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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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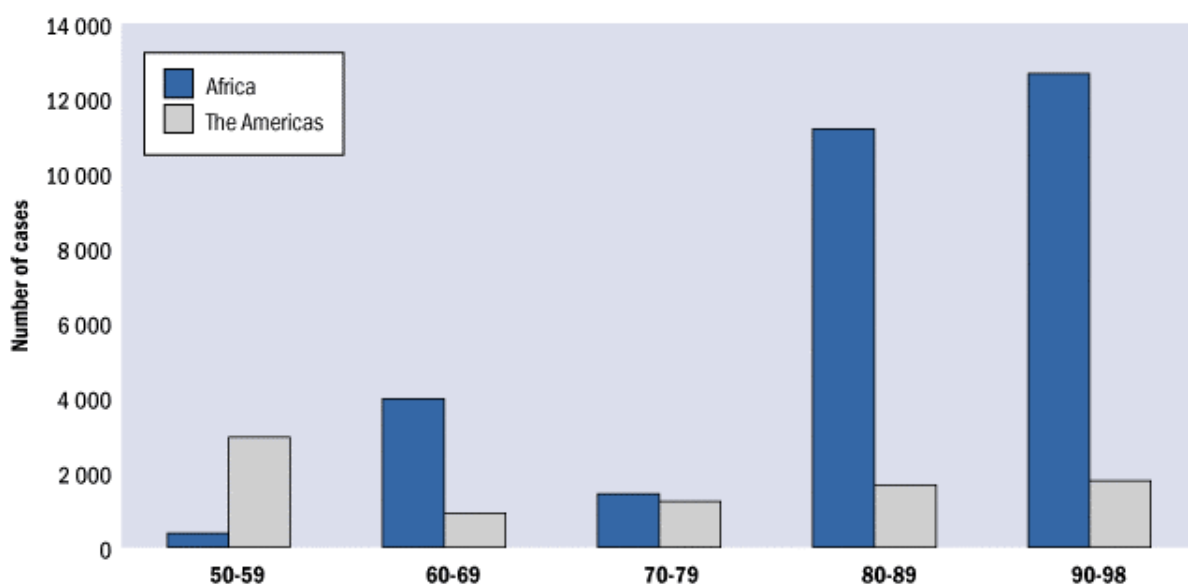
CHAPTER 2

YELLOW FEVER

Background of the disease

Yellow fever is a viral disease transmitted by infected mosquitos that has caused large epidemics in Africa and the Americas. It can be recognized from historic texts stretching back 400 years. Infection causes a wide spectrum of disease, from mild symptoms to severe illness and death. The “yellow” in the name is explained by the jaundice that affects some patients. The number of epidemics, and the number of people infected with yellow fever have increased over the last two decades, and yellow fever is now a serious public health problem again (Fig. 2.1). Case fatality rates for reported cases are in the order of 15 to 50%.

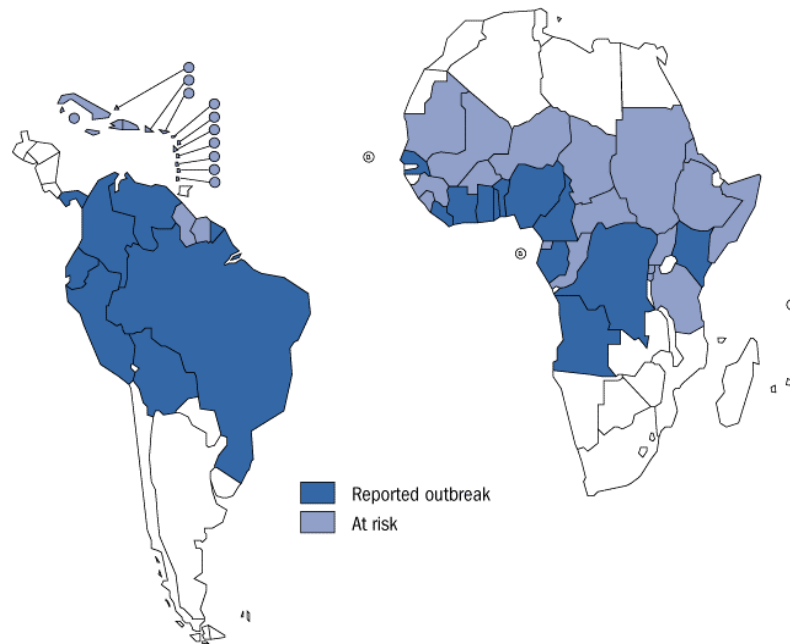
Fig. 2.1 Number of reported cases of yellow fever per decade, 1950-1998



An important reason for the re-emergence of yellow fever is the lapse of yellow fever immunization programmes in areas where they had been implemented in the past. Although a safe and effective vaccine has been available for 60 years, there are now large susceptible populations living in high-risk areas. Other factors contributing to the spread of yellow fever include increased urbanization, because mosquitos in urban areas increase the potential for explosive large urban outbreaks, increase in the distribution and density of mosquitos that transmit yellow fever and increased intrusion of people into forested areas.

The yellow fever virus is constantly present in mosquitos and non-human primates in some tropical areas of Africa and the Americas. Certain species of mosquitos are the reservoir of yellow fever virus; thus eradication of yellow fever is not feasible. This viral presence sometimes amplifies into regular epidemics. At present, 33 countries, with a combined population of 468 million, are at risk in Africa. These lie within a band ranging from 15°N to 10°S of the equator. In the Americas, yellow fever is endemic in ten South American countries and in several Caribbean islands. Bolivia, Brazil, Colombia, Ecuador and Peru are considered at greatest risk (see Map 2.1).

Map 2.1 Countries at risk of yellow fever and countries that have reported at least one outbreak of yellow fever, 1985-1999



Transmission

Several different species of the *Aedes* and *Haemogogus* (South America only) mosquitos transmit the yellow fever virus. These mosquitos are either domestic (i.e. they breed around houses), wild (they breed in the jungle) or semi-domestic species (they display a mixture of habits). Any region populated with these mosquitos can potentially harbour the disease. There are three types of transmission cycles for yellow fever: sylvatic, intermediate and urban. All three cycles exist in Africa, but in South America, only sylvatic and urban yellow fever occur.

Sylvatic (or jungle) yellow fever: In tropical rainforests, yellow fever occurs in monkeys that are infected by wild mosquitos. The infected monkeys can then pass the virus onto other mosquitos that feed on them. These infected mosquitos bite humans entering the forest resulting in sporadic cases of yellow fever. The majority of cases are young men working in the forest (logging, etc.). On occasion, the virus spreads beyond the affected individual.

Intermediate yellow fever: In humid or semi-humid savannahs of Africa, small-scale epidemics occur. These behave differently from urban epidemics; many separate villages in an area suffer cases simultaneously, but fewer people are infected. Semi-domestic mosquitos infect both monkey and human hosts. This area is often called the “zone of emergence”, where increased contact between man and infected mosquitos leads to disease. This is the most common type of outbreak seen in recent decades in Africa. It can shift to a more severe urban-type epidemic if the infection is carried into a suitable environment (with the presence of domestic mosquitos and unvaccinated humans).

Urban yellow fever: Large epidemics can occur when migrants introduce the virus into areas with high human population density. Domestic mosquitos (of one species, *Aedes aegypti*) carry the virus from person to person; no monkeys are involved in transmission. These outbreaks tend to spread outwards from one source to cover a wide area.

The potential for large-scale urban epidemics exists in many parts of the world. The density and habitats of *Aedes aegypti*, one of the mosquitos that transmits yellow fever, have expanded in both urban and rural areas. This mosquito is infesting regions where it was previously eradicated. Therefore,

although yellow fever has never been reported from Asia, this region is at risk because the appropriate mosquitos and primates are present. In addition, in the past, yellow fever outbreaks also occurred in Europe, the Caribbean islands and Central and North America - they must still be considered at risk for yellow fever epidemics even though the virus is not felt to be present in these areas now.

Prevention

Immunization is the single most important measure for preventing yellow fever. In populations where vaccination coverage is low, vigilant surveillance is critical for prompt recognition and rapid control of outbreaks. Mosquito control measures can be used to prevent virus transmission until vaccination has taken effect.

Yellow fever vaccine is safe and highly effective. The protective effect (immunity) occurs within one week in 95% of people vaccinated. A single dose of vaccine provides protection for 10 years and probably for life. Immunization with yellow fever vaccine can and should be part of the routine immunization system (administered during the same visit as measles vaccine). In addition, preventive immunization can be done in mass “catch-up” campaigns to increase immunization coverage in areas where it is low. This is often done on an emergency basis after the beginning of an outbreak. WHO strongly recommends routine childhood vaccination, which includes yellow fever. This is more cost effective and prevents more cases (and deaths) than emergency immunization campaigns to control an epidemic. Mosquito control measures can also play a role in reducing the risk of yellow fever, but are not as effective as immunization.

Description of the data

Yellow fever is one of the diseases reportable under the International Health Regulations (IHR). As such, countries are required to report cases and deaths to WHO within 24 hours of being notified of a case of yellow fever on their territory. Reporting of yellow fever cases and deaths to WHO began in 1948. Table 2.2 presents the total number of yellow fever cases and deaths reported to WHO from Africa and the Americas since 1950. WHO also collects data on immunization coverage, which is presented in Table 2.1 and Fig. 2.2.

Strengths and weaknesses of the data

As with other diseases under the International Health Regulations, only a small fraction of cases are reported to WHO. However, it is unlikely that major epidemics of yellow fever have been missed completely.¹

There are often long delays in detection of yellow fever outbreaks. This is due to a number of reasons including the often remote epidemic sites, lack of diagnostic facilities, difficulties in clinical recognition of the disease by peripheral health workers (yellow fever shares its symptoms with many other diseases that are common in the tropics), delays in recognition of the epidemic, and sparse communication of reports to the central level. These cause delays in the implementation of control measures, such as mass vaccination and vector control.

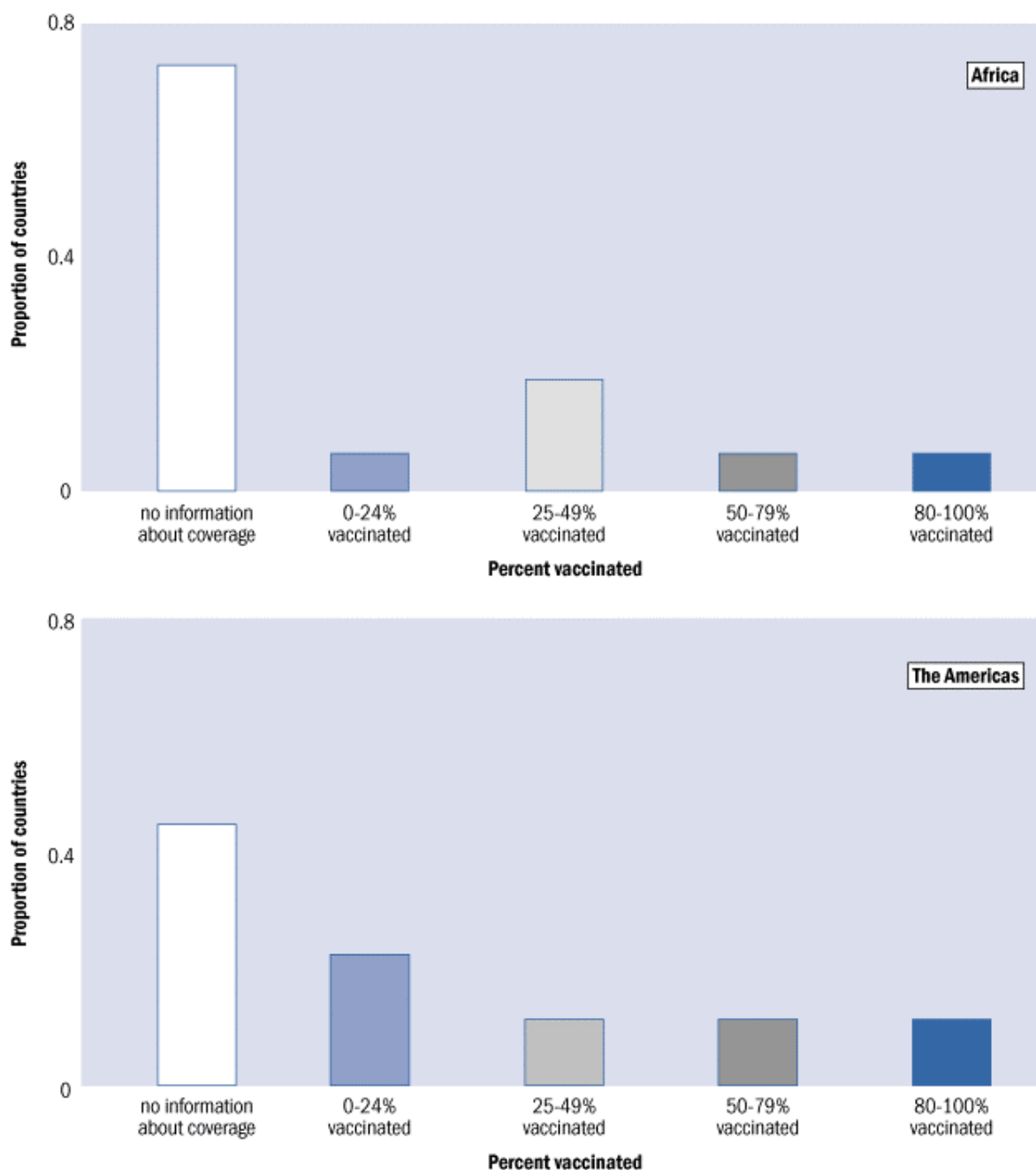
Logistical capacity to collect specimens and ready access to laboratory testing is essential for the confirmation of suspect cases but it is not always available (particularly in Africa). Accurate laboratory analysis depends upon trained laboratory staff, appropriate equipment and supplies, the provision of reagents, and proficiency testing. WHO has recently recommended that every at-risk country has at least one national laboratory where basic yellow fever blood tests can be performed,² and is actively assisting countries to upgrade the capacity for laboratory testing.

¹ A recent literature search for all available reports of yellow fever outbreaks indicated that when epidemics were known about, they had been reported to WHO – although often fewer cases were reported than had occurred.

² *District guidelines for yellow fever surveillance*, World Health Organization, 1998, WHO/EPI/GEN/98.09.

Data on routine yellow fever childhood immunization is weak. Not many countries are reporting routine childhood yellow fever immunization coverage to WHO. Of those countries that did report, coverage usually failed to reach even a rate of 50% of eligible children³ (Fig. 2.2).

Fig. 2.2 Yellow fever childhood immunization coverage, 1996-1998



³EPI information system: global summary, World Health Organization, 1998, WHO/EPI/GEN/98.10.

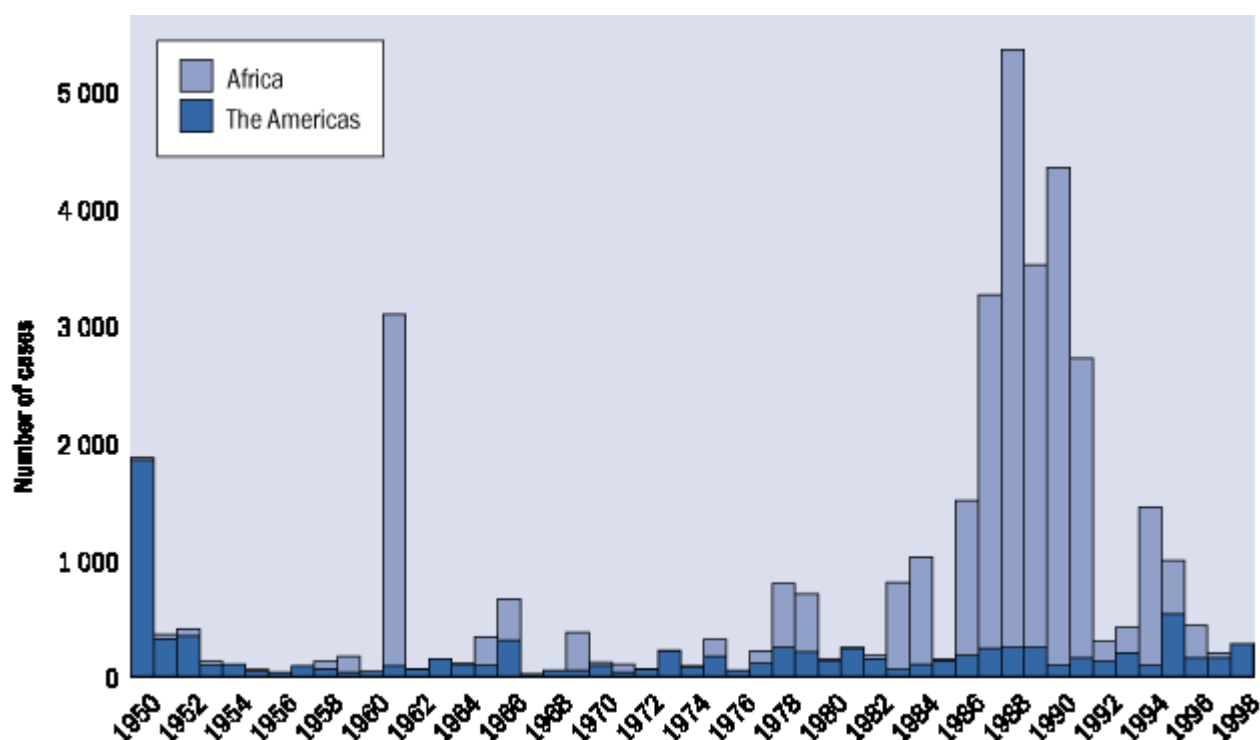
Trends

- The six-year period from 1986 to 1992 represents a remarkably active period for yellow fever and represents the greatest amount of yellow fever reported to WHO for any such period since 1950. The reported number of cases of yellow fever has declined since 1994, although the number of countries reporting yellow fever has not (Fig. 2.3 and Table 2.2).
- Reported case fatality rates for reported cases of yellow fever are high, often greater than 50% of all cases reported.

Immunization coverage

- To prevent epidemics, it is estimated that at least 80% of the population should have acquired immunity to yellow fever. At present, only two countries have reported achieving 50% coverage - namely Côte d'Ivoire and the Gambia.
- In terms of childhood immunization, two very small countries, Trinidad and Tobago and the Seychelles, have reported over 90% coverage, and Venezuela, Senegal and Côte d'Ivoire have reported over 50% coverage. Other countries have either not reported during the last three years or have lower coverage rates.

Fig 2.3 Reported number of cases of yellow fever, 1950-1998



Conclusions

1. Yellow fever is an important public health threat, which needs more attention. Currently it is endemic in Africa and South America, but other continents, particularly Asia, with mosquitos that are known to transmit yellow fever virus must be considered potentially at risk.
2. The efficacy of immunization has been well documented historically, and immunization of at-risk populations is the most important action to take for the prevention of epidemics. Yellow fever control programmes have lapsed in many countries, and current levels of immunization are well below their targets.
3. In the absence of adequate immunization levels, surveillance for yellow fever cases is essential to rapidly control disease outbreaks. Physicians must promptly report suspected cases, and health officials in at-risk countries should have laboratory capacity to perform diagnostic tests for yellow fever. Monitoring and surveillance of yellow fever incident cases and immunization coverage need strengthening to assess risk and detect outbreaks.

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District guidelines for yellow fever surveillance, World Health Organization, 1998, WHO/EPI/GEN/98.09.

Yellow fever – Technical Consensus Meeting, Geneva, 2-3 March 1998, World Health Organization, 1998, WHO/EPI/GEN/98.08.

Module 8: Yellow fever, The Immunological Basis for Immunization Series, World Health Organization, 1993, WHO/EPI/GEN/93.18.

Web pages

WHO yellow fever web pages:

http://www.who.int/vaccines-diseases/diseases/Yellow_fever.htm

http://www.who.int/emc/diseases/Yellow_fever

Table 2.1 Reported childhood immunization coverage, 1990-1998

Country	1990	1991	1992	1993	1994	1995	1996	1997	1998
Angola		35	22	32	34				36
Burkina Faso	65	78	41	42	45	55		27	
Central African Republic		60	35		36	52			36
Chad			24	16	28				25
Cote d'Ivoire		44	35	37	38	43	53	59	57
Dem. Rep. of the Congo			8						
Gabon		23					35		
Gambia		87	87	50	68			91	
Ghana			3	33	22	24	28		
Kenya			27	27	7	11	0		
Mali			9	0	3		0		10
Mauritania	32								
Niger		18	22	19	17	27			
Nigeria				1					
Sao Tome & Principe			2	1	2				
Senegal		59	41	46	46				50
Seychelles									96
Togo			37	14					
Zambia		8							
Africa: Total number of countries reporting	2	9	14	13	12	6	5	3	7
Brazil									38
Guyana									7
Panama									10
Trinidad & Tobago									91
Venezuela									79
America: Total number of countries reporting	0	0	0	0	0	0	0	0	5

Source: *EPI information system: global summary*, World Health Organization, 1998, WHO/EPI/GEN/98.10.

Table 2.2 Yellow fever, number of cases and total number of deaths reported to WHO, and number of countries reporting, 1950-1998

Africa	1950	1951	1952	1953	1954	1955	1956	1957	1958	1959	1960	1961	1962	1963	1964	1965	1966
Angola																	
Benin																	
Burkina Faso																	
Cameroon																	
Central African Republic						1											
Congo	2	1	5	8	1	3	4	3	60	11	7	4					
Cote d'Ivoire																	
Dem. Rep. of the Congo																	
Equatorial Guinea																	
Ethiopia												>3,000	10				350
Gabon																	
Gambia																	
Ghana	13	25	6		2	7				2				3			
Guinea			1														
Guinea Bissau															6		
Kenya																	
Liberia																	
Mali																	
Mauritania																	
Niger																	
Nigeria	1	13	42	18		1		2									
Senegal				2													243
Sierra Leone	1			1	3	2											
Sudan										120							
Togo																	
Uganda			1												1		
Total no. of cases	17	39	55	29	6	14	4	5	60	133	7	>3,000	10	3	7	243	350
Total no. of deaths	9	24	21	18	3	12	4	4	23	98	7	3,000	6	3	7	216	0
No. of countries reporting	5	3	5	4	3	5	1	2	1	3	1	2	1	1	2	1	1

Table 2.2 Yellow fever, number of cases and total number of deaths reported to WHO, and number of countries reporting, 1950-1998

Africa	1967	1968	1969	1970	1971	1972	1973	1974	1975	1976	1977	1978	1979	1980	1981	1982	1983
Angola					65												
Benin																	
Burkina Faso			87														356
Cameroon				1		2	1	1	2	1				7			
Central African Republic																	
Congo																	
Cote d'Ivoire																25	
Dem. Rep. of the Congo					2												
Equatorial Guinea				4													
Ethiopia																	
Gabon																	
Gambia												270					
Ghana			5	12	3	5	5	1	2	2	110	219	494	9	4	6	372
Guinea																	
Guinea Bissau																	
Kenya																	
Liberia	5																
Mali			21														
Mauritania																	
Niger																	
Nigeria			208	4			3	7				60		8			15
Senegal													1		3		
Sierra Leone									134								
Sudan																	
Togo			1	2													
Uganda																	
Total no. of cases	5		322	23	70	7	9	9	138	3	110	549	495	24	7	31	743
Total no. of deaths	3		119	12	44	6	5	2	44	2	33	103	120	9	2	29	488
No. of countries reporting	1	0	5	5	3	2	3	3	3	2	1	3	2	3	2	2	3

Table 2.2 Yellow fever, number of cases and total number of deaths reported to WHO, and number of countries reporting, 1950-1998

Africa	1984	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998
Angola					37										
Benin													120	18	6
Burkina Faso	17	7													2
Cameroon	1						173				10				
Central African Republic															
Congo															
Cote d'Ivoire														11	
Dem. Rep. of the Congo															
Equatorial Guinea															
Ethiopia															
Gabon											28	16			
Gambia															
Ghana										39	79		27	6	
Guinea				5											
Guinea Bissau															
Kenya									27	27	7	3			
Liberia												360		3	25
Mali				305											
Mauritania				21											
Niger															
Nigeria	898	6	1,318	2,676	5,067	3,270	4,075	2,561	149	152	1,227			7	
Senegal												79	128		
Sierra Leone												1	4		
Sudan															
Togo	1			5											
Uganda															
Total no. of cases	917	13	1,318	3,012	5,104	3,270	4,248	2,561	176	218	1,351	459	279	45	33
Total no. of deaths	21	3	424	1,014	1,516	618	341	661	21	38	452	34	141	9	10
No. of countries reporting	4	2	1	5	2	1	2	1	2	3	5	5	4	5	3

Table 2.2 Yellow fever, number of cases and total number of deaths reported to WHO, and number of countries reporting, 1950-1998

The Americas	1950	1951	1952	1953	1954	1955	1956	1957	1958	1959	1960	1961	1962	1963	1964	1965	1966
Argentina																2	51
Bolivia	1,806	3	1	18		4	6	19	2	1	14	2		81	13	19	69
Brazil	4	50	221	39	9	8	2	10	26	4	1	2	1		13	14	167
Colombia	12	26	16	11	12	22	16	35	21	21	11	9	30	10	10	2	3
Costa Rica		180	93	5													
Ecuador		42															
French Guiana																	
Guatemala								3									
Guyana												2					
Honduras					1												
Nicaragua			7	8													
Panama	2	3	1				1	4									
Paraguay																	
Peru	16	4	1		26			3	6	1	6	53	20	49	60	45	9
Suriname																	
Trinidad and Tobago					18					2							
Venezuela	3	4	1	8	29	5	3	6	6	1	2	14	1	1	2	5	5
United States of America																	
Total no. of cases	1,843	312	341	89	95	39	28	80	61	30	34	82	52	141	98	87	304
Total no. of deaths	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
No. of countries reporting	6	8	8	7	6	4	5	7	5	6	5	6	4	4	5	6	6

Table 2.2 Yellow fever, number of cases and total number of deaths reported to WHO, and number of countries reporting, 1950-1998

The Americas	1967	1968	1969	1970	1971	1972	1973	1974	1975	1976	1977	1978	1979	1980	1981	1982	1983
Argentina	1																
Bolivia		27	8	2	8	9	86	12	151	18	2	11	10	46	102	95	11
Brazil	2	2	4	2	11	12	70	13	1	1	9	27	12	27	22	24	6
Colombia	5	11	7	7	9	3	16	36	12	23	9	105	51	11	7	2	1
Costa Rica																	
Ecuador	1								3	1		1	14	2	2		5
French Guiana																	
Guatemala																	
Guyana		1															
Honduras																	
Nicaragua																	
Panama								4									
Paraguay								9									
Peru	3	5	28	75		7	33	2	1	1	82	93	97	30	98	19	27
Suriname		1	1			2											
Trinidad and Tobago													18				
Venezuela						22	7					3	3	4			
United States of America																	
Total no. of cases	12	47	48	86	28	55	212	76	168	44	102	240	205	120	231	140	50
Total no. of deaths	0	0	0	64	21	41	148	45	95	35	82	91	161	104	104	77	43
No. of countries reporting	5	6	5	4	3	6	5	6	5	5	4	6	7	6	5	4	5

Table 2.2 Yellow fever, number of cases and total number of deaths reported to WHO, and number of countries reporting, 1950-1998

The Americas	1984	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998
Argentina															
Bolivia	5	54	30	23	12	107	50	91	22	18	7	15	30	63	57
Brazil	45	7	9	16	26	9	2	15	12	83	19	4	15	3	34
Colombia	16	5	6	17	7	1	7	4	2	1	2	3	8	6	0
Costa Rica															
Ecuador	1	1	12				12	14	16	1		1	8	31	3
French Guiana															1
Guatemala															
Guyana															
Honduras															
Nicaragua															
Panama															
Paraguay															
Peru	28	59	118	179	195	120	17	27	67	89	61	499	86	44	160
Suriname															
Trinidad and Tobago															
Venezuela															14
United States of America													1		
Total no. of cases	95	126	175	235	240	237	88	151	119	192	89	522	148	147	269
Total no. of deaths	67	91	131	211	199	191	69	90	81	81	40	213	81	80	109
No. of countries reporting	5	5	5	4	4	4	5	5	5	5	4	5	6	5	7