

Pandemic

A **pandemic** (from Greek *πᾶν*, *pan*, 'all' and *δῆμος*, *demos*, 'people') is an epidemic of disease that has spread across a large region, for instance multiple continents or worldwide, affecting a substantial number of people. A widespread endemic disease with a stable number of infected people is not a pandemic. Widespread endemic diseases with a stable number of infected people such as recurrences of seasonal influenza are generally excluded as they occur simultaneously in large regions of the globe rather than being spread worldwide.

Throughout history, there have been a number of pandemics of diseases such as smallpox and tuberculosis. One of the most devastating pandemics was the Black Death (also known as The Plague), which killed an estimated 75–200 million people in the 14th century. Other notable pandemics include the 1918 influenza pandemic (Spanish flu) and the 2009 influenza pandemic (H1N1). Current pandemics include HIV/AIDS and COVID-19.



The 1918–20 "Spanish flu" influenza pandemic resulted in dramatic mortality worldwide.

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Definition and stages

A pandemic is an epidemic occurring on a scale that crosses international boundaries, usually affecting people on a worldwide scale.^[1] A disease or condition is not a pandemic merely because it is widespread or kills many people; it must also be infectious. For instance, cancer is responsible for many deaths but is not considered a pandemic because the disease is neither infectious nor contagious.^[2]

The World Health Organization (WHO) previously applied a six-stage classification to describe the process by which a novel influenza virus moves from the first few infections in humans through to a pandemic. This starts with the virus mostly infecting animals, with a few cases where animals infect people, then moves through the stage where the virus begins to spread directly between people and ends with a pandemic when infections from the new virus have spread worldwide. In February 2020, a WHO spokesperson clarified that "there is no official category [for a pandemic]".^{[a][3]}

In a virtual press conference in May 2009 on the influenza pandemic, Dr. Keiji Fukuda, Assistant Director-General *ad interim* for Health Security and Environment, WHO said "An easy way to think about pandemic ... is to say: a pandemic is a global outbreak. Then you might ask yourself: 'What is a global outbreak'? Global outbreak means that we see both spread of the agent ... and then we see disease activities in addition to the spread of the virus."^[4]

In planning for a possible influenza pandemic, the WHO published a document on pandemic preparedness guidance in 1999, revised in 2005 and in February 2009, defining phases and appropriate actions for each phase in an *aide-mémoire* titled *WHO*

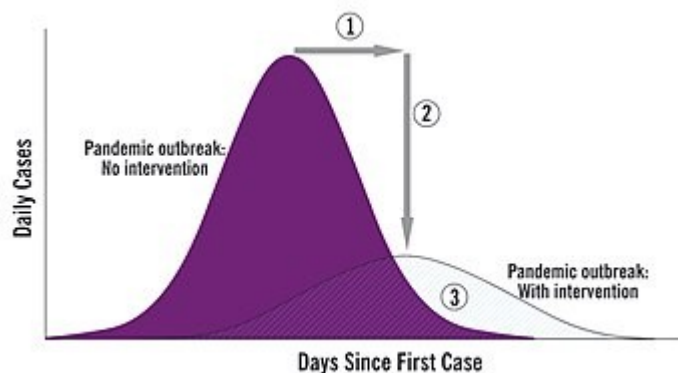
WHO Phases	
INTER-PANDEMIC PERIOD	
1	No new influenza virus subtypes have been detected in humans. An influenza virus subtype that has caused human infection may be present in animals. If present in animals, the risk of human disease is considered to be low.
2	No new influenza virus subtypes have been detected in humans. However, a circulating animal influenza virus subtype poses a substantial risk of human disease.
PANDEMIC ALERT PERIOD	
3	Human infection(s) with a new subtype, but no human-to-human spread, or at most rare instances of spread to a close contact.
4	Small cluster(s) with limited human-to-human transmission but spread is highly localized, suggesting that the virus is not well adapted to humans.
5	Larger cluster(s) but human-to-human spread still localized, suggesting that the virus is becoming increasingly better adapted to humans, but may not yet be fully transmissible (substantial pandemic risk).
PANDEMIC PERIOD	
6	Pandemic phase: increased and sustained transmission in general population.

The World Health Organization's former influenza pandemic alert phases—WHO no longer uses this old system of six phases

pandemic phase descriptions and main actions by phase. The 2009 revision, including definitions of a pandemic and the phases leading to its declaration, were finalized in February 2009. The pandemic H1N1 2009 virus was neither on the horizon at that time nor mentioned in the document.^{[5][6]} All versions of this document refer to influenza. The phases are defined by the spread of the disease; virulence and mortality are not mentioned in the current WHO definition, although these factors have previously been included.^[7]

Management

The basic strategies in the control of an outbreak are **containment** and **mitigation**. Containment may be undertaken in the early stages of the outbreak, including contact tracing and isolating infected individuals to stop the disease from spreading to the rest of the population, other public health interventions on infection control, and therapeutic countermeasures such as vaccinations which may be effective if available.^[10] When it becomes apparent that it is no longer possible to contain the spread of the disease, management will then move on to the mitigation stage, in which measures are taken to slow the spread of the disease and mitigate its effects on society and the healthcare system. In reality, containment and mitigation measures may be undertaken simultaneously.^[11]



The goals of community mitigation: (1) delay outbreak peak; (2) reduce peak burden on healthcare, known as flattening the curve; and (3) diminish overall cases and health impact.^{[8][9]}

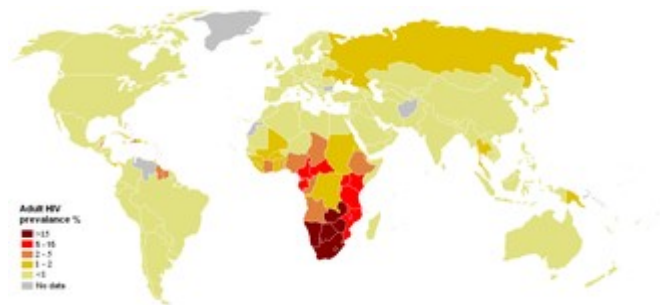
A key part of managing an infectious disease outbreak is trying to decrease the epidemic peak, known as "flattening the epidemic curve".^[8] This helps decrease the risk of health services being overwhelmed, and provides more time for a vaccine and treatment to be developed.^[8] Non-pharmaceutical interventions may be taken to manage the outbreak. In a flu pandemic, these actions may include: personal preventive measures such as hand hygiene, wearing face-masks, and self-quarantine; community measures aimed at social distancing such as closing schools and cancelling mass gatherings; community engagement to encourage acceptance and participation in such interventions; and environmental measures such as cleaning of surfaces.^[9]

Another strategy, **suppression**, requires more extreme long-term non-pharmaceutical interventions so as to reverse the pandemic by reducing the basic reproduction number to less than 1. The suppression strategy, which includes stringent population-wide social distancing, home isolation of cases, and household quarantine, was undertaken by China during the 2019–20 coronavirus pandemic where entire cities were placed under lockdown, but such strategy carries with it considerable social and economic costs.^[12]

Current pandemics

HIV/AIDS

Although the WHO uses the term 'global epidemic' to describe HIV ("WHO HIV/AIDS Data and Statistics" (<https://www.who.int/hiv/data/en/>). Retrieved 12 April 2020.), some authors use the term 'pandemic'.^[13] HIV originated in Africa, and spread to the United States via Haiti between 1966 and 1972.^[14] AIDS is currently a pandemic, with infection rates as high as 25% in southern and eastern Africa. In 2006, the HIV prevalence rate among pregnant women in South Africa was 29%.^[15] Effective education about safer sexual practices and bloodborne infection precautions training have helped to slow down infection rates in several African countries sponsoring national education programs.



Estimated HIV/AIDS prevalence among young adults (15-49) by country as of 2008









COVID-19

A new strain of coronavirus which originated in Wuhan, Hubei province, China, in late December 2019,^[16] has caused a cluster of cases of an acute respiratory disease, which is referred to as coronavirus disease 2019 (COVID-19). According to media reports, more than 200 countries and territories have been affected by COVID-19, with major outbreaks occurring in the United States, central China, western Europe, and Iran.^{[17][18]} On 11 March 2020, the World Health Organization characterized the spread of COVID-19 as a pandemic.^{[19][20]} As of 17 April 2020, the number of people infected with COVID-19 reached 2.25 million worldwide, the death toll was 154,295 and the number of patients recovered was 574,383.^[21]



People queuing outside a Wuhan pharmacy to buy face masks and medical supplies

Major outbreaks in countries

Country Name	Total Cases	Total Deaths	Total Recovered	Active Cases	Deaths Percentage %	Recover Percentage %
 USA	■ 710,272	37,175 ^[22]	63,510	609,587	5.23	8.94
 Spain	■ 190,839	20,002	74,797	96,040	10.48	39.19
 Italy	■ 172,434	22,745	42,727	106,962	13.19	24.78
 France	■ 147,969	18,681	34,420	94,868	12.62	23.26
 Germany	■ 141,397	4,352	83,114	53,931	3.08	58.78
 United Kingdom	■ 108,692	14,576	N/A	93,772	13.41	N/A
 China	■ 82,719	4,632	77,029	1,058	5.6	93.12
 Iran	■ 79,494	4,958	54,064	20,472	6.24	68.01

[2] (<https://www.worldometers.info/coronavirus/>)

Notable outbreaks

In human history, it is generally zoonoses such as influenza and tuberculosis, which constitute most of the widespread outbreaks, coming about as a result of the domestication of animals. There have been a number of particularly significant epidemics that deserve mention above the "mere" destruction of cities:

- Plague of Athens (430 to 426 BCE) - During the Peloponnesian War, Typhoid fever killed a quarter of the Athenian troops, and a quarter of the population over four years. This disease fatally weakened the dominance of Athens, but the sheer virulence of the disease prevented its wider spread; i.e. it killed off its hosts at a rate faster than they could spread it. The exact cause of the plague was unknown for many years. In January 2006, researchers from the University of Athens analyzed teeth recovered from a mass grave underneath the city, and confirmed the presence of bacteria responsible for typhoid.^[23]
- Antonine Plague (165 to 180 AD) - Possibly measles or smallpox brought to the Italian peninsula by soldiers returning from the Near East; it killed a quarter of those infected, and up to five million in all.^[24]
- Plague of Cyprian (251–266 AD) - A second outbreak, which may have been the same disease as the Antonine Plague. 5,000 people a day were said to be dying in Rome.
- Plague of Justinian (541 to 750 AD) - Was the first recorded outbreak of the bubonic plague. It started in Egypt and reached Constantinople the following spring, killing (according to the Byzantine chronicler Procopius) 10,000 a day at its



Contemporary engraving of Marseille during the Great Plague of Marseille in 1720–1721

height, and perhaps 40% of the city's inhabitants. The plague went on to eliminate a quarter to half the human population of the known world.^{[25][26]} It caused Europe's population to drop by around 50% between 550 AD and 700 AD.^[27]

- **Black Death (1331 to 1353)** - The total number of deaths worldwide is estimated at 75 to 200 million people. Eight hundred years after the last outbreak, the plague returned to Europe. Starting in Asia, the disease reached Mediterranean and western Europe in 1348 (possibly from Italian merchants fleeing fighting in Crimea), and killed an estimated 20 to 30 million Europeans in six years;^[28] a third of the total population,^[29] and up to a half in the worst-affected urban areas.^[30] It was the first of a cycle of European plague epidemics that continued until the 18th century.^[31] There were more than 100 plague epidemics in Europe in this period.^[32] The disease recurred in England every two to five years from 1361 to 1480.^[33] By the 1370s, England's population was reduced by 50%.^[34] The Great Plague of London of 1665–66 was the last major outbreak of the plague in England. The disease killed approximately 100,000 people, 20% of London's population.^[35]
- **Third plague pandemic (1855)** - Started in China and spread into India, where 10 million people died.^[36] During this pandemic, the United States saw its first outbreak: the San Francisco plague of 1900–1904.^[37] Today, isolated cases of plague are still found in the western United States.^[38]
- **Spanish flu (1918 to 1920)** - It infected 500 million people around the world,^[39] including people on remote Pacific islands and in the Arctic, and resulted in the deaths of 20 to 100 million people.^{[39][40]} Most influenza outbreaks disproportionately kill the very young and the very old, with higher survival rate for those in between, but the Spanish flu had an unusually high mortality rate for young adults.^[41] Spanish flu killed more people than World War I did and it killed more people in 25 weeks than AIDS did in its first 25 years.^{[42][43]} Mass troop movements and close quarters during World War I caused it to spread and mutate faster; the susceptibility of soldiers to Spanish flu might have been increased due to stress, malnourishment and chemical attacks.^[44] Improved transportation systems made it easier for soldiers, sailors, and civilian travelers to spread the disease.^[45]

Encounters between European explorers and populations in the rest of the world often introduced epidemics of extraordinary virulence. Disease killed part of the native population of the Canary Islands in the 16th century (Guanches). Half the native population of Hispaniola in 1518 was killed by smallpox. Smallpox also ravaged Mexico in the 1520s, killing 150,000 in Tenochtitlán alone, including the emperor, and Peru in the 1530s, aiding the European conquerors.^[46] Measles killed a further two million Mexican natives in the 17th century. In 1618–1619, smallpox wiped out 90% of the Massachusetts Bay Native Americans.^[47] During the 1770s, smallpox killed at least 30% of the Pacific Northwest Native Americans.^[48] Smallpox epidemics in 1780–1782 and 1837–1838 brought devastation and drastic depopulation among the Plains Indians.^[49] Some believe the death of up to 95% of the Native American population of the New World was caused by Europeans introducing Old World diseases such as smallpox, measles, and influenza.^[50] Over the centuries, the Europeans had developed high degrees of herd immunity to these diseases, while the indigenous peoples had no such immunity.^[51]

Smallpox devastated the native population of Australia, killing around 50% of Indigenous Australians in the early years of British colonisation.^[52] It also killed many New Zealand Māori.^[53] As late as



Aztecs dying of smallpox, *Florentine Codex* (compiled 1540–1585)

1848–49, as many as 40,000 out of 150,000 Hawaiians are estimated to have died of measles, whooping cough and influenza. Introduced diseases, notably smallpox, nearly wiped out the native population of Easter Island.^[54] Measles killed more than 40,000 Fijians, approximately one-third of the population, in 1875,^[55] and in the early 21st century devastated the Andamanese population.^[56] The Ainu population decreased drastically in the 19th century, due in large part to infectious diseases brought by Japanese settlers pouring into Hokkaido.^[57]

Researchers concluded that syphilis was carried from the New World to Europe after Columbus' voyages. The findings suggested Europeans could have carried the nonvenereal tropical bacteria home, where the organisms may have mutated into a more deadly form in the different conditions of Europe.^[58] The disease was more frequently fatal than it is today. Syphilis was a major killer in Europe during the Renaissance.^[59] Between 1602 and 1796, the Dutch East India Company sent almost a million Europeans to work in Asia. Ultimately, fewer than a third made their way back to Europe. The majority died of diseases.^[60] Disease killed more British soldiers in India and South Africa than war.^[61]

As early as 1803, the Spanish Crown organized a mission (the Balmis expedition) to transport the smallpox vaccine to the Spanish colonies, and establish mass vaccination programs there.^[62] By 1832, the federal government of the United States established a smallpox vaccination program for Native Americans.^[63] From the beginning of the 20th century onwards, the elimination or control of disease in tropical countries became a driving force for all colonial powers.^[64] The sleeping sickness epidemic in Africa was arrested due to mobile teams systematically screening millions of people at risk.^[65] In the 20th century, the world saw the biggest increase in its population in human history due to lessening of the mortality rate in many countries due to medical advances.^[66] The world population has grown from 1.6 billion in 1900 to an estimated 6.8 billion in 2011.^[67]

Cholera

Since it became widespread in the 19th century, cholera has killed tens of millions of people.^[68]

- 1817–1824 cholera pandemic. Previously restricted to the Indian subcontinent, the pandemic began in Bengal, then spread across India by 1820. 10,000 British troops and countless Indians died during this pandemic.^[69] It extended as far as China, Indonesia (where more than 100,000 people succumbed on the island of Java alone) and the Caspian Sea before receding. Deaths in the Indian subcontinent between 1817 and 1860 are estimated to have exceeded 15 million persons. Another 23 million died between 1865 and 1917. Russian deaths during a similar period exceeded 2 million.^[70]
- 1826–1837 cholera pandemic. Reached Russia (see Cholera Riots), Hungary (about 100,000 deaths) and Germany in 1831, London in 1832 (more than 55,000 persons died in the United Kingdom),^[71] France, Canada (Ontario), and United States (New York City) in the same year,^[72] and the Pacific coast of North America by 1834. It is believed that more than 150,000 Americans died of cholera between 1832 and 1849.^[73]
- 1846–1860 cholera pandemic. Deeply affected Russia, with more than a million deaths. A two-year outbreak began in England and Wales in 1848 and claimed 52,000 lives.^[74] Throughout Spain, cholera caused more than 236,000 deaths in 1854–55.^[75] It claimed 200,000 lives in Mexico.^[76]
- 1863–75 cholera pandemic. Spread mostly in Europe and Africa. At least 30,000 of the 90,000

Mecca pilgrims fell victim to the disease. Cholera claimed 90,000 lives in Russia in 1866.^[77]

- In 1866, there was an outbreak in North America. It killed some 50,000 Americans.^[73]
- 1881–96 cholera pandemic. The 1883–1887 epidemic cost 250,000 lives in Europe and at least 50,000 in the Americas. Cholera claimed 267,890 lives in Russia (1892);^[78] 120,000 in Spain;^[79] 90,000 in Japan and 60,000 in Persia.
- In 1892, cholera contaminated the water supply of Hamburg, and caused 8,606 deaths.^[80]
- 1899–1923 cholera pandemic. Had little effect in Europe because of advances in public health, but Russia was badly affected again (more than 500,000 people dying of cholera during the first quarter of the 20th century).^[81] The sixth pandemic killed more than 800,000 in India. The 1902–1904 cholera epidemic claimed more than 200,000 lives in the Philippines.^[82]
- 1961–75 cholera pandemic. Began in Indonesia, called EI Tor after the new biotype responsible for the pandemic, and reached Bangladesh in 1963, India in 1964, and the Soviet Union in 1966. Since then the pandemic has reached Africa, South America, and Central America.

Influenza

- The Greek physician Hippocrates, the "Father of Medicine", first described influenza in 412 BC.^[83]
- The first influenza pandemic was recorded in 1580, and since then, influenza pandemics occurred every 10 to 30 years.^{[84][85][86]}
- The 1889–1890 flu pandemic, also known as Russian Flu or Asiatic Flu, was first reported in May 1889 in Bukhara, Uzbekistan. By October, it had reached Tomsk and the Caucasus. It rapidly spread west and hit North America in December 1889, South America in February–April 1890, India in February–March 1890, and Australia in March–April 1890. The H3N8 and H2N2 subtypes of the Influenza A virus have each been identified as possible causes. It had a very high attack and mortality rate, causing around a million fatalities.^[87]
- The "Spanish flu", 1918–1919. First identified early in March 1918 in U.S. troops training at Camp Funston, Kansas. By October 1918, it had spread to become a worldwide pandemic on all continents, and eventually infected about one-third of the world's population (or ≈500 million persons).^[39] Unusually deadly and virulent, it ended almost as quickly as it began, vanishing completely within 18 months. Within six months, some 50 million people were dead;^[39] some estimates put the total number of fatalities worldwide at over twice that number.^[88] About 17 million died in India, 675,000 in the United States,^[89] and 200,000 in the United Kingdom. The virus that caused Spanish flu was also implicated as a cause of encephalitis lethargica in children.^[90] The virus was recently reconstructed by scientists at the CDC studying remains preserved by the Alaskan permafrost. The H1N1 virus has a small but crucial structure that is similar to the Spanish flu.^[91]
- The "Asian Flu", 1957–58. A H2N2 virus first identified in China in late February 1957. It caused about two million deaths globally.^[92]
- The "Hong Kong Flu", 1968–69. A H3N2 virus first detected in Hong Kong in early 1968 and spread across the world, lasting until 1972. This pandemic killed approximately one million people worldwide.^[93]
- The "Swine Flu", 2009–10. An H1N1 virus first detected in Mexico in early 2009. Estimates for the



Advice for travelers (in French and English) on the risks of epidemics abroad; posters from the Charles De Gaulle airport, Paris

mortality of this pandemic range from 150 to 500 thousand.^[94]

Typhus

Typhus is sometimes called "camp fever" because of its pattern of flaring up in times of strife. (It is also known as "gaol fever" and "ship fever", for its habits of spreading wildly in cramped quarters, such as jails and ships.) Emerging during the Crusades, it had its first impact in Europe in 1489, in Spain. During fighting between the Christian Spaniards and the Muslims in Granada, the Spanish lost 3,000 to war casualties, and 20,000 to typhus. In 1528, the French lost 18,000 troops in Italy, and lost supremacy in Italy to the Spanish. In 1542, 30,000 soldiers died of typhus while fighting the Ottomans in the Balkans.

During the Thirty Years' War (1618–1648), about eight million Germans were killed by bubonic plague and typhus.^[95] The disease also played a major role in the destruction of Napoleon's Grande Armée in Russia in 1812. During the retreat from Moscow, more French military personnel died of typhus than were killed by the Russians.^[96] Of the 450,000 soldiers who crossed the Neman on 25 June 1812, fewer than 40,000 returned. More military personnel were killed from 1500–1914 by typhus than from military action.^[97] In early 1813, Napoleon raised a new army of 500,000 to replace his Russian losses. In the campaign of that year, more than 219,000 of Napoleon's soldiers died of typhus.^[98] Typhus played a major factor in the Irish Potato Famine. During World War I, typhus epidemics killed more than 150,000 in Serbia. There were about 25 million infections and 3 million deaths from epidemic typhus in Russia from 1918 to 1922.^[98] Typhus also killed numerous prisoners in the Nazi concentration camps and Soviet prisoner of war camps during World War II. More than 3.5 million Soviet POWs died out of the 5.7 million in Nazi custody.^[99]

Smallpox

Smallpox was a contagious disease caused by the variola virus. The disease killed an estimated 400,000 Europeans per year during the closing years of the 18th century.^[100] During the 20th century, it is estimated that smallpox was responsible for 300–500 million deaths.^{[101][102]} As recently as the early 1950s, an estimated 50 million cases of smallpox occurred in the world each year.^[103] After successful vaccination campaigns throughout the 19th and 20th centuries, the WHO certified the eradication of smallpox in December 1979. To this day, smallpox is the only human infectious disease to have been completely eradicated,^[104] and one of two infectious viruses ever to be eradicated, along with rinderpest.^[105]



A child with smallpox infection, c. 1908

Measles

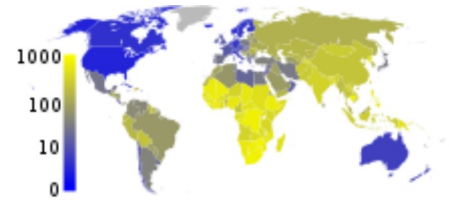
Historically, measles was prevalent throughout the world, as it is highly contagious. According to the U.S. National Immunization Program, 90% of people were infected with measles by age 15. Before the vaccine was introduced in 1963, there were an estimated three to four million cases in the U.S. each year.^[106] Measles killed around 200 million people

worldwide over the last 150 years.^[107] In 2000 alone, measles killed some 777,000 worldwide out of 40 million cases globally.^[108]

Measles is an endemic disease, meaning it has been continually present in a community, and many people develop resistance. In populations that have not been exposed to measles, exposure to a new disease can be devastating. In 1529, a measles outbreak in Cuba killed two-thirds of the natives who had previously survived smallpox.^[109] The disease had ravaged Mexico, Central America, and the Inca civilization.^[110]

Tuberculosis

One-quarter of the world's current population has been infected with *Mycobacterium tuberculosis*, and new infections occur at a rate of one per second.^[111] About 5–10% of these latent infections will eventually progress to active disease, which, if left untreated, kills more than half its victims. Annually, eight million people become ill with tuberculosis, and two million die from the disease worldwide.^[112] In the 19th century, tuberculosis killed an estimated one-quarter of the adult population of Europe;^[113] by 1918, one in six deaths in France were still caused by tuberculosis. During the 20th century, tuberculosis killed approximately 100 million people.^[107] TB is still one of the most important health problems in the developing world.^[114]



In 2007, the prevalence of TB per 100,000 people was highest in Sub-Saharan Africa, and was also relatively high in Asian countries like India.

Leprosy

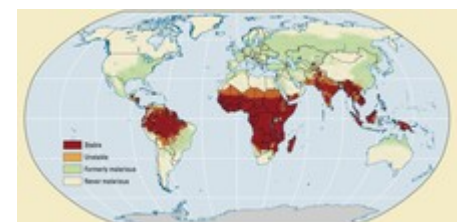
Leprosy, also known as Hansen's disease, is caused by a bacillus, *Mycobacterium leprae*. It is a chronic disease with an incubation period of up to five years. Since 1985, 15 million people worldwide have been cured of leprosy.^[115]

Historically, leprosy has affected people since at least 600 BC.^[116] Leprosy outbreaks began to occur in Western Europe around 1000 AD.^{[117][118]} Numerous *leprosorium*, or leper hospitals, sprang up in the Middle Ages; Matthew Paris estimated that in the early 13th century, there were 19,000 of them across Europe.^[119]

Malaria

Malaria is widespread in tropical and subtropical regions, including parts of the Americas, Asia, and Africa. Each year, there are approximately 350–500 million cases of malaria.^[120] Drug resistance poses a growing problem in the treatment of malaria in the 21st century, since resistance is now common against all classes of antimalarial drugs, except for the artemisinins.^[121]

Malaria was once common in most of Europe and North America, where it is now for all purposes non-existent.^[122] Malaria may have contributed to the decline of the Roman Empire.^[123] The



Past and current malaria prevalence in 2009

disease became known as "Roman fever".^[124] *Plasmodium falciparum* became a real threat to colonists and indigenous people alike when it was introduced into the Americas along with the slave trade. Malaria devastated the Jamestown colony and regularly ravaged the South and Midwest of the United States. By 1830, it had reached the Pacific Northwest.^[125] During the American Civil War, there were more than 1.2 million cases of malaria among soldiers of both sides.^[126] The southern U.S. continued to be afflicted with millions of cases of malaria into the 1930s.^[127]

Yellow fever

Yellow fever has been a source of several devastating epidemics.^[128] Cities as far north as New York, Philadelphia, and Boston were hit with epidemics. In 1793, one of the largest yellow fever epidemics in U.S. history killed as many as 5,000 people in Philadelphia—roughly 10% of the population. About half of the residents had fled the city, including President George Washington.^[129] In colonial times, West Africa became known as "the white man's grave" because of malaria and yellow fever.^[130]

Concerns about future pandemics

Antibiotic resistance

Antibiotic-resistant microorganisms, sometimes referred to as "superbugs", may contribute to the re-emergence of diseases which are currently well controlled.^[131] For example, cases of tuberculosis that are resistant to traditionally effective treatments remain a cause of great concern to health professionals. Every year, nearly half a million new cases of multidrug-resistant tuberculosis (MDR-TB) are estimated to occur worldwide.^[132] China and India have the highest rate of multidrug-resistant TB.^[133] The World Health Organization (WHO) reports that approximately 50 million people worldwide are infected with MDR TB, with 79 percent of those cases resistant to three or more antibiotics. In 2005, 124 cases of MDR TB were reported in the United States. Extensively drug-resistant tuberculosis (XDR TB) was identified in Africa in 2006, and subsequently discovered to exist in 49 countries, including the United States. There are about 40,000 new cases of XDR-TB per year, the WHO estimates.^[134]

In the past 20 years, common bacteria including *Staphylococcus aureus*, *Serratia marcescens* and Enterococcus, have developed resistance to various antibiotics such as vancomycin, as well as whole classes of antibiotics, such as the aminoglycosides and cephalosporins. Antibiotic-resistant organisms have become an important cause of healthcare-associated (nosocomial) infections (HAI). In addition, infections caused by community-acquired strains of methicillin-resistant *Staphylococcus aureus* (MRSA) in otherwise healthy individuals have become more frequent in recent years.

Viral hemorrhagic fevers

Viral hemorrhagic fevers such as Ebola virus disease, Lassa fever, Rift Valley fever, Marburg virus disease and Bolivian hemorrhagic fever are highly contagious and deadly diseases, with the theoretical potential to become pandemics.^[135] Their ability to spread efficiently enough to cause a pandemic is limited, however, as transmission of these viruses requires close contact with the infected vector, and the vector has only a short time before death or serious illness. Furthermore, the short time between a vector becoming infectious and the onset of symptoms allows medical professionals to

quickly quarantine vectors, and prevent them from carrying the pathogen elsewhere. Genetic mutations could occur, which could elevate their potential for causing widespread harm; thus close observation by contagious disease specialists is merited.

Coronaviruses

Coronaviruses (CoV) are a large family of viruses that cause illness ranging from the common cold to more severe diseases such as Middle East Respiratory Syndrome (MERS-CoV) and Severe Acute Respiratory Syndrome (SARS-CoV). A new strain of coronavirus (SARS-CoV-2) causes Coronavirus disease 2019, or COVID-19.^[136]

COVID-19 was declared a pandemic by the WHO on 11 March 2020.

Some coronaviruses are zoonotic, meaning they are transmitted between animals and people. Detailed investigations found that SARS-CoV was transmitted from civet cats to humans, and MERS-CoV from dromedary camels to humans. Several known coronaviruses are circulating in animals that have not yet infected humans. Common signs of infection include respiratory symptoms, fever, cough, shortness of breath, and breathing difficulties. In more severe cases, infection can cause pneumonia, severe acute respiratory syndrome, kidney failure and even death. Standard recommendations to prevent the spread of infection include regular hand washing, covering mouth and nose when coughing and sneezing, thoroughly cooking meat and eggs, and avoiding close contact with anyone showing symptoms of respiratory illness such as coughing and sneezing. The recommended distance from other people is 6 feet, a practice more commonly called social distancing.

Severe acute respiratory syndrome

In 2003 the Italian physician Carlo Urbani (1956–2003) was the first to identify severe acute respiratory syndrome (SARS) as a new and dangerously contagious disease, although he became infected and died. It is caused by a coronavirus dubbed SARS-CoV. Rapid action by national and international health authorities such as the World Health Organization helped to slow transmission and eventually broke the chain of transmission, which ended the localized epidemics before they could become a pandemic. However, the disease has not been eradicated and could re-emerge. This warrants monitoring and reporting of suspicious cases of atypical pneumonia.^[137]

Influenza

Wild aquatic birds are the natural hosts for a range of influenza A viruses. Occasionally, viruses are transmitted from these species to other species, and may then cause outbreaks in domestic poultry or, rarely, in humans.^{[139][140]}

H5N1 (Avian flu)

In February 2004, avian influenza virus was detected in birds in Vietnam, increasing fears of the emergence of new variant strains. It is feared that if the avian influenza virus combines with a human influenza virus (in a bird or a human), the new subtype created could be both highly contagious and highly lethal in humans. Such a subtype could cause a global influenza pandemic, similar to the Spanish flu or the lower mortality pandemics such as the Asian Flu and the Hong Kong Flu.

From October 2004 to February 2005, some 3,700 test kits of the 1957 Asian Flu virus were accidentally spread around the world from a lab in the U.S.^[141]

In May 2005, scientists urgently called upon nations to prepare for a global influenza pandemic that could strike as much as 20% of the world's population.^[142]

In October 2005, cases of the avian flu (the deadly strain H5N1) were identified in Turkey. EU Health Commissioner Markos Kyprianou said: "We have received now confirmation that the virus found in Turkey is an avian flu H5N1 virus. There is a direct relationship with viruses found in Russia, Mongolia and China." Cases of bird flu were also identified shortly thereafter in Romania, and then Greece. Possible cases of the virus have also been found in Croatia, Bulgaria and the United Kingdom.^[143]

By November 2007, numerous confirmed cases of the H5N1 strain had been identified across Europe.^[144] However, by the end of October, only 59 people had died as a result of H5N1, which was atypical of previous influenza pandemics.

Avian flu cannot be categorized as a "pandemic" because the virus cannot yet cause sustained and efficient human-to-human transmission. Cases so far are recognized to have been transmitted from bird to human, but as of December 2006 there had been few (if any) cases of proven human-to-human transmission.^[145] Regular influenza viruses establish infection by attaching to receptors in the throat and lungs, but the avian influenza virus can attach only to receptors located deep in the lungs of humans, requiring close, prolonged contact with infected patients, and thus limiting person-to-person transmission.

Zika virus

An outbreak of Zika virus began in 2015 and strongly intensified throughout the start of 2016, with more than 1.5 million cases across more than a dozen countries in the Americas. The World Health Organization warned that Zika had the potential to become an explosive global pandemic if the outbreak was not controlled.^[146]

Economic consequences

In 2016, the Commission on a Global Health Risk Framework for the Future estimated that pandemic disease events would cost the global economy over \$6 trillion in the 21st century—over \$60 billion per year.^[147] The same report recommended spending \$4.5 billion annually on global prevention and response capabilities to reduce the threat posed by pandemic events.

See also

- List of epidemics
- Biological hazard
- Bushmeat



President Barack Obama is briefed in the Situation Room about the 2009 flu pandemic, which killed as many as 17,000 Americans.^[138]

- [Compartmental models in epidemiology](#)
- [Crowdmapping](#)
- [Disease X](#)
- [European Centre for Disease Prevention and Control \(ECDC\)](#)
- [Mathematical modelling of infectious disease](#)
- [Medieval demography](#)
- [Mortality from infectious diseases](#)
- [Pandemic severity index](#)
- [Public health emergency of international concern](#)
- [Super-spreader](#)
- [Syndemic](#)
- [Tropical disease](#)
- [Timeline of global health](#)
- [WHO pandemic phases](#)

Notes

- a. For clarification, WHO does not use the old system of six phases—ranging from phase 1 (no reports of animal influenza causing human infections) to phase 6 (a pandemic)—that some people may be familiar with from H1N1 in 2009.

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External links

- WHO | World Health Organization (<https://www.who.int/en/>)
- Past pandemics that ravaged Europe (<http://news.bbc.co.uk/2/hi/health/4381924.stm>)
- Pandemic Influenza (<https://www.cdc.gov/flu/pandemic-resources/>) at CDC
- European Centre for Disease Prevention and Control (<http://www.ecdc.europa.eu/>)
- The American Journal of Bioethics' ethical issues in pandemics page (<http://pandemic.bioethics.n>

et/)

- TED-Education video (<https://www.youtube.com/user/TEDEducation?feature=watch>) [How pandemics spread \(https://www.youtube.com/watch?v=UG8YbNbdaco\)](https://www.youtube.com/watch?v=UG8YbNbdaco).
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