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**WHO Report on Global Surveillance of Epidemic-prone
Infectious Diseases**

World Health Organization

Department of Communicable Disease Surveillance and
Response

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CHAPTER 3

PLAGUE

Background of the disease

Plague is primarily a disease of rodents and their fleas, which can infect humans. It is transmitted between rodents by rodent fleas, and can be transmitted to people when infected rodent fleas bite them. As with many primarily zoonotic diseases, plague is a very severe disease in people, with case fatality rates of 50-60% if left untreated.

Plague has been responsible for widespread pandemics with high mortality. It was known as the "Black Death" during the fourteenth century, causing an estimated 50 million deaths, approximately half of them in Asia and Africa and the other half in Europe, where a quarter of the population succumbed.

There are three main forms of plague in humans, namely bubonic, septicaemic and pneumonic. Bubonic plague is the result of an insect bite in which the plague bacillus travels through the lymphatic system to the nearest lymph node where it forms a swelling. The most usual place for this swelling is the groin, but it also occurs in the armpits and the neck. These swellings are known as buboes (derived from the Greek word for groin). The septicaemic form of plague occurs when the insect deposits the bacillus directly into the bloodstream. This form is almost always fatal. Pneumonic plague is an infection of the lungs with the plague bacillus. Pneumonic plague can be transmitted directly from person to person via infected air droplets or through infected clothing and other contaminated articles.

Plague has declined dramatically since the early part of the twentieth century, when outbreaks could cause tens of millions of deaths. This is due primarily to improvements in living standards and health services. However, a substantial number of countries continue to be affected by plague, case fatality rates remain high and antimicrobial resistance has begun. Therefore, continued vigilance is required, particularly in human populations living near natural plague foci. Plague foci are not fixed, and can change in response to shifts in factors such as climate, landscape, and rodent population migration. Natural foci of plague are situated in all continents except Australia, within a broad belt in tropical, subtropical and warmer temperate climates, between the parallels 55° N and 40° S. These foci are presented in Map 3.1.

Map 3.1 Natural plague foci (in rodent populations)



Transmission

Plague is transmitted between rodents and other animals primarily via wild rodent fleas. *Wild plague* exists in natural foci independent of human populations and their activity. *Domestic plague* is intimately associated with rodents living with humans and can produce epidemics in both human and animal populations.

Humans are extremely susceptible to plague and may be infected either directly or indirectly. Indirect transmission through the bite of a flea is the most common route of transmission between plague-infected rodents and humans. Human infection can occur within the natural foci of plague but this is rare. Infection occurs more frequently in human settlements when domestic rodents become infected. This can happen when the domestic rodents come into contact with infected wild rodents living in the surrounding areas. Infected fleas leave the bodies of rodents killed by plague seeking a blood meal from another host and may bite human beings. Humans who contract the disease may subsequently become infective to other people via the respiratory route.¹

History

Cases of human plague have been known from time immemorial.² The first record of plague was an outbreak among the Philistines in 1320 BC, described in the Bible (I Samuel, V and VI). In the last two millennia, plague has become widespread, affecting a large number of countries on most continents during several pandemics.

The first pandemic that we are certain of, known as Justinian's plague, occurred between 542 AD and 546 AD, causing epidemics in Asia, Africa and Europe. It is estimated to have claimed nearly 100 million victims.

The second plague pandemic is the well-known "Black Death" of the fourteenth century (1347–1350). This pandemic was the beginning of a number of outbreaks of plague, which ravaged Europe and Africa in subsequent centuries.

The third pandemic began in Canton and Hong Kong in 1894 and spread rapidly throughout the world, by rats aboard the swifter steamships that replaced slow-moving sailing vessels in merchant fleets. Within 10 years (1894–1903) plague entered 77 ports on five continents. Plague became widespread in a number of countries. In India, there were over 6 million deaths from 1898 to 1908.³

Prevention and control

Many natural foci of plague have been identified, and prevention and control measures have been developed which make it possible to prevent plague outbreaks. Effective treatment methods enable almost all plague patients to be cured if diagnosed in time. The use of these measures has led to a sharp reduction in the epidemicity of plague throughout the world. Today the distribution of plague coincides with the geographical distribution of its natural foci.

Description of the data

WHO has data on the number of cases and deaths due to human plague notified to WHO under the International Health Regulations over the past 44 years (Table 3.1).

¹ Plague that can be transmitted via the respiratory route is known as pneumonic plague.

² Pollitzer R. *Plague*. Geneva, World Health Organization, 1954 (Monograph series).

³ Datta KK. *Plague epidemiology, prevention and control*. National Institute of Communicable Diseases, Delhi, India, 1994.

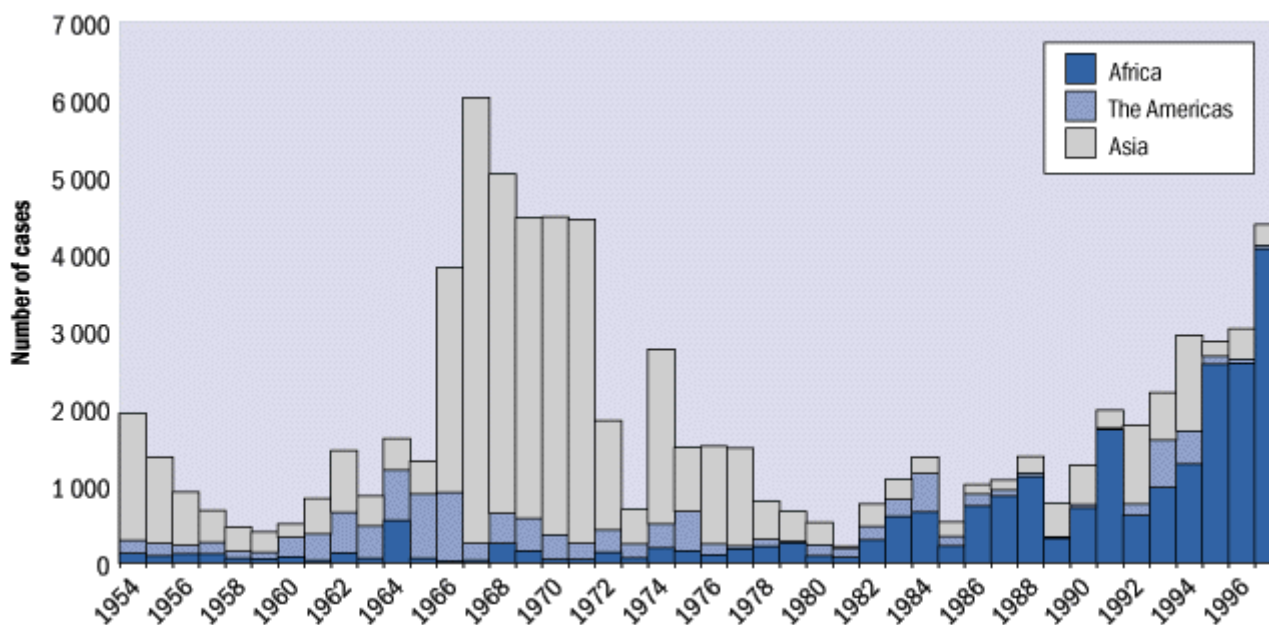
Strengths and weaknesses of the data

Plague is one of the diseases under the International Health Regulations, and countries are required to report cases of plague to WHO within 24 hours of being notified. However, as with other diseases under the International Health Regulations, officially reported data on plague do not adequately reflect the incidence of plague. They represent only a portion of the actual number of cases and may not even represent all of the known, active enzootic foci in the world. Global statistics on plague are incomplete because of the reluctance to officially notify plague cases as well as inadequate surveillance and reporting. In addition systems of reporting differ considerably in countries, and underreporting of plague due to lack of laboratory facilities for diagnostic confirmation is common. In most countries only bacteriologically or serologically confirmed cases are reported. It is estimated that laboratory confirmation of cases is obtained in only approximately one-third of suspected cases, making the actual epidemiological situation or disease incidence difficult to assess. However, a general description of the distribution of plague and global trends can be obtained from WHO data.

Trends

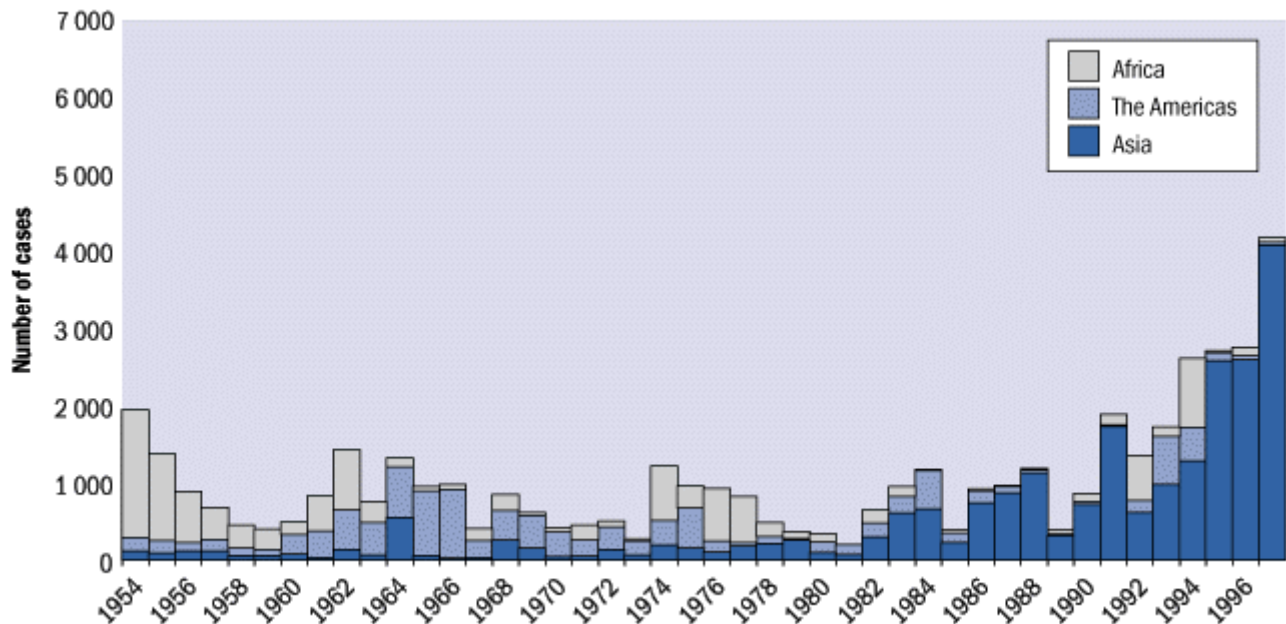
- Reports of plague were received from 38 countries during the period 1954-1997. These reports included notification of 80 613 cases and 6587 deaths. The maximum number of reported plague cases (6004) occurred in 1967 and the minimum (200) occurred in 1981.
- There are seven countries, namely Brazil, Democratic Republic of the Congo, Madagascar, Myanmar, Peru, United States of America, and Viet Nam which have been affected by plague virtually every year during the last 44 years.
- Over the past 44 years there have been three periods of increased plague activity. The first was during the mid-1960s, the second between 1973 and 1978, and the third was from the mid-1980s to the present. The rise in reported plague morbidity has continued worldwide in the 1990s (Fig. 3.1) particularly in Africa.

Fig. 3.1 Number of cases of plague reported to WHO, 1954-1997



- There has been a clear shift in the geographical distribution of plague over the last half-century. In the 1950s plague was primarily a problem of Asia, with some plague also occurring in the Americas. During the early 1960s there was an increased plague activity in the Americas, and the beginning of plague activity in Africa as well. During the last half of the 1960s and early 1970s there was a large plague epidemic in Viet Nam, which accounted for most of the plague activity in Asia, and plague became a more regular occurrence in Africa. During the last 20 years, reported cases of plague have increased dramatically in Africa, a trend that is still continuing.
- A plague epidemic in Viet Nam from 1966 to 1972 was largely responsible for the increased plague activity during the mid-sixties. This epidemic is considered to have been largely a result of the defoliation of vast areas during military operations, as well as the disruption of the economy, ecosystem and infrastructure as a result of prolonged armed conflict. If an epidemic in Viet Nam had not taken place the global trends shown in Fig. 3.1 would appear quite different. Fig. 3.2 presents the number of reported cases of plague with data from Viet Nam excluded, and it shows that during the last half century, there has been a shift in the main focus of plague, from Asia to the Americas to Africa.

Fig. 3.2 Number of cases of plague reported to WHO 1954-1997-Viet Nam excluded



Africa

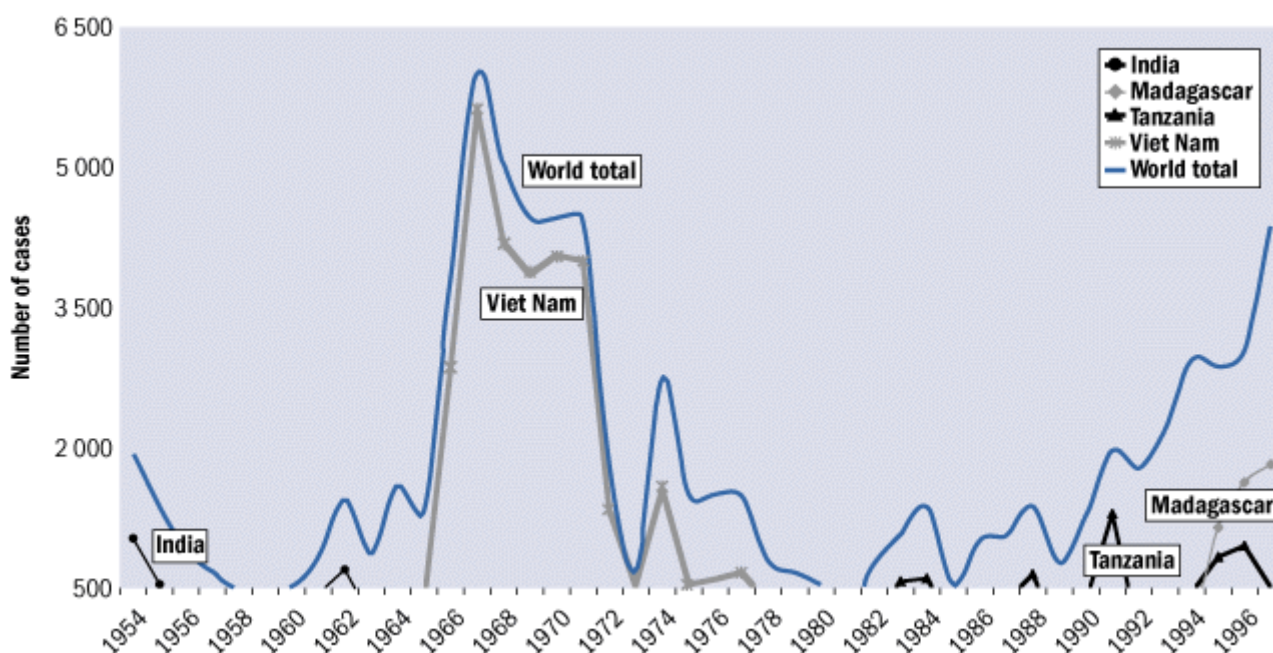
- Beginning in the 1980s, there has been a steep upward trend in the number of plague cases in Africa.
- There were a total of 19 349 cases and 1781 deaths in Africa from 1980 to 1997, comprising 66.8% and 75.8% of the world's total with an average case fatality rate of 9.2%.
- From 1980-1997, human plague was reported from 13 countries in Africa (Angola, Botswana, Democratic Republic of the Congo, Kenya, Libya, Madagascar, Malawi, Mozambique, South Africa, Uganda, United Republic of Tanzania, Zambia, Zimbabwe). Two of these countries, namely the Democratic Republic of the Congo and Madagascar have notified cases of human plague virtually every year, and Madagascar⁴ and the United Republic of Tanzania have accounted for 62.5% of the total plague cases reported in Africa during the last 15 years.

⁴ Madagascar reports all suspected cases of plague, including those that are not confirmed in laboratories. For example in 1997, there were 2863 cases of human plague reported, 1858 of which were bacteriologically negative.

Asia

- From 1954 to the early 1980s, most cases of plague worldwide were reported from Asia.
- Myanmar and Viet Nam have reported cases of human plague virtually every year since 1954.
- From 1980 to 1997, human plague was reported from seven countries in Asia (China, India, Kazakhstan, Lao People's Democratic Republic, Mongolia, Myanmar, and Viet Nam).
- The large plague epidemic in Viet Nam dominated the global picture from 1966 to 1972. Other large epidemics, such as the one in India in the 1950s and those in Tanzania and Madagascar in the 1990s have a strong effect on the world totals (Fig. 3.3).

Fig. 3.3 Plague in selected countries 1954 to 1997



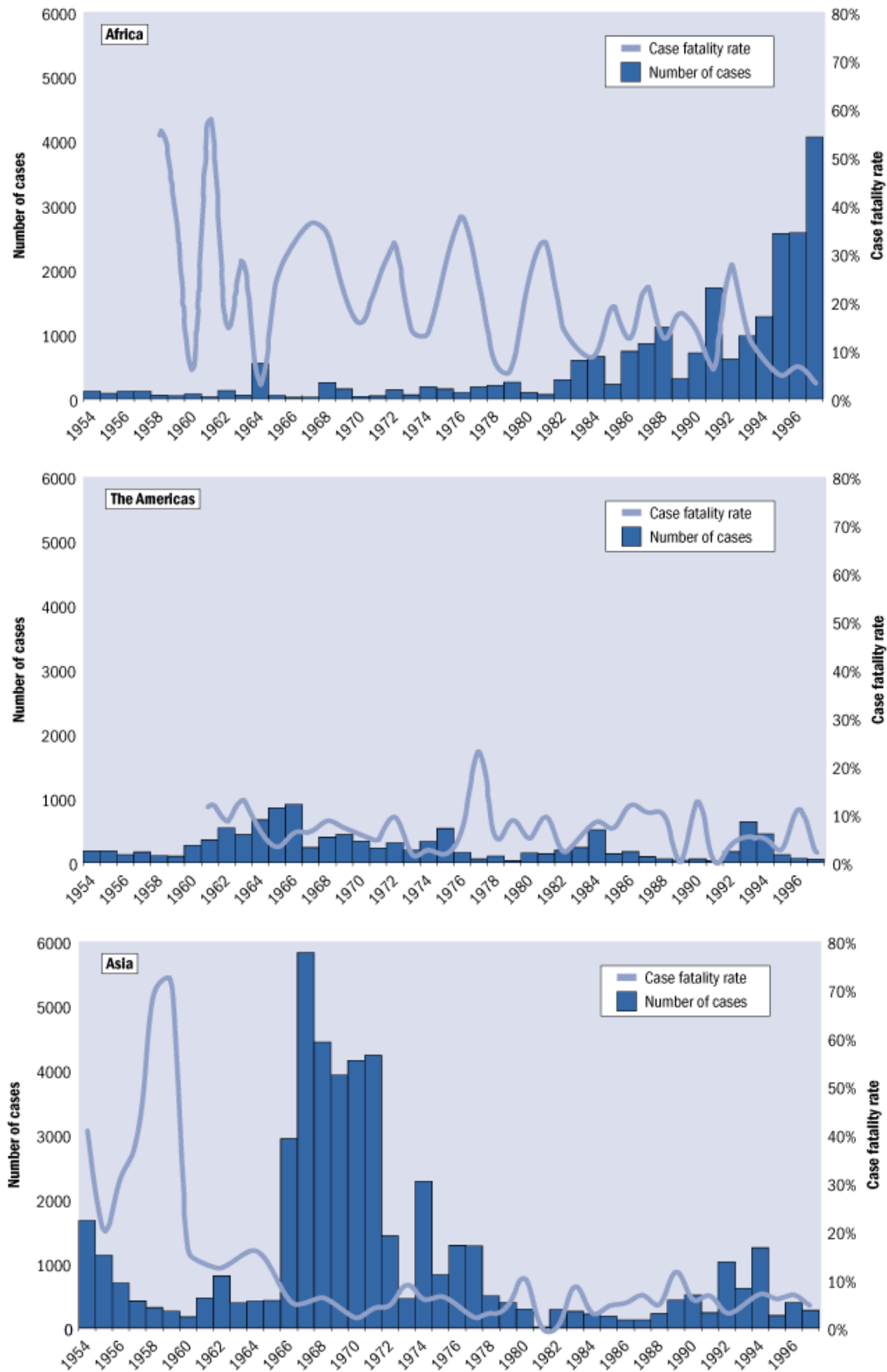
- In India, large plague outbreaks occurred during the first half of the twentieth century. There were also outbreaks in 1954, 1963, and then again 30 years later in 1994. Although the exact circumstances are unknown, factors contributing to the re-emergence of plague in India in 1994, are thought to include ecological changes created by the earthquake in September 1993 that disturbed the equilibrium density of domestic rodents and their fleas.⁵ Rainfall and flooding that occurred several weeks before the outbreak, as well as a large holiday that brought crowds of people together are also thought to have facilitated the spread of human plague.

The Americas

- Human plague was reported from five countries (Bolivia, Brazil, Ecuador, Peru and the United States of America). Three of these countries have notified some cases of human plague every year (Brazil, Peru, and the United States of America). Brazil and Peru accounted for 82% of the total cases reported in the Americas during the last 15 years. Totals for the period from 1980-1997 were 3137 cases with 194 deaths. The mean case fatality rate was 6.2% during the period.

⁵ Report on an Interregional Meeting on Prevention and Control of Plague, New Delhi. Geneva, World Health Organization, 1995 (unpublished document WHO/CDS/BVI/95.4).

Fig. 3.4 Reported number of plague cases and case fatality rates per continent, 1954-1997



Mortality

- For the last 45 years the mean perennial plague case fatality for the world (i.e. the average over the past 45 years of the annual reported number of plague deaths divided by the annual reported number of plague cases) has been 11.8%. There is wide variation in reported case fatality rates by continent and by year (Fig 3.4). There is also considerable variation from country to country and from epidemic to epidemic.
- Despite the availability of a number of highly effective therapeutic agents, mortality due to plague in many countries was high during the period 1954–1997.

Conclusions

1. Although there has been a general decline in the incidence of plague worldwide, the number of countries affected by plague remains substantial.
2. There has been an obvious change in the distribution of plague morbidity by continent. Whereas in the 1970s plague cases were reported predominately from Asia, in the 1980s and the 1990s a small number of African countries with well-known natural plague foci reported the highest number of cases.
3. Despite the availability of a number of highly effective therapeutic agents, mortality due to plague remains unacceptably high.

References

Publications and Documents

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Human Plague in 1997, *Weekly Epidemiological Record*, Vol. 74, 41, 1999.

Human Plague in 1996, *Weekly Epidemiological Record*, Vol. 73, 47, 1998.

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Table 3.1 Plague, cases and total number of deaths reported to WHO, and number of countries reporting, 1954-1998

Africa	1954	1955	1956	1957	1958	1959	1960	1961	1962	1963	1964	1965	1966	1967	1968	1969	1970
Angola																	
Botswana																	
Burkina Faso													1				
Cameroon								1									
Dem. Rep. of the Congo	42	25	22	35	8	12	26	6	1	4	4	16	8	7	104	68	16
Guinea																49	3
Kenya	9	27	8	6	19	14	36	3	2	3	1			1			
Lesotho	8	2												3	108	2	
Libyan Arab Jamahiriya																	
Madagascar ¹	17	17	20	57	21	5	6	4	28	9	6	32	9	10	28	26	13
Malawi										30							
Mozambique																	
Namibia								9	80	3							
South Africa	4	8	3	5		10	1	1	7	4	17			1	2		
Uganda	18				2	2											
United Rep. of Tanzania ¹			5	5					2		513	1			6	2	
Zambia																	
Zimbabwe	12		49										1				
Total no. of cases	110	79	107	108	50	43	69	24	120	53	541	49	19	22	248	147	32
Total no. of deaths					27	16	4	14	18	15	14	12	6	8	84	32	5
No. of countries reporting	7	5	6	5	4	5	4	6	6	6	5	3	4	5	5	5	3

¹ Includes suspected cases.

Table 3.1 Plague, cases and total number of deaths reported to WHO, and number of countries reporting, 1954-1998

The Americas	1954	1955	1956	1957	1958	1959	1960	1961	1962	1963	1964	1965	1966	1967	1968	1969	1970
Argentina					1												
Bolivia	9	45	3				12	20		53	49	149	3	3	30	95	54
Brazil	6	27	4	37	25	16	28	106	36	39	285	115	48	157	285	293	101
Ecuador	81	85	80	79	22	40	77	140	326	258	194	369	171	19	24	23	30
El Salvador		6															
Peru	75	8	24	37	50	33	139	68	164	72	125	200	662	41	45	8	128
United States of America			1	1		4	2	3	1	1		8	5	3	3	5	13
Venezuela			3					6		1							
Total no. of cases	171	171	115	154	98	93	258	343	527	424	653	841	889	223	387	424	326
Total no. of deaths		91						40	44	54	42	26	54	14	33	30	19
No. of countries reporting	4	5	6	4	4	4	5	6	4	6	4	5	5	5	5	5	5
Asia	1954	1955	1956	1957	1958	1959	1960	1961	1962	1963	1964	1965	1966	1967	1968	1969	1970
China																	
Cambodia	1	12	2	1													
India	1,031	542	262	162	206	214	122	402	697	205	109	14	11	6			
Indonesia	348	354	113	17		18	5								102	4	10
Iran					12			7		26							
Kazakhstan																	
Lao People's Dem. Rep.																	
Mongolia																	
Myanmar	265	203	273	227	76	21	22	39	68	34		36	48	120	86	32	43
Nepal														24	13		
Philippines			2														
Viet Nam ¹		1	34	4	15		14	8	29	115	297	368	2,844	5,619	4,193	3,850	4,056
Total no. of cases	1,645	1,112	686	411	309	253	163	456	794	380	406	418	2,903	5,769	4,394	3,886	4,109
Total no. of deaths	663	220	209	162	214	180	26	60	97	55	64	50	156	294	273	161	82
No. of countries reporting	4	5	6	5	4	3	4	4	3	4	2	3	3	4	4	3	3

¹ Includes suspected cases.

Table 3.1 Plague, cases and total number of deaths reported to WHO, and number of countries reporting, 1954-1998

Africa	1971	1972	1973	1974	1975	1976	1977	1978	1979	1980	1981	1982	1983	1984	1985	1986
Angola					49					21	6					
Botswana																
Burkina Faso																
Cameroon																
Dem. Rep.of the Congo	6	8	36	20	1	12	4		1			1				
Guinea																
Kenya								166	227	5						
Lesotho		8			8											
Libyan Arab Jamahiriya		16				19	11							8		
Madagascar ¹	31	63	20	38	55	47	58	25	23	11	44	38	24	39	85	29
Malawai																
Mozambique						15	97	12								
Namibia				102												
South Africa		1											19			
Uganda												153				340
United Rep. of Tanzania ¹		32					2			49	9	76	569	603	129	360
Zambia																
Zimbabwe				23	34							3	1		1	
Total no. of cases	37	128	56	183	147	93	172	203	251	86	59	290	594	650	215	729
Total no. of deaths	9	41	8	25	41	35	41	15	15	22	19	43	59	59	41	90
No. of countries reporting	2	6	2	4	5	4	5	3	3	4	3	6	3	3	3	3

¹ Includes suspected cases.

Table 3.1 Plague, cases and total number of deaths reported to WHO, and number of countries reporting, 1954-1998

The Americas	1971	1972	1973	1974	1975	1976	1977	1978	1979	1980	1981	1982	1983	1984	1985	1986
Argentina																
Bolivia	19			14	2	24	29	68	10	26	21	1	21	12		94
Brazil	146	169	152	291	496	97	1	11		98	59	151	82	37	64	58
Ecuador	27	9	1			8					8		65	7	3	
El Salvador																
Peru	22	118	30	8	3	1		6			27	11	17	413	44	
United States of America	2	1	2	8	20	16	18	12	13	18	13	19	40	31	17	10
Venezuela																
Total no. of cases	216	297	185	321	521	146	48	97	23	142	128	182	225	500	128	162
Total no. of deaths	10	28	3	8	9	9	11	5	2	7	12	4	12	42	9	19
No. of countries reporting	5	4	4	4	4	5	3	4	2	3	5	4	5	5	4	3
Asia	1971	1972	1973	1974	1975	1976	1977	1978	1979	1980	1981	1982	1983	1984	1985	1986
China									8	30	1		25		6	8
Cambodia		5	1													
India																
Indonesia																
Iran																
Kazakhstan																
Lao People's Dem. Rep.																
Mongolia										2					1	
Myanmar	189	63	17	700	275	673	591	171	73	73	1	165	96	10	35	6
Nepal																
Philippines																
Viet Nam ¹	3,997	1,340	425	1,552	536	593	667	314	306	180	11	116	127	196	137	104
Total no. of cases	4,186	1,408	443	2,252	811	1,266	1,258	485	387	285	13	281	248	206	179	118
Total no. of deaths	165	66	39	130	52	60	26	14	16	29		1	21	6	8	6
No. of countries reporting	2	3	3	2	2	2	2	2	3	4	3	2	3	2	4	3

¹ Includes suspected cases.

Table 3.1 Plague, cases and total number of deaths reported to WHO, and number of countries reporting, 1954-1998

Africa	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998
Angola												
Botswana			103	70								
Burkina Faso												
Cameroon												
Dem. Rep. of the Congo	474	369	1		289	390	636	82	582			
Guinea												
Kenya				44								
Lesotho												
Libyan Arab Jamahiriya												
Madagascar ¹	23	93	170	226	137	198	147	126	1,147	1,629	2,863	677
Malawi								9			582	
Mozambique								216			825	430
Namibia												
South Africa												
Uganda							167					49
United Rep. of Tanzania ¹	356	647	31	364	1,293	16	18	444	831	947	504	
Zambia	1										319	
Zimbabwe								392			8	5
Total no. of cases	854	1,109	305	704	1,719	604	968	1,269	2,560	2,576	5,101	1,161
Total no. of deaths	198	138	54	98	118	168	130	106	123	173	261	61
No. of countries reporting	4	3	4	4	3	3	4	6	3	2	6	4

¹ Includes suspected cases.

Table 3.1 Plague, cases and total number of deaths reported to WHO, and number of countries reporting, 1954-1998

The Americas	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998
Argentina												
Bolivia	2	2		10						26	1	
Brazil	43	25	26	18	10	25		4	9	1		
Ecuador												11
El Salvador												
Peru	31	10		18		120	611	420	97	23	39	8
United States of America	12	15	4	2	11	13	10	14	9	5	4	8
Venezuela												
Total no. of cases	88	52	30	48	21	158	621	438	115	55	44	27
Total no. of deaths	9	5		6		6	32	21	3	6	1	11
No. of countries reporting	4	4	2	4	2	3	2	3	3	4	3	3
Asia	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998
China	7	6	10	75	29	35	13	7	8	98	43	
Cambodia												
India								876				
Indonesia											6	
Iran												
Kazakhstan			2	4	1		3				1	
Lao People's Dem. Rep.									7	3		
Mongolia			5	15	3	12	21		1	6	4	8
Myanmar	5	8	34	6	100	528	87	6				
Nepal												
Philippines												
Viet Nam ¹	107	196	374	405	94	437	481	339	170	279	220	
Total no. of cases	119	210	425	505	227	1,012	605	1,228	186	386	274	8
Total no. of deaths	8	10	49	29	15	30	28	85	11	26	12	5
No. of countries reporting	3	3	5	5	5	4	5	4	4	4	5	1

¹ Includes suspected cases.