel B); and conjunctivitis (Panel C). Day 0 denotes the day the measles rash appears; Day -4 is the probable start of infectiousness, Day 4 is the probable end of infectiousness, and Day -23 is the earliest possible exposure day (Panel D). CD150+ lymphocytes are T and B memory lymphocytes targeted by the measles virus. 3 Cs denotes cough, coryza, and conjunctivitis, and MeV measles virus. Images in Panels A, B, and C were provided by Du Tuan Quy, M.D., with the approval of Le Nguyen Thanh Nhan, M.D., Ph.D., Children's Hospital 1, Ho Chi Minh City, Vietnam.

https://www.nejm.org/doi/full/10.105 6/NEJMra2504516



# Physiology & Immunology of Measles Infection Cycle

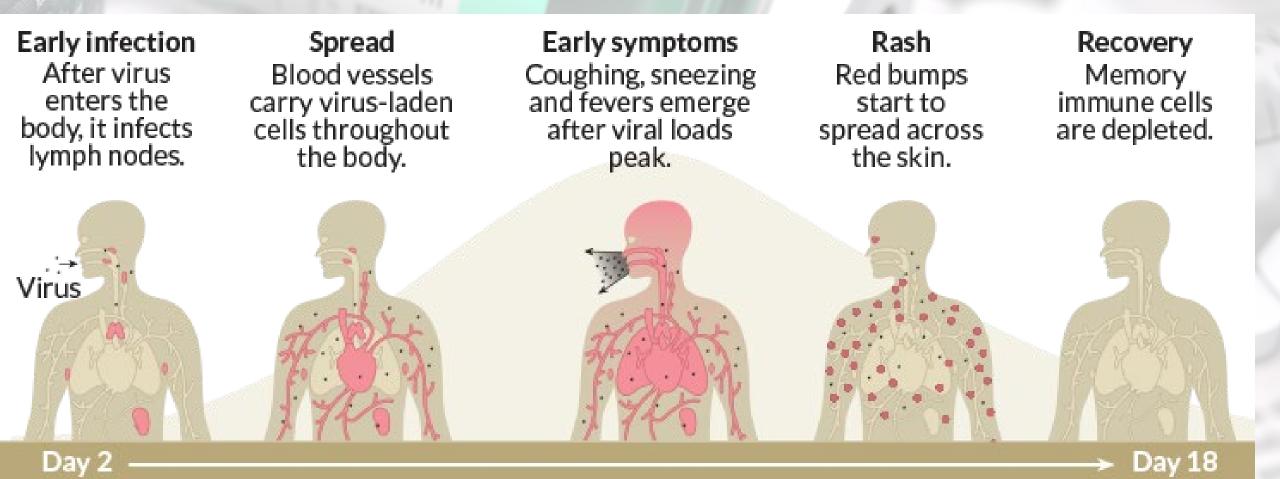




Measles virus is transmitted between humans by aerosal inhalation or contact with respiratory secretions. The main target cells are immune cells such as T and B cells, macrophages and dendritic cells that express CD150 (or SLAM) which serves as an entry receptor. CD46 expressed on most cells can also be used by some wild-type strains, but mainly vaccine strains. Measles virus infects epithelial cells using nectin-4. Endothelial cells and neurons are also infectable, but the entry receptors are unknown. It is thought that the first cells infected in the lungs are alveolar macrophages and dendritic cells that transport virus to regional lymph nodes where T and B cells become infected. Dissemination to other sites including spleen, lymphatic tissue, liver, thymus, skin and lungs follows. The characteristic skin rash is immune-mediate due to infection of dermal capillary endothelial cells and immune complex formation. Measles virus can also penetrate the brain, but is usually controlled. Infection of pulmonary epithelial cells permits transmission to other hosts.

https://pdb101.rcsb.org/motm/231

### Measles Can Harm a Child's Defense Against Other Serious Infections

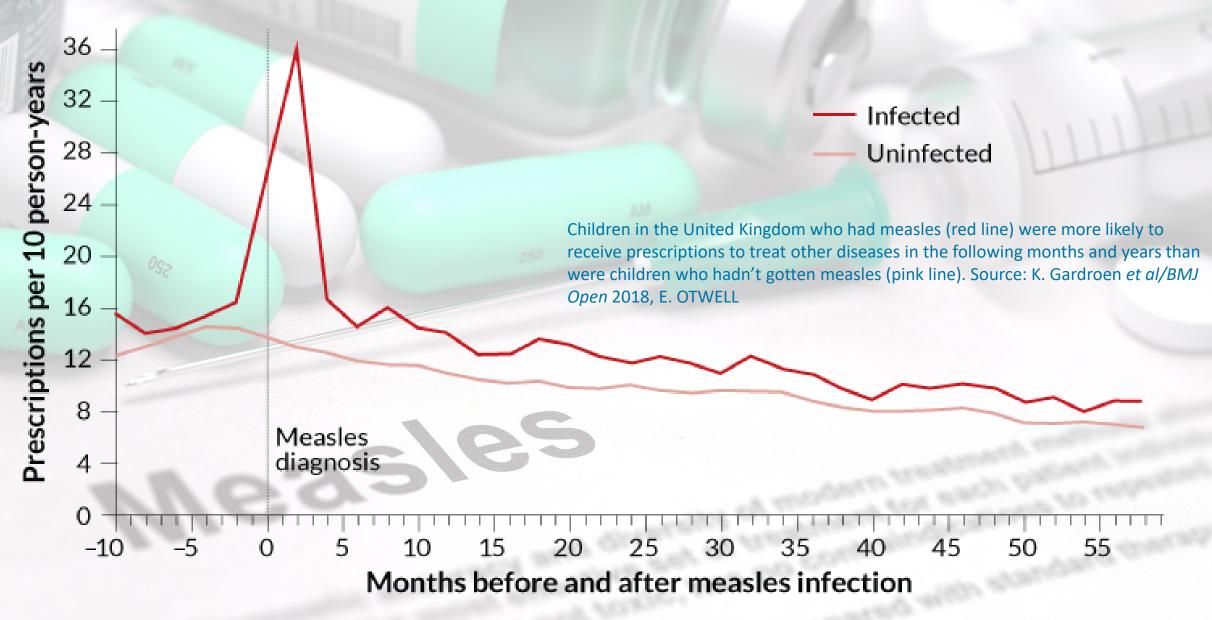


MV can infect 20 to 70% of memory cells, including B cells, T cells, and plasma cells in the lymphoid tissue and peripheral blood during the first 3 to 10 days after infection. Afterward, the body is left with fewer memory immune cells. Source: B.M. Laksono, Erasmus MC, Rotterdam, Netherlands

# Immune Amnesia: How Your Immune System Forgets to Fight

- One of the most unique—and most dangerous—features of measles pathogenesis is its ability to <u>reset the immune systems</u> of infected patients.
- During the acute phase of infection, measles induces immune suppression through a process called immune amnesia.
- Studies in non-human primates revealed that MV actually replaces the old memory cells of its host with new, MV-specific lymphocytes.
- As a result, the patient emerges with both a strong MV-specific immunity and an increased vulnerability to all other pathogens.
- It was determined that it takes approximately **2-3 years** post-measles infection for protective immune memory to be restored.
- Re-vaccination or exposure to all previously encountered microbes will be required in order to rebuild proper immune function since measles resets a child's developing immunity to that of a newborn.

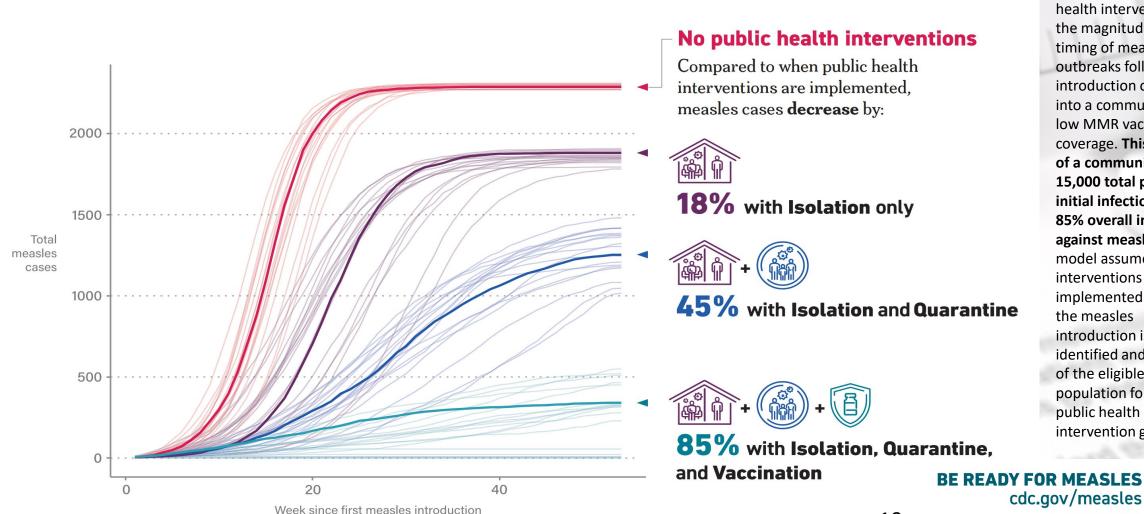
# Measles Erases the Immune System's Memory



https://www.sciencenews.org/article/measles-immune-system-memory-infection

# Interventions to Control a Measles Outbreak

Isolation, Quarantine, and active Vaccination can substantially reduce the spread of measles, particularly in communities with low MMR vaccination coverage.



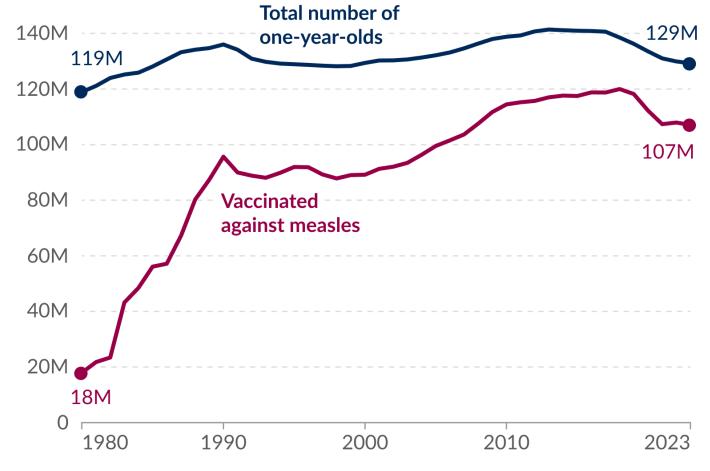
Modeling can illustrate the impact of public health interventions on the magnitude and timing of measles outbreaks following the introduction of measles into a community with low MMR vaccination coverage. This model is of a community with 15,000 total people, 5 initial infections, and 85% overall immunity against measles. The model assumes that interventions are implemented as soon as the measles introduction is identified and that 50% of the eligible population follows the public health intervention guidance.

# Over a hundred million infants receive measles vaccines annually, protecting them and communities against a deadly disease.

# Global number of infants vaccinated against measles each year



Estimated number of one-year-olds who receive the first dose of measles vaccination each year, compared to the total number of one-year-olds.



Data source: UN, World Population Prospects (2024); WHO & UNICEF (2024) CC BY

# New evidence revives fears over safety of MMR vaccine

THE safety of the MMR jab was again called into question last night after doctors unveiled new evidence linking it to autism and

with autism and gut disorder

By Rachel Ellis

and with all the published studies

Dr Andrew Wakefield ents separate jabs offered



#### THE LANCET

The Lancet, Volume 351, Issue 9103, Pages 637 - 641, 28 February 1998 doi:10.1016/50140-6736(97)11096-0

This article was retracted

# RETRACTED: Ileal-lymphoid-nodular hyperplasia, non-specific colitis, and pervasive developmental disorder in children

Dr AJ Wakefield FRCS a M, SH Murch MB b, A Anthony MB a, J Linnell PhD a, DM Casson MRCP b, M Malik MRCP b, M Berelowitz FRCPsych c, AP Dhillon MRCPath a, MA Thomson FRCP b, P Harvey FRCP d, A Valentine FRCR a, SE Davies MRCPath a, JA Walker-Smith FRCP a

#### Summary

#### Background

We investigated a consecutive series of children with chronic enterocolitis and regressive developmental disorder.

#### Methods

12 children (mean age 6 years [range 3–10], 11 boys) were referred to a paediatric gastroenterology unit with a history of normal development followed by loss of acquired skills, including language, together with diarrhoea and abdominal pain. Children underwent gastroenterological, neurological, and developmental assessment and review of developmental records. Ileocolonoscopy and biopsy sampling, magnetic-resonance imaging (MRI), electroencephalography (EEG), and lumbar puncture were done under sedation. Barium follow-through radiography was done where possible. Biochemical, haematological, and immunological profiles were examined.

#### The study had serious flaws

No Control Group: The researchers failed to compare vaccinated children with unvaccinated ones. Since about 90% of children in the UK received the MMR vaccine at the time, and autism symptoms typically emerge around the same age the vaccine is administered, the study could not establish a meaningful causal relationship. Misleading Timeline: Wakefield suggested that gastrointestinal issues preceded the onset of autism, supporting his theory of causation. However, investigations later revealed that in all eight cases, autism symptoms

•Small Sample, Big Claims: Drawing broad conclusions from a small, non-representative group of just 12 children is scientifically irresponsible, especially when public health is at stake

appeared before any reported digestive

problems - contradicting the study's

central premise.

#### WHAT STARTED THE RUMORS?



# <u> 1998</u>



Lancet published a paper by Dr. Andrew Wakefield, a dramatic study that found a connection between autism and vaccines

#### The Study Had Some Problems



Not based on statistics



No control group



It relied on people's memories



Made vague conclusions that weren't statistically valid

#### **Profile: Dr Andrew Wakefield**

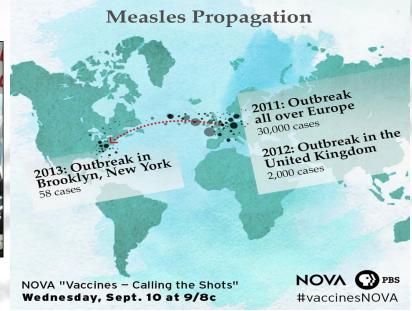
The suggestion that there is a link between MMR and autism has been one of the biggest health controversies of recent years. But just who is the doctor behind the headlines?

Dr Andrew Wakefield was the lead author of the controversial study, which suggested there may be a link between MMR and autism and bowel disease.



Dr Wakefield stands by his findings





#### NO LINK WAS FOUND



a study of **500 CHILDREN** 

no connection was found

Following Dr. Wakefield's study, here's what other more rigorous studies found

2001

a study of 10,000 CHILDREN

still found no connection

a study from Denmark of 537,000 CHILDREN

found no connection

2002

a study from Finland of 535,000 CHILDREN once again found no connection

2012

A review of 27 cohort studies, 17 case control studies, 6 selfcontrolled case series studies, 5 time series trials, 2 ecological studies, I case cross-over trial covering over

> 14,700,000 **CHILDREN**

A review of 31 studies covering more than

10.000.000 CHILDREN

Also found no connection

Lancet released a statement REFUTING the original findings

NO LINK TO AUTISM WAS FOUND IN ANY CASE, IN ALL OF THE STUDIES.

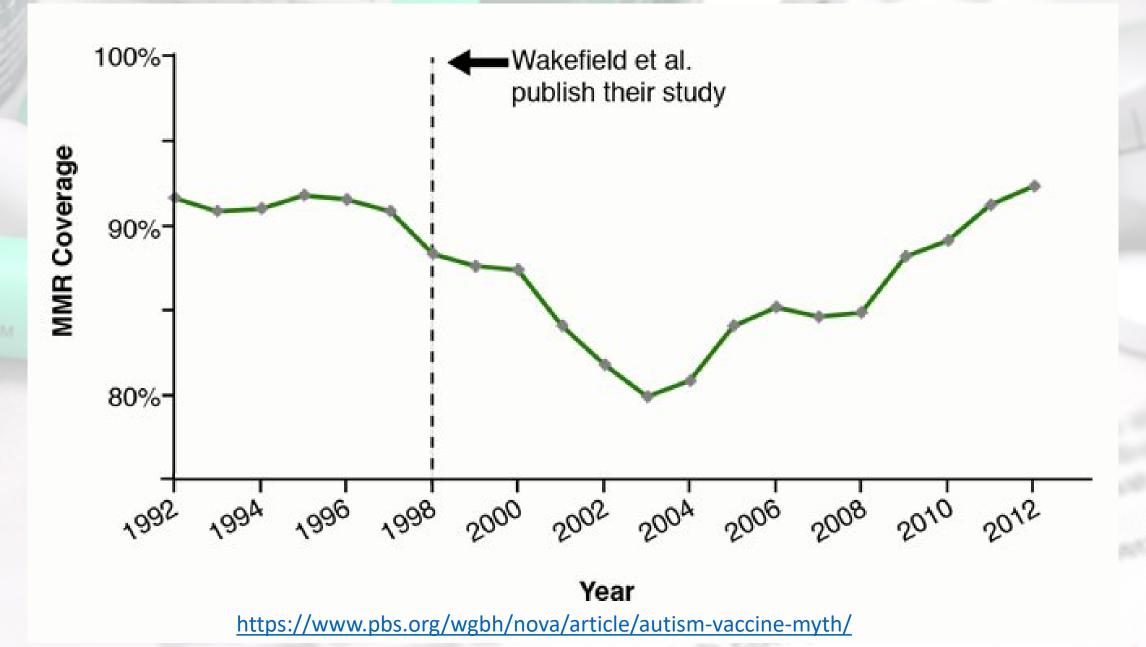
They had conducted invasive investigations on the children without obtaining the necessary ethical clearances... picked and chose data that suited their case;

THEY FALSIFIED FACTS. 9 9

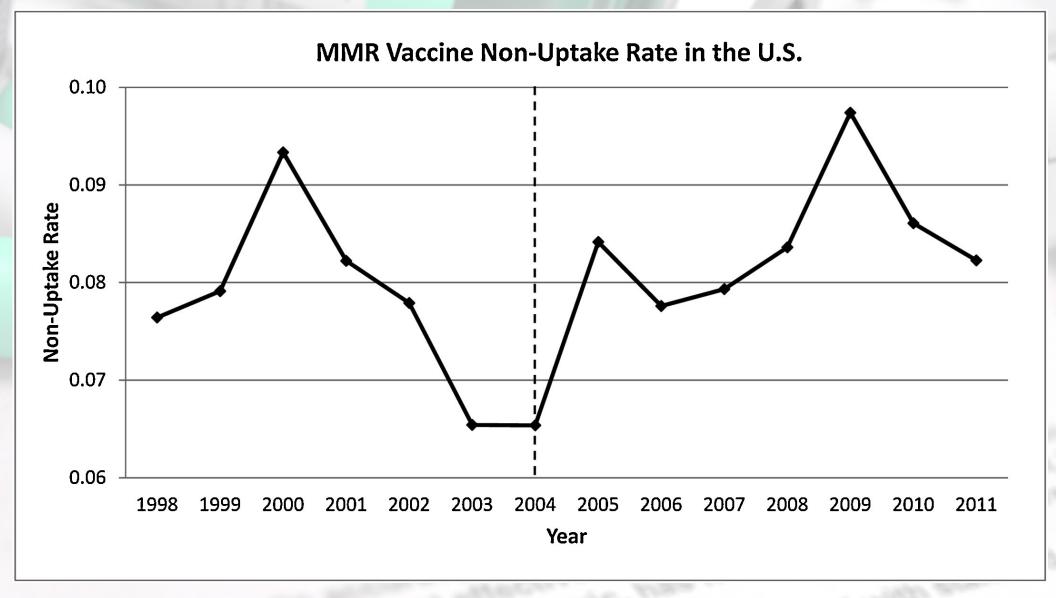




# Impact of the Alleged Vaccine-autism Connection (UK)



# Impact of the Alleged Vaccine-autism Connection (US)



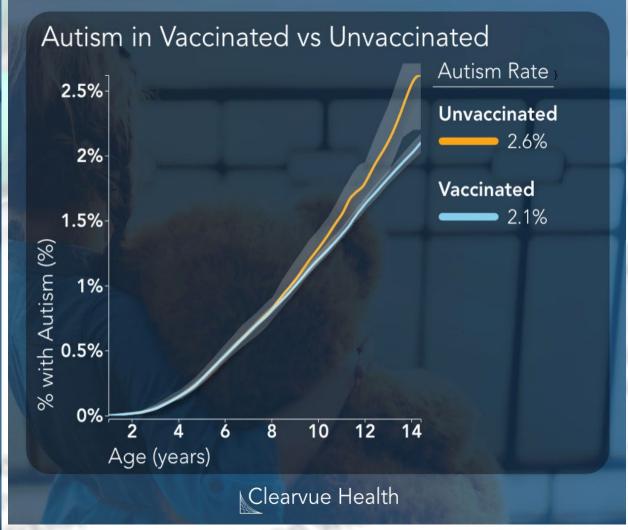
Qian M, Chou SY, Lai EK. Confirmatory bias in health decisions: Evidence from the MMR-autism controversy. J Health Econ. 2020 Mar;70:102284. doi: 10.1016/j.jhealeco.2019.102284. Epub 2020 Feb 10. PMID: 32057491.

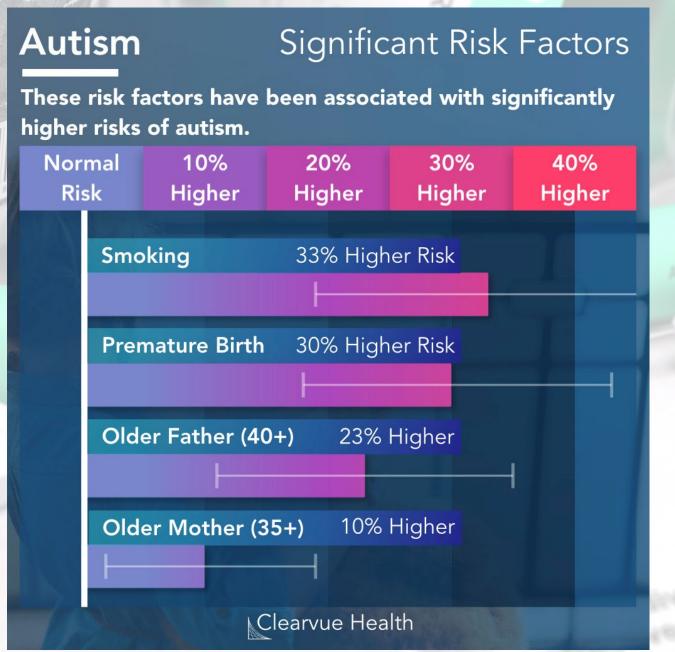
### Vaccines + Autism the evidence The balance of the evidence suggests that vaccines do not cause autism Studies **Supporting** MMR + Autism Link 1998 (n=12) Retracted 2002 (n=161) Retracted Studies **Refuting** MMR + Autism Link 1999 2019 2002 n = 498n = 657,461n = 537,3032001 n = 262Circles are scaled to the size of the study Clearvue Health



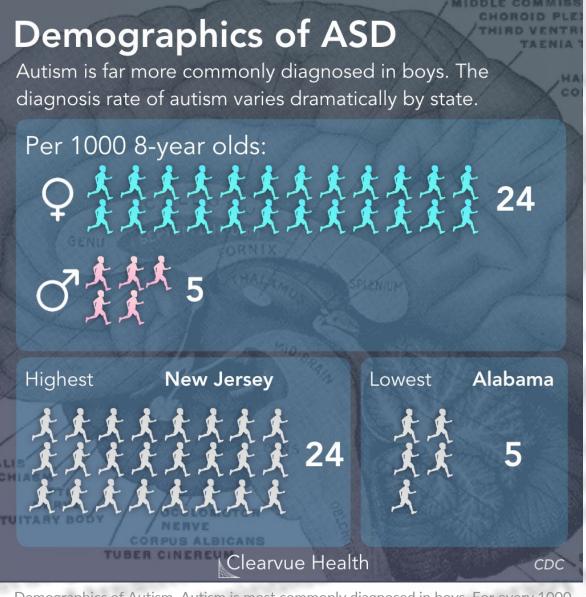
the evidence

The balance of the evidence suggests that vaccines do not cause autism





https://www.clearvuehealth.com/b/autism-mmr-stats/https://www.acpjournals.org/doi/10.7326/M18-2101



Demographics of Autism. Autism is most commonly diagnosed in boys. For every 1000 8 year-old boys, 24 are diagnosed with autism. For every 1000 8 year-old girls, 5 are diagnosed with autism. Interestingly, the diagnostic rate of autism varies significantly by state. In New Jersey, the CDC estimates that 24/1000 8 year olds are diagnosed with autism. Meanwhile, this number is only 5% in Alabama.

# Vaccines & Autism: Research Evidence

Large studies across multiple countries find no link between vaccines and autism

# Madsen et al. (2002, NEJM, Denmark)

n=537,303 — No link after MMR

# Hviid et al. (2019, Ann Intern Med, Denmark)

n=657,461 — No link incl. high-risk children

#### Jain et al. (2015, JAMA, USA)

n=95,727 — No link, even with autistic siblings

# Smeeth et al. (2004, Lancet, UK)

1,294 cases / 4,469 controls — No association with MMR

#### Taylor et al. (1999, Lancet, UK)

n=498 — No temporal relation to MMR introduction

# Fombonne et al. (2006, Pediatrics, Canada)

n=27,749 — No link with thimerosal/MMR schedule

# Hviid et al. (2003, JAMA, Denmark)

n=467,450 — No link with thimerosal

# Price et al. (2010, Pediatrics, USA)

256 cases / 752 controls — No link with thimerosal

#### DeStefano et al. (2013, J Pediatr, USA)

256 cases / 752 controls — No link with antigen load

# Uno et al. (2012, Vaccine, Japan)

189 cases / 224 controls — No link with MMR/total vaccines

# Mrozek-Budzyn et al. (2010, PIDJ, Poland)

96 cases / 192 controls — No link with MMR

# Taylor, Swerdfeger & Eslick (2014, Vaccine)

>1.25M children — Meta-analysis: No link across designs

# Measles Vaccine Saves Lives

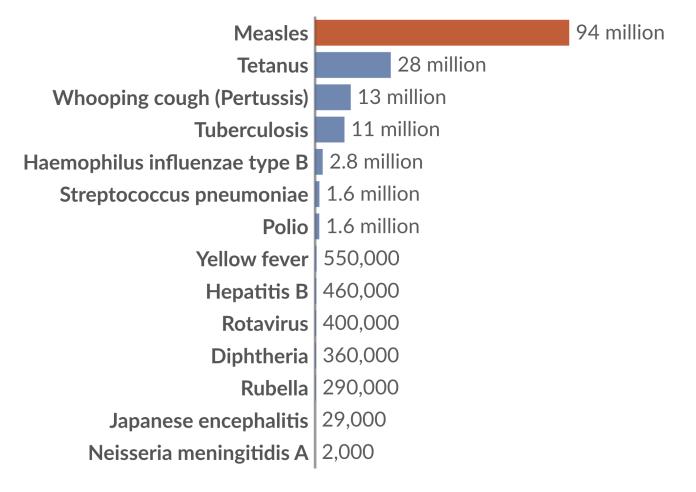
# 94 million lives

Since 1974, **measles vaccines** have **saved approximately 94 million lives** globally.

Source: 2024 WHO Expanded Program on Immunization 50-year Impact Analysis

# Number of lives saved by childhood vaccinations since 1974

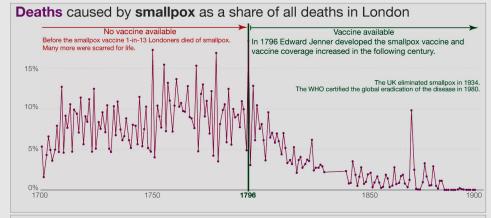


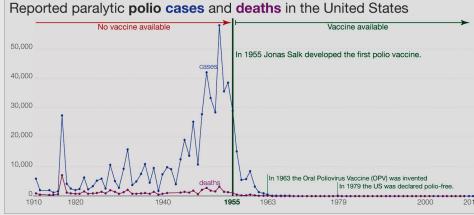


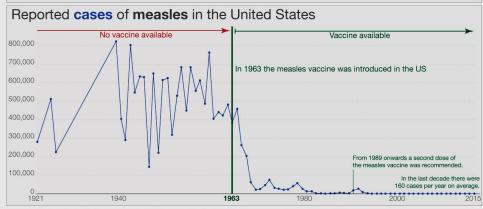
**Data source:** Shattock et al. (2024). Contribution of vaccination to improved survival and health: modelling 50 years of the Expanded Programme on Immunization OurWorldinData.org/vaccination | CC BY

#### Infectious diseases before and after a vaccine became available









Data sources: Smallpox: Our World in Data based on Guy (1892) and several publications of the Registrar General between 1896 and 1903 Polio: Our World in Data based on US Public Health Service (1910-1951) and US Center for Disease Control (1960-2010) Measles: Our World in Data based on several publications from the Public Health Seports, the US Public Health Service's Morbidity and Mortality Weekly Report Annual Supplements, and the US Census's Annual Statistical Abstracts

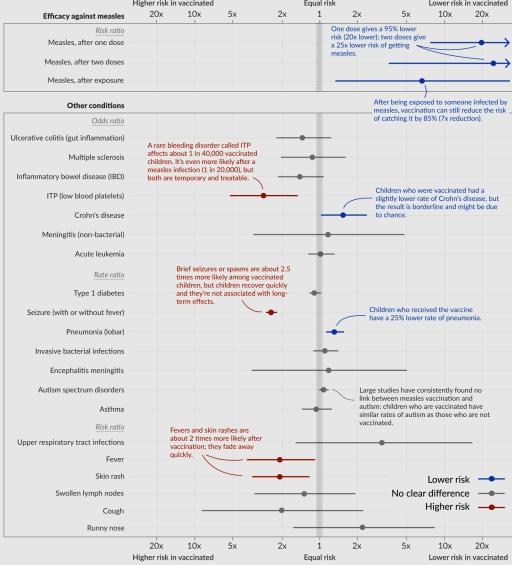
OurWorldinData.org - Research and data to make progress against the world's largest problems.

Licensed under CC-BY by the author Max Roser.

#### How does measles vaccination affect the chances of getting sick or having side effects?



Each row shows the association between vaccination and a particular outcome, comparing vaccinated versus unvaccinated children. For each outcome, the dot shows the midpoint estimate and the line width shows the 95% confidence interval.



Note: Estimates come from a meta-analysis of 138 studies in total, which used a range of metrics. Odds ratios compare the odds of that an outcome occurred in each group; common in case-control studies. Risk ratios compare the chances of an outcome occurring and are commonly used in cohort studies and trials. Rate ratios compare how often outcomes have occurred in a given time span.

Data source: Cochrane Database of Systematic Reviews (2021). Vaccines for measles, mumps, rubella, and varicella in children.

OurWorldinData.org — Research and data to make progress against the world's largest problems.

Licensed under CC-BY by the author Saloni Dattani



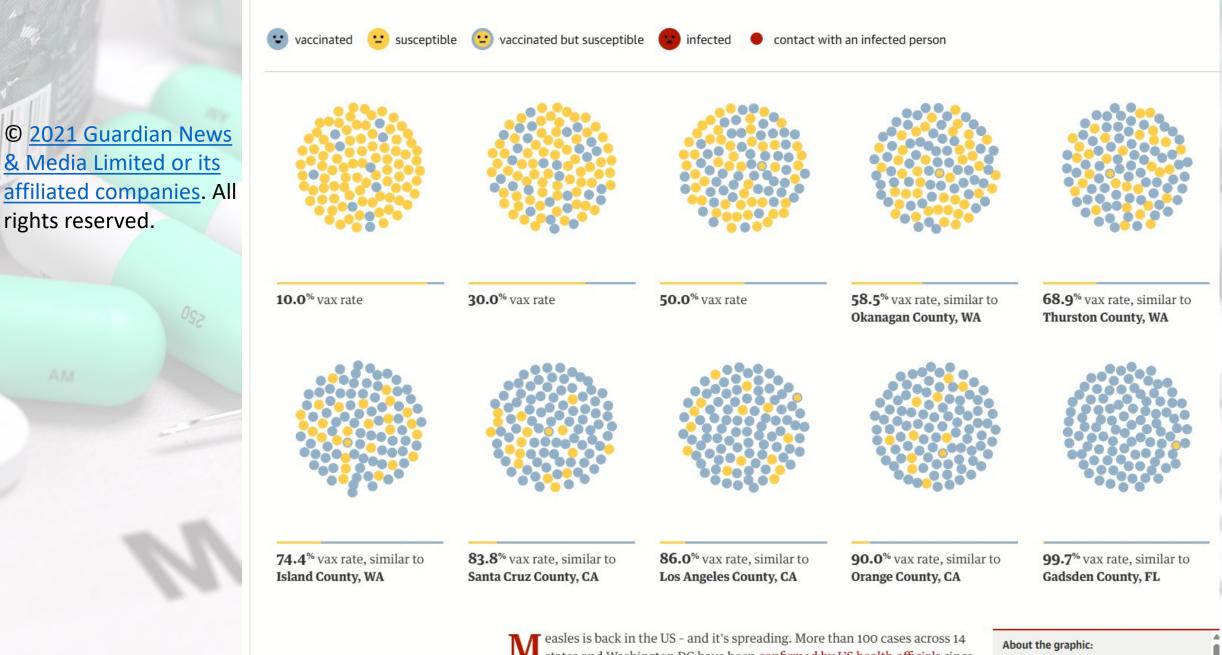




Data source: Project Tycho (2018); Centers for Disease Control and Prevention (1959-2022)

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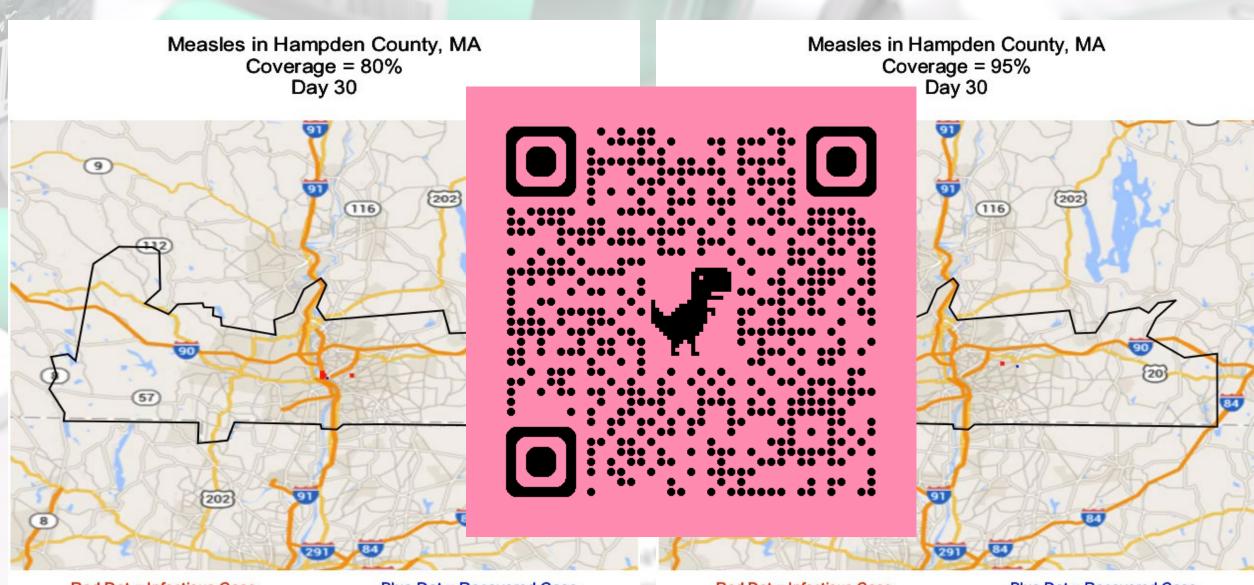
Licensed under CC-BY by the author Fiona Spooner



states and Washington DC have been confirmed by US health officials since an outbrook bogon at Dispouland last Dosombor With a majority of those

Here are 10 hypothetical communities

# FRED U.S. Measles Simulator



Red Dot = Infectious Case

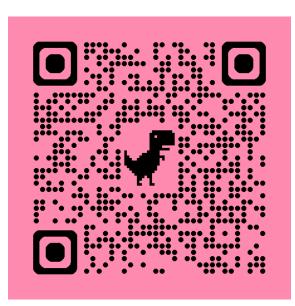
Blue Dot = Recovered Case

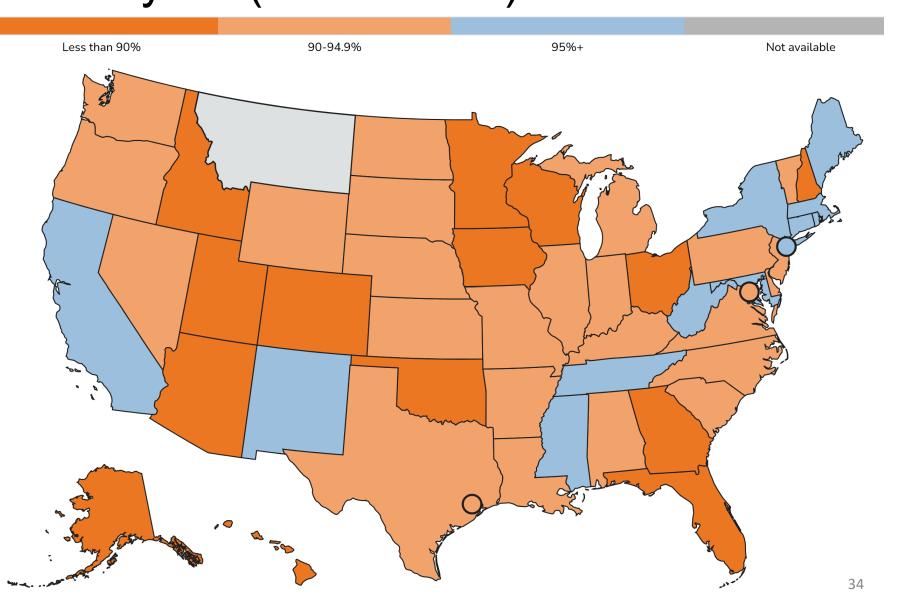
Red Dot = Infectious Case

Blue Dot = Recovered Case

# MMR vaccine coverage for kindergarteners by school year (2009–2024)

https://www.cdc.gov/ measles/dataresearch/index.html

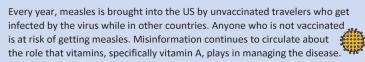


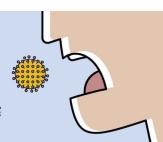


# 3 MEASLES AND VITAMIN A



### Measles is making a comeback around the world





#### 1. Vitamins do NOT prevent measles



Only the measles vaccine can prevent measles—All children should get 2 doses of MMR (measles-mumps-rubella) vaccine to prevent measles



Vitamins should NOT be used to prevent measles

#### 2. Giving high doses of vitamins may be dangerous



Routinely getting an overload of vitamins can actually hurt you—For example, too much vitamin A can cause dizziness, nausea, headache, coma, and even death



Due to the danger of overdoses, high-dose vitamin A should only be used in the management of measles under the direct supervision of a healthcare professional once a diagnosis is confirmed

#### 3. The best way to prevent measles is through vaccination



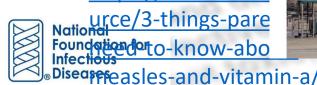
Stay up-to-date with all recommended vaccines, including MMR



Stay healthy by exercising and eating a balanced diet. The best sources of vitamin A include: milk, eggs, cheese, fortified breakfast cereals, leafy green vegetables, orange vegetables, and fighttps://www.nfid.c

#### #GetVaccinated to #PreventMeasles

LEARN MORE AT www.nfid.org/measles



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🏫 — Global Center for Health Security — The Transmission — West Texas children treated for vitamin A toxicity as medical disinformation spreads alongside measles outbreak

# West Texas children treated for vitamin A toxicity as medical disinformation spreads alongside measles outbreak

Some measles patients in West Texas show signs of vitamin A toxicity, doctors say, raising concerns about misinformation

E (IN) Health Life, But Better Fitness Food Sleep Mindfulness Relationships

By Neha Mukherjee, CNN

2 4 min read · Published 8:40 PM EDT, Wed March 26, 2025

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RESOURCE LINKS

ibute Content



# Current vaccination rates aren't high enough to achieve herd immunity

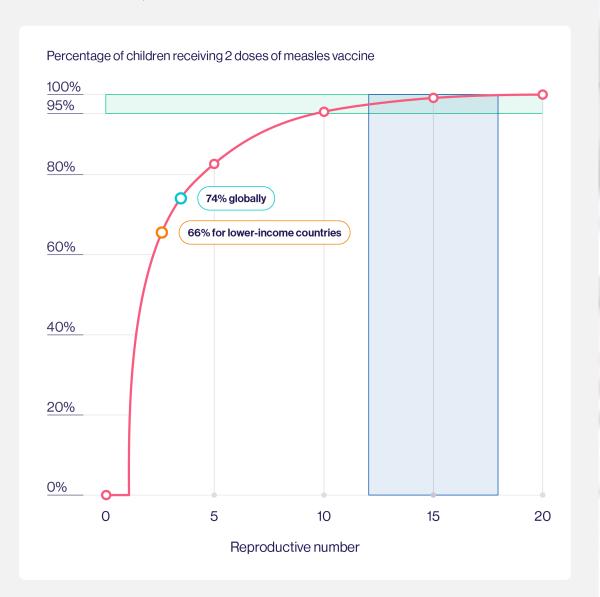
# Vaccination levels needed to maintain herd immunity

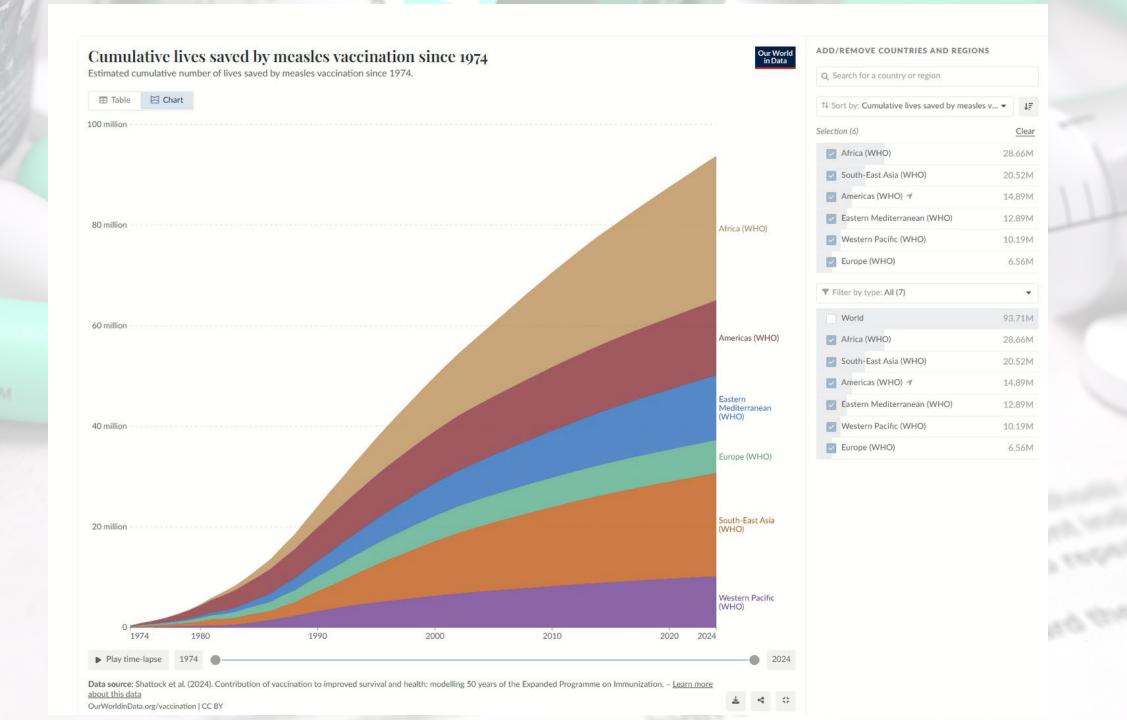
Required for herd immunity

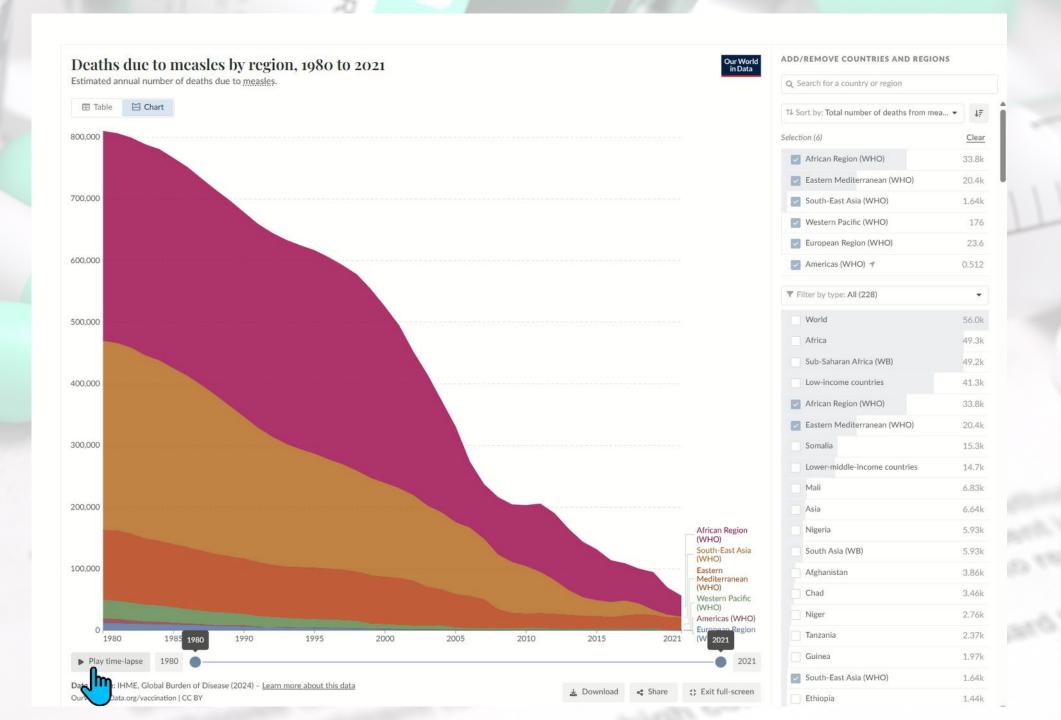
Measles rangeLower-income

O Global

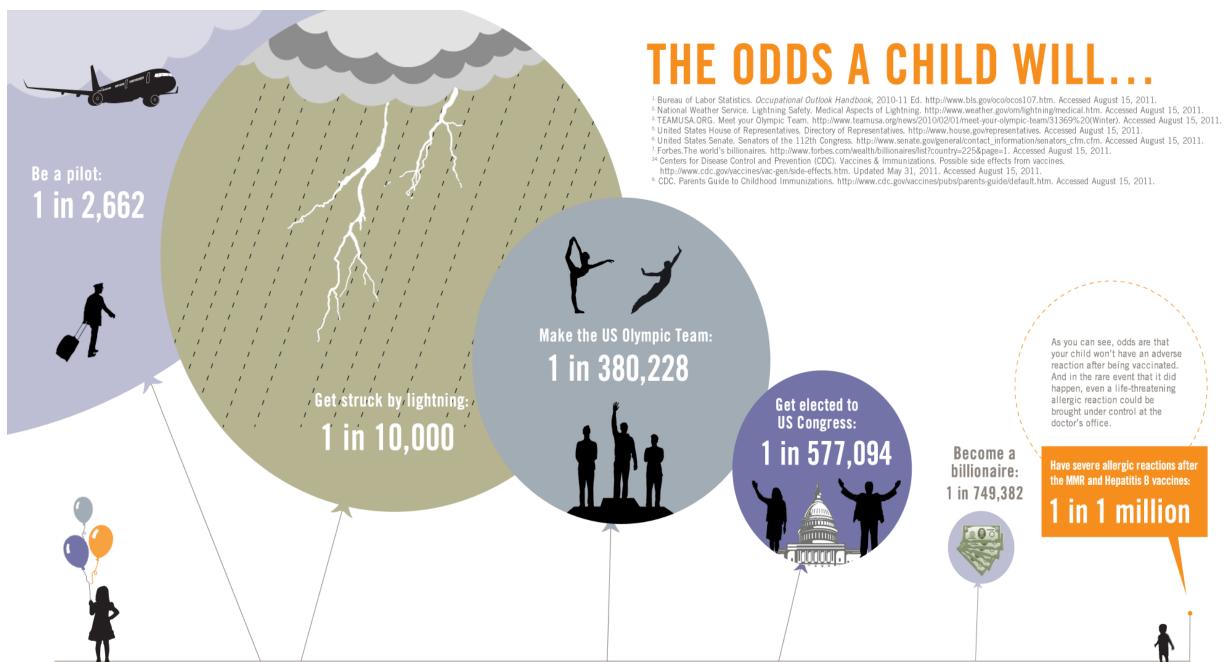
Data source: UKHSA; Adam Kleczkowski







### Reasons to Vaccinate: "Choose Facts Over Fear"



# **History of Measles Over the Past 50 Years**



# Measles vaccine licensed

A vaccine for measles is developed and licensed in the United States.



# Measles declared eliminated

Measles is declared eliminated in the U.S., meaning there is no continuous transmission



# Resurgence due to vaccine hesitancy

Measles cases increase amid declining vaccination rates and the spread of misinformation



# Severe health consequences

Measles can cause compleations such as pneumonia, encephalitis, and death

Washington-Watch > Washington Watch

#### CDC Director Fired After Refusing to Resign

- "Monarez refused to rubber-stamp unscientific, reckless directives," her lawyers said

by Kristina Fiore, Director of Enterprise & Investigative Reporting, MedPage Today August 27, 2025 · 4 min read Last Updated August 28, 2025















CDC Director Susan Monarez, PhD, was fired on Wednesday night after a dramatic showdown with the Trump administration.



#### Daniel Jernigan

Former director of the National Center for Emerging and Zoonotic Infectious Diseases at the CDC



Jernigan, a longtime CDC official, directed the National Center for Emerging and Zoonotic Infectious Diseases and played a key role in influenza and pandemic preparedness. Jernigan first joined the CDC's epidemic intelligence service in 1994 and worked in the respiratory diseases branch on the prevention and control of bacterial respiratory pathogens.

He left his position in August 2025 after Monarez's ouster, joining other top officials in objecting to what they saw as the politicization of science and diminished trust in the agency's leadership.

#### Jennifer Layden

Former director of office of public health data, science, technology at the CDC



Layden, who led the office of public health data, surveillance, and technology at the CDC, focused on modernizing outbreak tracking and response systems. Layden received both her doctor of medicine and her doctorate in epidemiology from the University of Illinois at Chicago.

Formerly Illinois' chief medical officer, she also resigned after Monarez's removal in August 2025, warning about the damaging effects of political influence on science-based decision-making.

#### **Debra Houry**

Former chief medical officer and deputy director for program and science at the CDC



Houry, a physician with degrees from Emory University and Tulane University, previously worked as an emergency doctor and at various facilities in Atlanta, as well as serving in academic leadership roles. At the CDC, she served as chief medical officer and deputy director for program and science.

She resigned in late August 2025 following Monarez's removal, citing the spread of vaccine misinformation, looming budget reductions and political meddling that she said undermined the agency's mission.

#### **Demetre Daskalakis**

Former director of the National Center for Immunization and Respiratory Diseases at the CDC



Daskalakis, a public health physician known for his leadership in HIV prevention and vaccination programs, led the CDC's National Center for Immunization and Respiratory Diseases. He received his medical degree from the NYU School of Medicine and completed postgraduate medical training at Harvard Medical School in 2003, before joining the CDC in 2020 as director of the division of HIV/Aids Prevention.

He resigned from the CDC on 28 August, publishing a letter that denounced political interference, data manipulation and what he called a decline in scientific integrity.

# The Bottomline



The MMR vaccine does not cause autism

