

Smallpox Occurrence in the Município of São Paulo, Brazil, 1945-69

LEO MORRIS, M.P.H., HERROS CAPPELLO, M.D., RUI SOARES, M.D.,
JUAN PONCE de LEON, M.D., and WALTER LESER, M.D.

THE national Brazilian Smallpox Eradication Campaign was established by the Brazilian Ministry of Health in August 1966. Vaccination programs were first initiated in the northeastern States, in the west central region, and in the State of Rio de Janeiro. As the program was completed in the northeastern States, field operations were progressively extended to the more populous southeastern and southern States.

In August 1968, in cooperation with the Ministry of Health, the São Paulo State Department of Health and Social Welfare (Secretária da Saúde Pública e Assistência Social) initiated a statewide campaign for the eradication of smallpox. The program called for the systematic vaccination of residents of all municípios (counties) in the State, concluding with the município of São Paulo, the capital, whose population was scheduled for vaccination during June and July 1970. The campaign was completed in August 1970, with a total of 15.7 million persons vaccinated.

Mr. Morris is statistician, Epidemiology Program, Center for Disease Control, Atlanta, Ga. He was formerly Pan American Health Organization (PAHO) statistical consultant to the smallpox eradication campaign in Brazil. Dr. Cappello is chief of the epidemiology and immunization section, State Department of Public Health and Social Welfare, São Paulo. Dr. Soares is superintendent of the department's smallpox eradication campaign. Dr. Ponce de Leon is PAHO medical consultant to the campaign. Dr. Leser is São Paulo's State health officer. Tearsheet requests to Leo Morris, Epidemiology Program, Center for Disease Control, Atlanta, Ga. 30333

With the end of smallpox in sight, documentation of its occurrence before eradication was thought to be of utmost importance. Although the experience of one small village and one institutional outbreak within the município of São Paulo have been described (1-3), a descriptive review of the occurrence of the disease over an extended period of time has never been published.

Detailed epidemiologic data on smallpox for the município of São Paulo are available for the 25-year period 1945-69, while data dealing with age, sex, and mortality by age have been available on a nationwide basis only since 1967. In addition, adequate nationwide data to describe seasonal patterns have been available only for 6 years. Thus data available for the município of São Paulo represent the best available information on the occurrence of smallpox in Brazil for documenting long-term epidemiologic patterns and trends of the disease.

Source of Data

The epidemiology and general immunization section of the município of São Paulo receives daily reports of admissions from the smallpox isolation ward at the Hospital Emilio Ribas and weekly reports of smallpox cases from all health centers throughout the município. Cases also are reported through maternal and child health care clinics and by private physicians. For every case reported, an epidemiologic record is completed, and all household contacts are vaccinated. The record includes such basic epidemiologic information as age, race, sex, residence, date of onset of illness, and clinical status of the patient.

The epidemiology and general immunization section has been responsible for reporting communi-

cable diseases and for disease control since 1938. During the period of this report (1945–69), São Paulo experienced explosive growth in population and economy. As the largest industrial center in Latin America, São Paulo and neighboring municípios have acted as a magnet to Brazilians from other States. In 1940 the município had a population of 1.3 million, in 1950 the population had grown to 2.2 million, and by 1960 it had reached 3.8 million. Estimates for 1969 placed the population at 6 million. Infant mortality from infectious and parasitic diseases steadily declined during 1945–69, reflecting the industrial and economic development of the município (4).

Cases Reported

The number of smallpox cases reported and the annual case rates since 1945 are shown in table 1. The case rates were relatively high (between 8 and 14 cases per 100,000 population) in the latter half of the 1940's, but since 1950 (fig. 1) a downward trend in incidence has occurred. This downward trend was interrupted in 1954, and a 5- to 6-year

Table 1.—Reported smallpox cases and annual case rates, município of São Paulo, Brazil, 1945–69

Year	Estimated ¹ population (thousands)	Number of cases	Case rate ²
1945	1,745	166	9.5
1946	1,828	209	11.4
1947	1,911	145	7.6
1948	1,994	278	13.9
1949	2,077	181	8.7
1950	2,198	268	12.2
1951	2,290	124	5.4
1952	2,382	140	5.9
1953	2,474	45	1.8
1954	2,567	77	3.0
1955	2,682	162	6.0
1956	2,786	247	8.9
1957	3,148	70	2.2
1958	3,316	215	6.5
1959	3,490	278	8.0
1960	3,825	307	8.0
1961	3,882	418	10.8
1962	4,099	293	7.1
1963	4,329	252	5.8
1964	4,571	235	6.1
1965	4,827	173	3.6
1966	5,098	225	4.4
1967	5,383	650	12.1
1968	5,685	384	6.8
1969	6,003	534	8.9

¹ Estimated midyear populations from the Anuário Estatístico, Instituto Brasileiro de Estatística.

² Cases per 100,000 population.

epidemic cycle is suggested by peaks of incidence in 1956, 1961, and 1967. The unexpected increase in reported cases in 1969 is believed to reflect the more intensive epidemiologic investigations and improved reporting stimulated by the field activities of the smallpox eradication campaign.

Through the week ending August 29, 1970, only 43 cases of smallpox were recorded in the município of São Paulo. This total compares with 292 reported cases for the corresponding time period in 1969. Forty-one of the 43 cases occurred before August. Epidemiologic investigation of the two cases discovered in August revealed that they were imported and that the patients were not infected in São Paulo.

The cyclical pattern of smallpox in São Paulo closely matches the epidemic cycle of extensive outbreaks that have occurred every 4 to 7 years in India, East Pakistan, and West and Central Africa (5–7). This periodic cyclical increase is attributed to an accumulation of susceptible persons, through birth and migration, during the interepidemic period until there is a sufficient number of persons to sustain a major epidemic.

Observations concerning hospitalized patients during the peak years of 1959–61, as well as an epidemiologic analysis of the spread of smallpox in households during the 1956 outbreak, have been published (8,9).

Seasonal Distribution

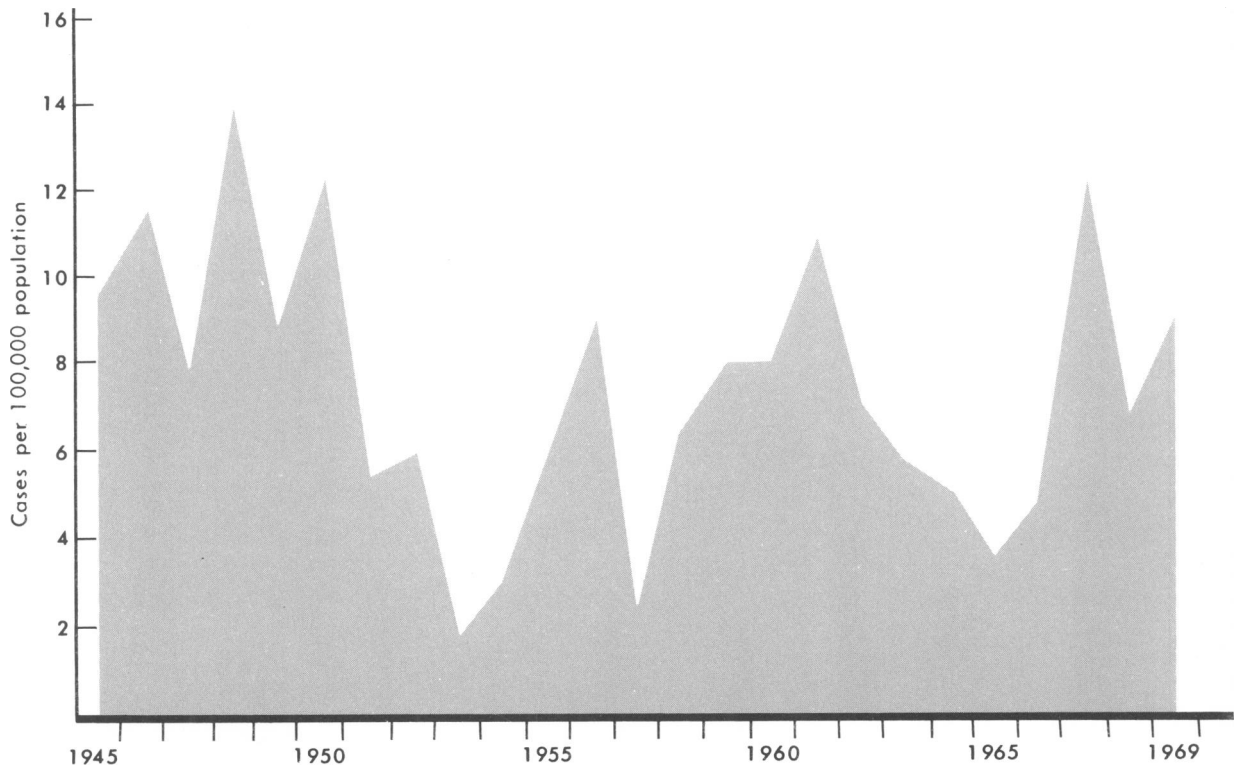
Seasonal incidence of smallpox in the 10 years from 1959 through 1968 is shown by month of report in figure 2. An increase during late winter and early spring, with peak incidence in August through October, occurred in 9 of the 10 years. The lowest incidence normally occurred between March and May. In São Paulo the early spring increase in cases corresponds with the end of the dry season before the coming of the summer rains, December through February.

Before the eradication of smallpox in Venezuela, cases of this disease were concentrated in the first half of the year, which is also the dry season (10). The association of peak incidence of smallpox with the dry season is not limited to South America but also has been reported in Asia and Africa (11–13).

Age and Sex

Age and sex distributions of reported cases are shown in table 2 by 5-year periods. During the 25-year period studied, smallpox occurred with increasing frequency in preschool children 0–4 years

Figure 1. Annual case rates of smallpox, município of São Paulo, Brazil, 1945-69



old. Thirty-one percent of all patients were in this age group during the last 5-year period compared with only 18 percent in the first 5-year period. Conversely, the percentage of patients who were 30 years old or older decreased progressively from 18 to 9 percent.

In contrast, the proportions of patients in the school age group 5-14 years and the young adult group 15-29 years were fairly constant from year to year through the 1960-64 period. The proportion

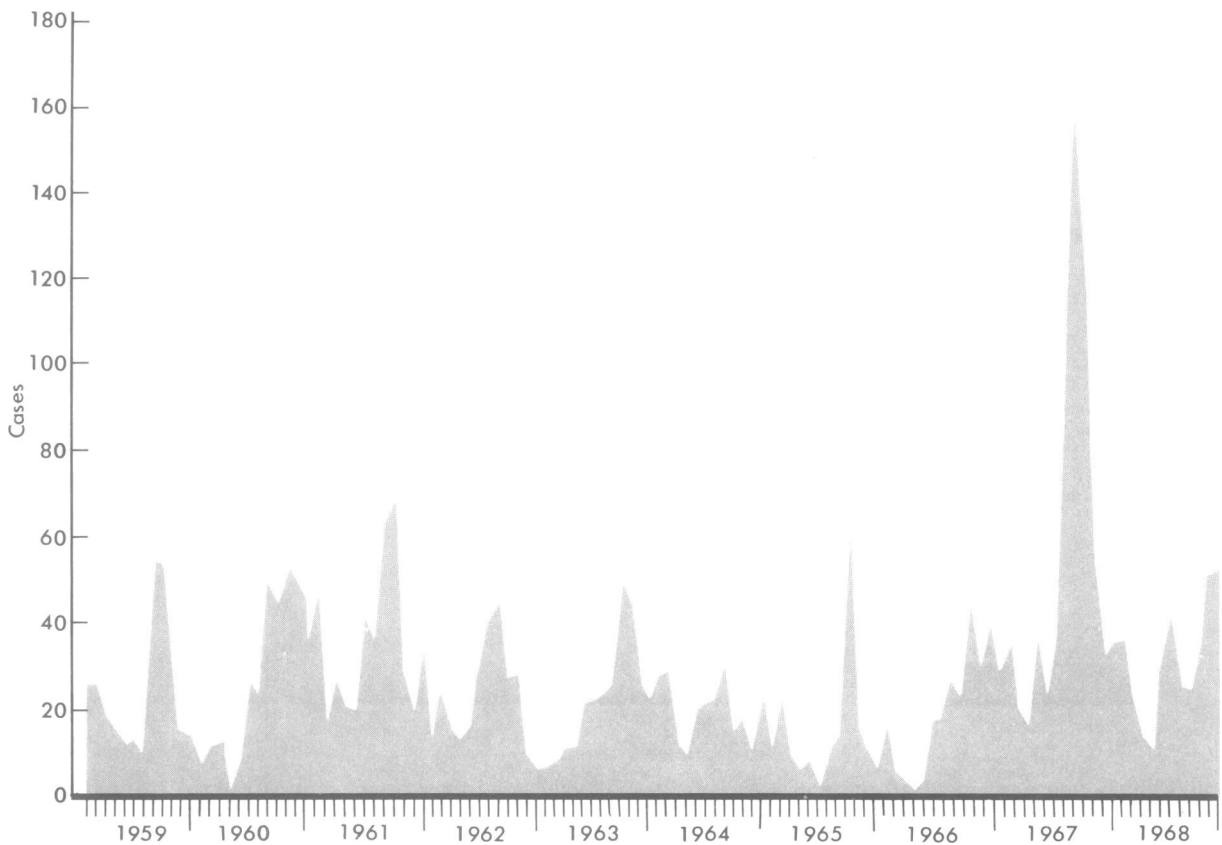
of cases in these age groups ranged from 18 to 21 percent and 43 to 45 percent of the total cases in each of the 5-year periods. This pattern changed abruptly, however, in 1965-69, when 34 percent of all cases occurred in the school-age group and only 26 percent in the young adult group. In this last quinquennial, 65 percent of all patients were under 15 years old and only 9 percent were over 30 years old.

From 58 to 68 percent of the reported cases of

Table 2.—Reported smallpox cases in 5-year periods, by sex and age groups, município of São Paulo, Brazil, 1945-69

Sex and age groups (years)	Number of cases					Percent distribution				
	1945-49	50-54	55-59	60-64	65-69	1945-49	50-54	55-59	60-64	65-69
Total.....	979	654	972	1,505	1,966	100.0	100.0	100.0	100.0	100.0
Males.....	584	448	620	951	1,141	59.7	68.5	63.8	63.2	58.0
Females.....	395	206	352	554	825	40.3	31.5	36.2	36.8	42.0
Less than 1.....	172	46	37	93	113	17.6	7.0	3.8	6.2	5.8
1-4.....		91	178	298	497		13.9	18.5	19.8	25.4
5-14.....	208	136	184	270	661	21.2	20.8	19.1	17.9	33.8
15-29.....	423	284	422	677	509	43.2	43.4	43.8	45.0	26.1
30-44.....	117	73	107	126	116	12.0	11.2	11.1	8.4	5.9
45 and over.....	59	24	36	41	58	6.0	3.7	3.7	2.7	3.0
Unknown.....	0	0	8	0	12					

Figure 2. Number of smallpox cases, by month of report, município of São Paulo, Brazil, 1959–68



smallpox occurred among males. This high proportion was due entirely to a two-thirds preponderance of male patients among those 20 years old or older. Little difference occurred in the sex distribution of patients under 20 years old.

Whether this high proportion of cases among adult males reflected more tendency to report or hospitalize males or whether females had a better level of immunization is not certain. Another factor

could have been the adult males from largely unvaccinated rural populations who left home to find work in São Paulo.

Mortality

At least one death annually from smallpox was registered in 22 of the 25 years, with the annual case-fatality rate ranging between 0.4 and 2.4 percent. Of the 6,076 cases recorded during this pe-

Table 3.—Smallpox cases, deaths, and fatality rates, by 5-year periods, município of São Paulo, Brazil, 1945–69

5-year period	Total			More than 1 year old			Less than 1 year old		
	Cases	Deaths	Fatality rate	Cases	Deaths	Fatality rate	Cases	Deaths	Fatality rate
Total.....	6,076	65	1.1	4,808	27	0.6	289	26	9.0
1945–49.....	979	12	1.2						
1950–54.....	654	11	1.7	608	4	.7	46	7	15.2
1955–59.....	972	8	.8	935	5	.5	37	3	8.1
1960–64.....	1,505	17	1.1	1,412	9	.6	93	8	8.6
1965–69.....	1,966	17	.9	1,853	9	.5	113	8	7.1

riod, 65 were fatal, with a 1.1 percent case-fatality rate indicative of variola minor.

It is important to note that half of the 53 deaths since 1950 were of infants under 1 year old. The case fatality rate for infants (9.0) was 15 times greater than the rate for all others (0.6). Cases and deaths are summarized by 5-year periods in table 3.

The rates for São Paulo were much like the annual case-fatality rates for the United States from 1913 to 1933, which ranged from 0.3 to 2.2 percent (14). In Venezuela the case-fatality rate for 1940-64 was 1.8 percent, with a higher mortality also reported for those less than 1 year old (10). Although a detailed age distribution was not included for the 13,686 cases of variola minor studied by Marsden, 10 of the 34 patients in this series who died were infants (15).

REFERENCES

- (1) Rodrigues-da-Silva, G., Rabello, S. I., and Angulo, J. J.: Epidemic of variola minor in a suburb of São Paulo. *Public Health Rep* 78: 165-171, February 1963.
- (2) Angulo, J. J., Rodrigues-da-Silva, G., and Rabello, S. I.: Variola minor in a primary school. *Public Health Rep* 79: 355-365, April 1964.
- (3) Angulo, J. J., and Salles-Gomes, L. F.: The mechanism of spread of variola minor in a hospital ward. *O Hospital* 71: 1037-1045 (1967).
- (4) Milanese, M. L., and Laurenti, R.: Mortalidade

- infantil no município de São Paulo. *Rev Saúde Públ* 1: 44-50 (1967).
- (5) Smallpox surveillance. *WHO Wkly Epidem Rec* 44: 669-676, Dec. 23, 1969.
- (6) Smallpox surveillance. *WHO Wkly Epidem Rec* 45: 137-143, Mar. 26, 1970.
- (7) National Communicable Disease Center: West Africa smallpox eradication program. *Surveillance Report No. 3. Smallpox Eradication Program, Atlanta, Ga., Oct. 1, 1966, pp. 1-3.*
- (8) Downie, A. W., Dumbell, K. R., Ayrosa Galvão, P. A., and Zatz, I.: Alastrim in Brazil. *Trop Geogr Med* 15: 25-28 (1963).
- (9) Angulo, J. J., Rodrigues-da-Silva, G., and Rabello, S. I.: Spread of variola minor in households. *Amer J Epidem* 86: 479-487 (1969).
- (10) Halbrohr, J. G.: Características epidemiológicas de la viruela (alastrim) en Venezuela durante el período 1935-1964. Paper presented at the 12th general assembly of the Venezuelan Society of Public Health, Maracaibo, April 1965.
- (11) National Communicable Disease Center: Smallpox eradication in West and Central Africa. *SEP Report No. 3. Smallpox Eradication Program, Atlanta, Ga., July 1968, vol. 2, pp. 2-3.*
- (12) Rao, A. R., Sukumar, M. S., and Appasamy, S.: Smallpox surveillance, Madras City, India. *WHO Wkly Epidem Rec* 44: 78-86 (1969).
- (13) Thomas, D. B., et al.: Endemic smallpox in rural East Pakistan. *WHO Wkly Epidem Rec* 44: 669-676 (1969).
- (14) Hedrich, A. W.: Changes in the incidence and fatality of smallpox in recent decades. *Public Health Rep* 51: 363-392, Apr. 3, 1936.
- (15) Marsden, J. P.: Variola minor: A personal analysis of 13,686 cases. *Bull Hyg* 23: 736-746 (1948).

MORRIS, LEO (Center for Disease Control), CAPPELLO, HERROS, SOARES, RUI, PONCE DE LEON, JUAN, and LESER, WALTER: *Smallpox occurrence in the município of São Paulo, Brazil, 1945-69. HSMHA Health Reports, Vol. 86, January 1971, pp. 87-91.*

During the 25-year period 1945-69, more than 6,000 cases of smallpox were recorded in the município of São Paulo, Brazil. Incidence of smallpox was consistently high in the latter half of the 1940's, but after 1950 epidemics occurred every 5 or 6 years, with peaks in 1956, 1961, and 1967. A distinct seasonal pattern occurred, with peak incidence in the late winter and early spring,

August through October, and lowest levels in March through May.

During the 25 years, smallpox occurred with increasing frequency in preschool children. In 1965-69 most patients (65 percent) were under 15 years old; only 9 percent were over 30 years. Most cases were in males; almost two-thirds of all adult patients 20 years old or older were males. It is not clear

whether this majority reflected a greater tendency to report or hospitalize men or that females had a better level of immunization.

The annual case-fatality rate ranged from 0.4 to 2.4 percent, with an overall rate of 1.1 percent, indicative of variola minor. More detailed analysis by age showed the case-fatality rate for infants to be 15 times greater than the rate for all other age groups.