

Epidemic of Poliomyelitis in Puerto Rico, 1960

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PUERTO RICO experienced the most severe outbreak of poliomyelitis of any occurring in the Western Hemisphere in 1960. The occurrence of 495 paralytic cases represented one of the largest epidemics in the island's history.

Interest in tropical poliomyelitis has increased as epidemics have occurred for the first time within the past two decades in developing countries throughout the world. The 1960 Puerto Rico epidemic provided an opportunity to investigate the emerging epidemiologic pattern of poliomyelitis in an advanced tropical area where Salk vaccine has been used and, in addition, provided a unique opportunity to study the effectiveness of Salk vaccine in such an environment.

The widespread type 1 epidemic affected 68 of the 76 municipalities in Puerto Rico, and those affected were predominantly unvaccinated preschool-age children. The disease was found to be relatively mild in the younger age groups, but among the few adult cases, the disease was very severe. Special studies in San Juan, the capital and largest city, revealed the highest attack rates were in the lower socioeconomic segments of the population. The effectiveness of Salk vaccine, adjusted for age and socioeconomic status, was found to be 82 percent for three or more doses.

Descriptive Data

Puerto Rico is the most easterly island of the Greater Antilles, which lie between the Atlantic Ocean and Caribbean Sea. It has an

area of 3,435 square miles, roughly one and one-half times the size of Delaware, and is located approximately 1,000 miles southeast of Miami and 500 miles north of Venezuela (1).

The island, 100 miles long and 35 miles wide, is crossed by mountain ranges, with the Cordillera Central rising to 4,400 feet. The coastal plain is about 15 miles wide at its broadest point. The tropical climate of Puerto Rico is moderated by the surrounding sea, and seasonal variation is slight. The mean temperature ranges from 75° F. in January to 81° F. in July. Mean annual rainfall varies from 35.34 inches in Ponce to 61.34 inches in San Juan (2).

The 1960 population of Puerto Rico was 2,349,544, of which 451,758, or 19 percent, live in the municipality of San Juan. The density of population is 684 per square mile.

In the fiscal year 1959, 14 percent, or \$37.4 million, of the budget went to health. Only education received a bigger share. In 1959, the Puerto Rico Department of Health operated 5 general hospitals, 6 tuberculosis hospitals, 1 mental hospital, 202 public health units and subunits, 32 small health centers, and 214 stations for distribution of milk to children (3).

Sugar was the main commodity in the island's economy until 1947. Since that time, 581 new

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factories have been established, creating 43,585 jobs. The average annual family income reached \$2,366 in 1959 (2).

Methods of Study

The 495 paralytic cases included in this study were officially reported during 1960 to the Puerto Rico Department of Health from the municipality (county) public health units and the 5 general hospitals, 1 in each health district. The great majority of patients were hospitalized at the district hospitals, located in Aguadilla, Arecibo, Río Piedras, Fajardo, and Ponce, and the municipal hospital in San Juan. All cases were verified by obtaining clinical and epidemiologic data on a prescribed health department form.

Epidemiologic data such as age, race, sex, residence, date of onset, and Salk vaccination history were transferred to a poliomyelitis surveillance case record. This was part of a program carried out in cooperation with the Poliomyelitis Surveillance Unit of the Communicable Disease Center in Atlanta, Ga.

In addition, epidemiologic followup was conducted to determine the clinical status of each patient at 60 days or longer after onset. Since approximately 90 percent of the patients were hospitalized or treated at the five district hospitals and a convalescent center in Guaynabo, hospital and physical therapy records were readily available on each case.

The 60-day classification of clinical status was obtained on 86 percent of the 495 paralytic cases reported. Patients were classified as follows:

1. Complete recovery with no residual paralysis.
2. Minor involvement including definite weakness or involvement of one limb or both conditions.
3. Significant disability which involved more than one limb.
4. Severe disability which included those confined to bed and wheelchairs and those who required extensive bracing.
5. Fatality.

Virus diagnostic work was performed by Dr. Andrew Fodor of the Laboratory Branch, Communicable Disease Center.

Additional studies included a survey conducted to estimate the levels of Salk vaccination among the population within the city limits of San Juan (4). An area-probability technique based on procedures described by Serfling and co-workers was used in the vaccination survey (5). The interviews were conducted by nurses and sanitarians of the Santurce and Río Piedras Public Health Units. Dr. Dana Quade, epidemic intelligence service statistician, Communicable Disease Center, and Mrs. Maria Perez, statistician, Puerto Rico Department of Health, were instrumental in the execution of the survey.

Information was collected on the vaccination status of each member of the households surveyed. These data, recorded as of January 1960 and May 1961, provided estimates of the immunization level prior to the epidemic and the extent of increase achieved during and after the epidemic. The socioeconomic status of each household was also determined using the two-factor index of social position developed by Hollingshead (6).

The city was divided into 20 survey districts, which were expressly drawn to make the Hollingshead index as homogeneous as possible within each district. The districts were then grouped into four areas classified as upper, upper-middle, lower-middle, and lower socioeconomic areas. Each socioeconomic group included those districts with comparable Hollingshead indexes.

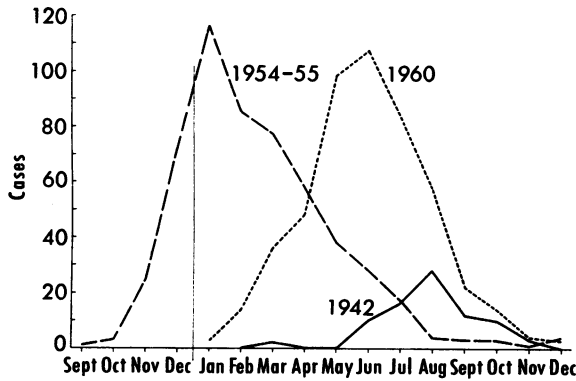
Information on poliomyelitis occurring in Puerto Rico in the past was obtained from health department reports and published papers (7-10).

Results

Seasonal and geographic distribution. In Puerto Rico, outbreaks of poliomyelitis have developed at various times of the year and have not followed any seasonal pattern. In figure 1, the monthly incidence of poliomyelitis during 1960 is compared with that of the outbreaks in 1942 and 1954-55.

The 1960 epidemic began in late January, reached a peak during the week ending June 11, and then declined steadily throughout the late summer and fall. During 1942, the outbreak

Figure 1. Poliomyelitis by month of onset, Puerto Rico, 1942, 1954-55, and 1960



approximated the occurrence of poliomyelitis in other parts of the Northern Hemisphere with a peak incidence during the late summer and fall. In contrast, the 1954-55 outbreak had a peak incidence during the winter months, the customary pattern of epidemics in the Southern Hemisphere. During the nonepidemic years, cases have occurred sporadically throughout the island with no seasonal concentration.

In 1960, 68 of the 76 municipalities had at least one case. The distribution of cases is shown in figure 2 by municipality. The highest attack rates occurred among the rural muni-

palities in the central and southern part of the island. Both Villalba and Orocovis suffered attack rates of more than 80 per 100,000.

The geographic spread of the epidemic is illustrated in figure 3. The three maps depict onset of cases during three time periods: January through March, April and May, and June and July. The initial cases of the widespread epidemic occurred in the Ponce area; Ponce, the second largest municipality, reached its peak incidence in March.

During March, cases began to appear in the populous San Juan area and reached a peak there during May. Cases continued to occur in Ponce during April and May, but the less populated neighboring municipalities suffered higher attack rates during this 2-month period.

In June, Río Piedras, which is shown as a separate unit although annexed to San Juan, reached its highest monthly incidence. During June and July, cases became widespread; Orocovis served as focal point in the central part of the island and Mayagüez as focal point in the western part. Neither Orocovis nor Mayagüez had cases before June.

Type 1 poliovirus was identified from the earlier cases with onsets in January, February, and March.

Figure 2. Attack rates of paralytic poliomyelitis by municipality, Puerto Rico, 1960

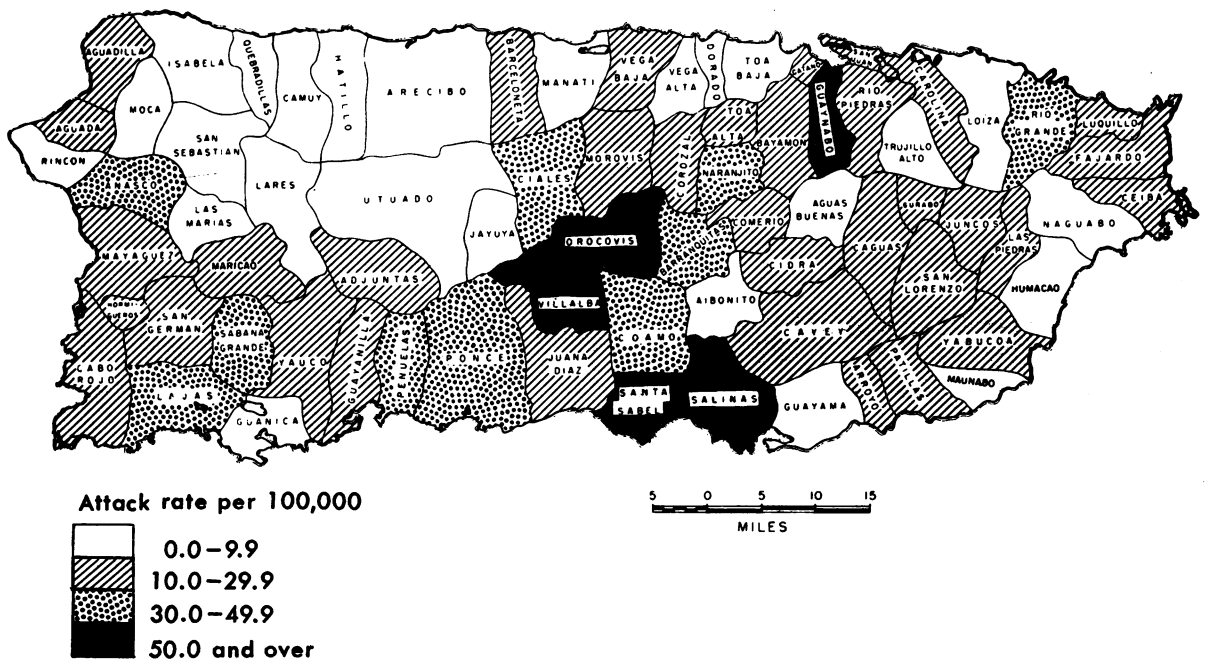
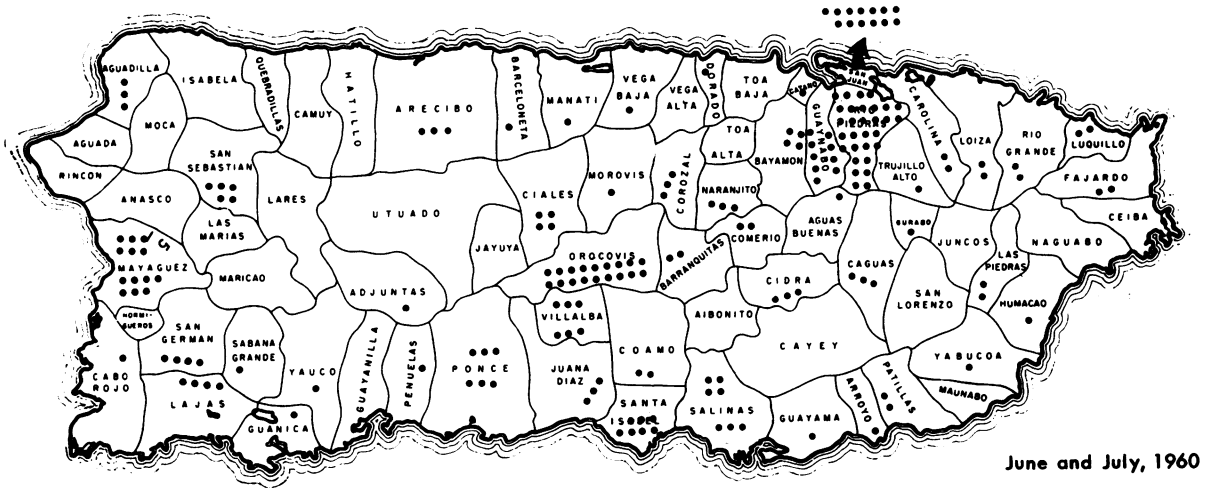
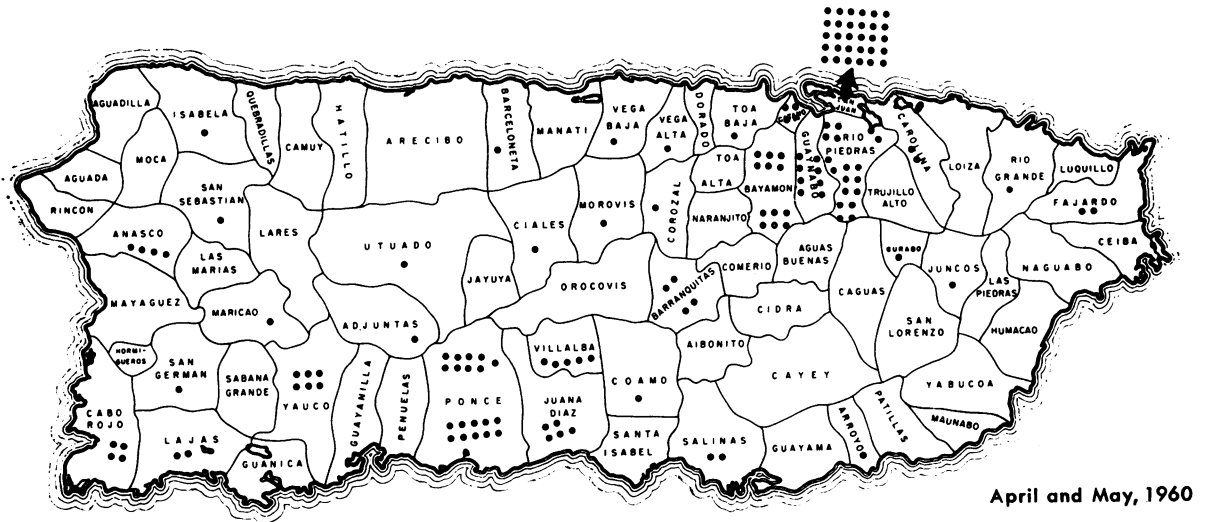
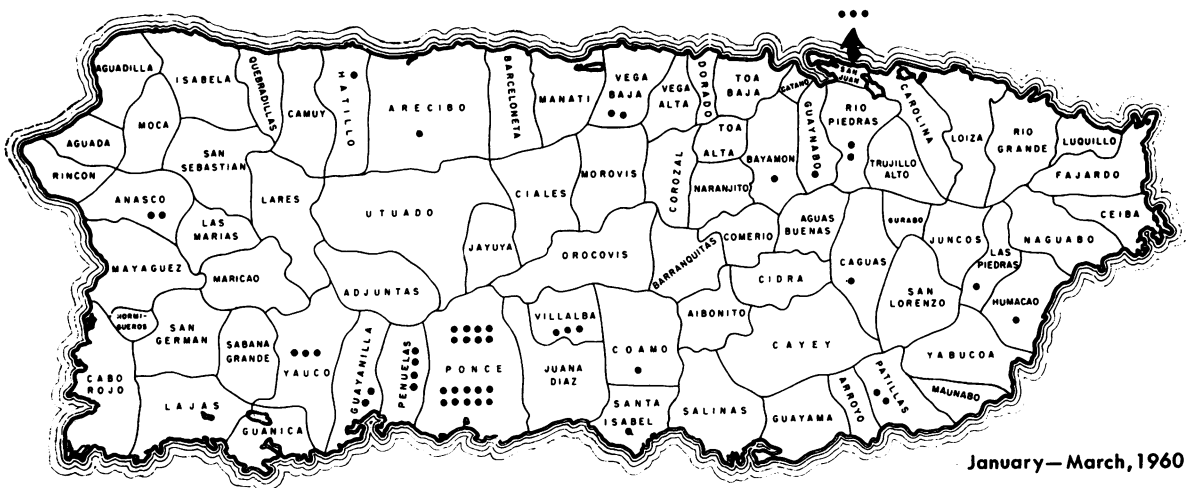


Figure 3. Cases of paralytic poliomyelitis by period of onset, Puerto Rico, 1960



Age, sex, and vaccination status. Table 1 contains the age and vaccination history of the 495 patients. Eighty-six percent were children under 5 years of age; 61 percent were less than 3 years of age. Only 11 patients, or 2.2 percent, were more than 10 years of age. The attack rate was highest in infants from 6 to 11 months of age and then declined progressively with age (table 2). Thus, the distribution of poliomyelitis in infants usually observed in areas with a tropical climate and less adequate sanitation is also evident in Puerto Rico.

Only 6 percent of the patients had received three or more doses of Salk vaccine, while 83 percent were unvaccinated. Considering that 12 of the 29 patients with three or more doses

were more than 4 years of age, the epidemic was clearly concentrated among unvaccinated preschool children.

Of the 495 cases, 293, or 59 percent, were in males (table 2). The highest age-specific attack rate in males occurred in infants in the 6- to 11-month age group (298 per 100,000); this was twice the rate in females of that age. Two-thirds of those with poliomyelitis under 1 year of age were males.

Severity of paralysis and type of involvement. Severity of paralysis and type of involvement for the 495 patients was also studied (table 3). Of the 426 for which severity of paralysis was known, more than 55 percent had either a complete recovery or only minor in-

Table 1. Age and vaccination history of poliomyelitis patients, Puerto Rico, 1960

Age group (years)	Vaccination history						Percent in age group
	0 dose	1 dose	2 doses	3 or more doses	Unknown	Total	
Under 1.....	86	7	5	2	2	102	20.6
1.....	109	4	3	3	1	120	24.2
2.....	71	2	4	3	2	82	16.6
3.....	56	10	4	4	2	76	15.4
4.....	38	1	3	5	0	47	9.5
5-9.....	38	3	4	11	1	57	11.5
10-14.....	3	0	1	0	0	4	.8
15 and over.....	4	0	1	1	1	7	1.4
Total.....	405	27	25	29	9	495	100.0
Percent doses.....	83.3	5.6	5.1	6.0	-----	100.0	-----

Table 2. Age-specific attack rates by sex, Puerto Rico, 1960

Age group ^a (years)	1960 population			Patients			Rate per 100,000		
	Total	Male	Female	Total	Male	Female	Total	Male	Female
Under 6 months ¹	37,941	19,111	18,830	18	12	6	47.4	62.8	31.9
6-11 months ¹	37,940	19,110	18,830	84	57	27	221.4	298.3	143.4
1.....	69,694	35,451	34,243	120	63	57	172.2	177.7	166.5
2.....	69,460	35,256	34,204	82	51	31	118.1	144.7	90.6
3.....	70,186	35,507	34,679	76	43	33	108.3	121.1	95.2
4.....	69,181	35,184	33,997	47	27	20	67.9	76.7	58.8
5.....	67,043	33,864	33,179	25	15	10	37.3	44.3	30.1
6.....	66,132	33,290	32,842	12	7	5	18.1	21.0	15.2
7.....	66,122	33,766	32,356	11	6	5	16.6	17.8	15.4
8.....	62,653	31,969	30,684	3	1	2	4.8	3.1	6.5
9.....	65,579	33,041	32,538	6	3	3	9.1	9.1	9.2
10-19.....	568,067	284,846	283,221	7	6	1	1.2	2.1	.4
20 and over.....	1,099,546	532,369	567,177	4	2	2	.4	.4	.4
Total.....	2,349,544	1,162,764	1,186,780	495	293	202	21.1	25.2	17.0

¹ Population under 1 year of age divided into 2 equal parts.

involvement at 60 days or longer following onset. Only 13 percent were severely disabled or died. The degree of residual paralysis did not show any relationship to previous vaccination history.

Of the 486 cases with type of involvement known, 55, or 11 percent, were classified as bulbar. Only 6 percent of those with less than severe disability had bulbar involvement. In contrast, 49 percent of those with severe disability or fatal outcome were classified as having bulbar involvement. More than 60 percent of the fatal cases had bulbar involvement.

There were 39 fatalities among the 435 patients with either residual paralysis or a preliminary paralytic report with no followup. The subsequent paralytic case-fatality rate of 9.0 percent is similar to that seen in the United States during 1960 (11). It is notable, however, that among the seven patients 15 years or older, five died, and one had severe disability at 60 days following onset.

The Epidemic in San Juan

Distribution of cases. The 102 cases which occurred within the city limits of San Juan are shown in figure 4 by geographic distribution within socioeconomic areas. The 16 cases with no residual paralysis are classified as non-paralytic; the remaining 86 cases as paralytic.

In table 4 the greater concentration of cases

Table 4. Paralytic poliomyelitis cases and rates by socioeconomic status, San Juan, Puerto Rico, 1960

Socioeconomic area	1960 population	Paralytic cases	Attack rate per 100,000
Upper-----	86, 610	12	13. 86
Upper-middle-----	131, 865	18	13. 65
Lower-middle-----	108, 856	25	22. 97
Lower-----	105, 046	31	29. 51
Total-----	432, 377	86	19. 89

in the lower and lower-middle socioeconomic groups is apparent. The paralytic attack rate was highest in the lower socioeconomic group and decreased with increasing socioeconomic status.

Vaccination survey. A total of 1,176 dwelling units were visited during the vaccination survey conducted in San Juan. Interviews were completed on 1,123 households, representing a population of 5,454 persons from the 4 socioeconomic groups. The increase in immunization levels from January 1960 to May 1961 is presented in figure 5 by socioeconomic group.

Prior to January 1, 1960, a relatively large proportion of children under 5 years of age had never received any vaccine, 77 percent among the lower and 68 percent among the lower-middle socioeconomic group. During the outbreak, the greatest increase in number of persons vaccinated was in this preschool age group. The percentage with no vaccination was reduced to 51 in the lower socioeconomic group and to 43 in the lower-middle. Because this group was hit hardest by the epidemic, much attention was directed toward their vaccination. The school-age and young adult populations (5-19 years of age) also showed improvement in vaccination status, while little improvement was shown in the adult population (20-39 years of age).

As has been found in other surveyed cities in the United States, the 5- to 14-year-olds in each socioeconomic group were generally better protected than the other age groups. In San Juan, 88 percent of the children from 5 to 9 in the upper socioeconomic group had three or more inoculations by May 1961. This proportion ranged downward to 56 percent among

Table 3. Severity of poliomyelitis and type of involvement, Puerto Rico, 1960

Severity	Cases		Type of involvement (number)		
	Number	Per cent	Bulbar	Spinal	Unknown
Total cases.	495	-----	55	431	9
Severity known---	426	100. 0	49	371	6
Complete recovery-----	60	14. 1	3	57	0
Minor involvement-----	177	41. 5	9	168	0
Significant disability-----	132	31. 0	10	120	2
Severely disabled-----	18	4. 2	4	14	0
Fatal-----	39	9. 2	23	12	4
Severity unknown	69	-----	6	60	3

children in this age group in the lower socioeconomic level. The older school children from 10 to 14 showed the smallest difference in vaccination levels by socioeconomic group. On May 1, 76 percent in the upper and 65 percent in the lower socioeconomic group had received at least three doses of vaccine. Among the adults (20-39 years of age), the proportion with three or more inoculations in any socioeconomic group was negligible.

Vaccine effectiveness. The survey data also made it possible to estimate vaccine effectiveness. For this purpose, the unvaccinated and vaccinated (three or more doses) populations were classified by age and socioeconomic level as of January 1, 1960, prior to the epidemic.

Of the 86 cases with residual paralysis in San Juan, 72 were in unvaccinated individuals and 7 were in persons who had had 3 or more doses of Salk vaccine. The calculation of the esti-

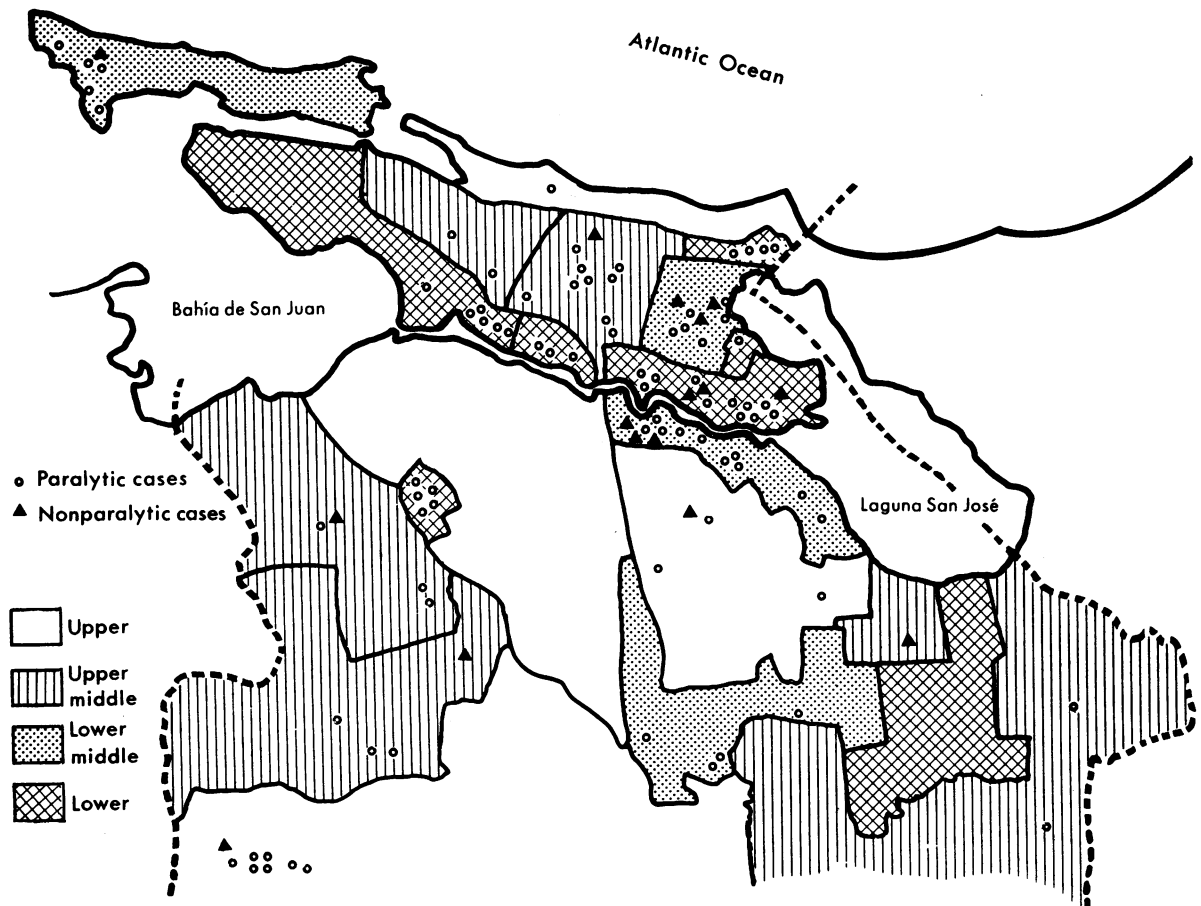
mated effectiveness of Salk vaccine in reducing paralytic poliomyelitis in San Juan is shown in table 5. The method was the same used in the 1954 Francis field trials with a further adjustment for socioeconomic status (12,13).

Attack rates in the unvaccinated were calculated, and from these rates, an expected number of cases in the vaccinated population was obtained. From these calculations, the estimate of vaccine effectiveness in San Juan for three or more doses of Salk vaccine was 82 percent. For the 0-4 age group alone, the effectiveness of three or more doses reached 90 percent.

Discussion

Paul (14) and Payne (15) have observed an inverse ratio between infant mortality rates and poliomyelitis case rates, the mortality rate serving as an index to the development of an

Figure 4. Distribution of poliomyelitis cases by socioeconomic area, San Juan, P.R., 1960



area. The endemic occurrence of poliomyelitis was associated with a high infant mortality rate; a rise in poliomyelitis was noted when the infant mortality rate fell below 60-80 per 1,000 live births. The infant mortality rate in Puerto Rico has decreased steadily since 1933 and fell below 100 per 1,000 live births for the first time in 1943 and below 60 per 1,000 live births in 1954. The infant mortality rate has remained below this level since 1954.

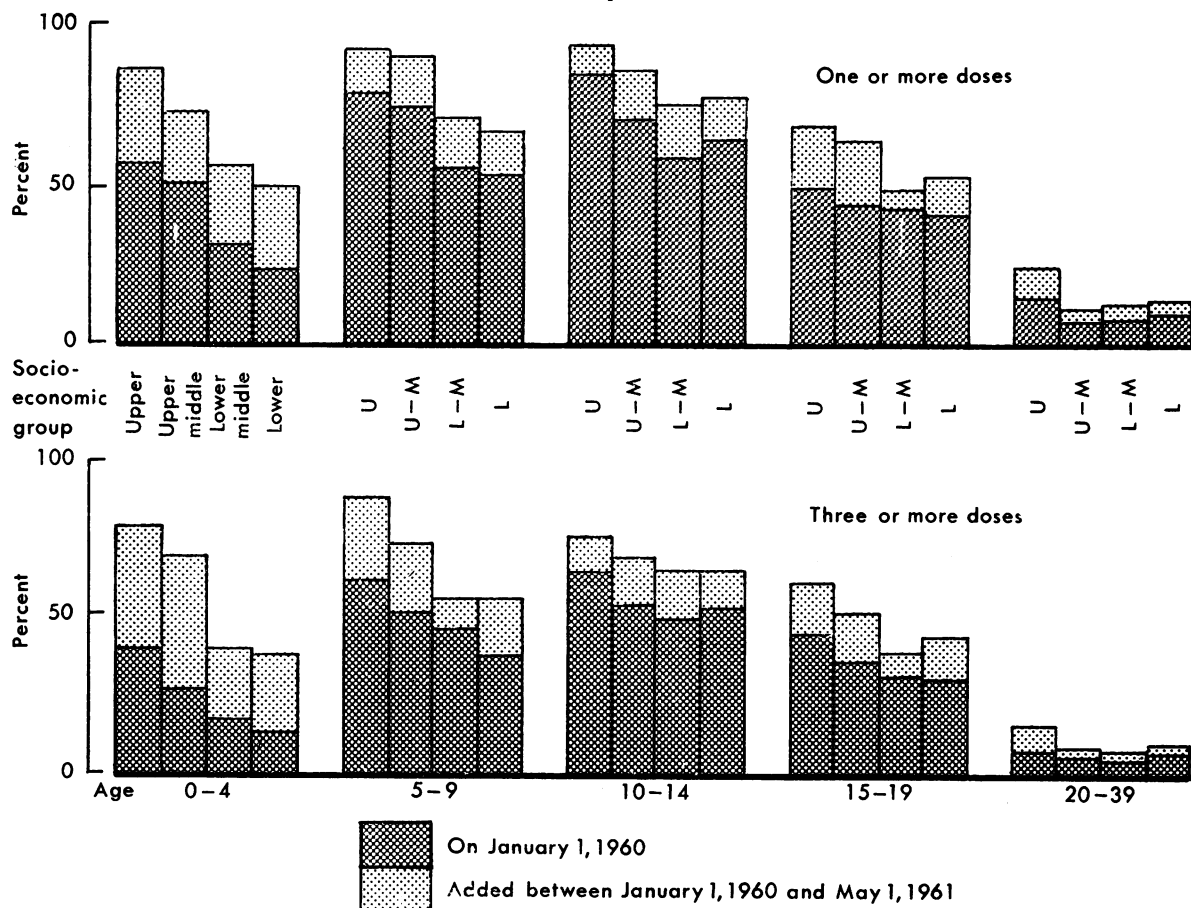
Poliomyelitis was first established as a clinical entity in Puerto Rico in 1928. The first outbreak in the island was noted in 1942 when 117 cases were reported. This was followed by a severe outbreak in 1946 (307 cases) and epidemics in 1954-55 (516 cases for the epidemic period of 9 months), and in 1960. During nonepidemic years, no seasonal pattern has been noted, and cases have occurred sporadically throughout the island without concentration.

In the mild tropical climate of Puerto Rico where there is only slight variation from the mean summer temperature, outbreaks of poliomyelitis have originated at various times of the year. This is in contrast to areas in the Temperate Zones which have the same seasonal pattern of poliomyelitis year after year.

The spread of disease during 1960, with Ponce and San Juan serving as focal points, was similar to the radial spread of the disease during the 1954-55 epidemic. The 1954-55 outbreak began in the municipality of Toa Baja and spread outward to surrounding municipalities. Toa Baja and Cataño, which suffered the highest attack rates during the 1954-55 epidemic, did not contribute heavily to the 1960 experience.

The 1960 pattern of age distribution among infants, with approximately 90 percent of the cases in the under-5 age group, was also seen in the 1942, 1946, and 1954-55 epidemics in

Figure 5. Vaccination status determined by survey of residents of San Juan, P.R., January 1960 and May 1961



Puerto Rico. This may be compared to the age pattern as it appeared in highly developed countries in the first two decades of this century. In 1911, only 12 percent of patients with paralysis in Sweden were over 20 years of age. Since that time, the pattern of poliomyelitis has been changing continuously until it has become an adult disease, and 40 years later, 57 percent of patients with paralysis were over 20 years of age (16). This change from an infantile to older age distribution has also been reported in the United States (17, 18).

As Puerto Rico develops more fully, there is

reason to expect a continuing increase in poliomyelitis in older age groups if no artificial immunity is induced by vaccine. Of the 420 children under 5 years of age with known vaccination status, only 17 had received 3 or more doses of vaccine. The unvaccinated children born during the 5-year interval between the 1954-55 and 1960 epidemics, who were bypassed by natural immunity, may have represented a population susceptible to the introduction of poliovirus. Only type 1 poliovirus was isolated during both the 1954-55 and the 1960 epidemics.

Of the 102 patients under 1 year of age, only

Table 5. Estimated effectiveness of vaccine¹ in reducing incidence of paralytic poliomyelitis in persons under 40 years of age, San Juan, Puerto Rico, 1960

Age and socioeconomic group	Population, by number of vaccine doses ²		Paralytic cases, by number of vaccine doses		Paralytic cases per 100,000 in unvaccinated population	Expected cases in vaccinated population
	0 dose	3 or more doses	0 dose	3 or more doses		
<i>0-4 years</i>						
Upper.....	3,978	3,861	10	0	251.38	9.71
Upper-middle.....	5,952	3,264	8	2	134.41	4.39
Lower-middle.....	10,062	2,574	15	0	149.08	3.84
Lower.....	12,240	2,091	24	0	196.08	4.10
<i>5-9 years</i>						
Upper.....	2,340	7,254	0	0	0.0	0
Upper-middle.....	4,128	8,448	4	1	96.90	8.19
Lower-middle.....	5,850	6,201	3	3	51.28	3.18
Lower.....	7,701	6,171	3	0	38.96	2.40
<i>10-14 years</i>						
Upper.....	1,521	6,435	0	0	0.0	0
Upper-middle.....	5,088	9,600	1	0	19.65	1.89
Lower-middle.....	5,616	7,020	0	0	0.0	0
Lower.....	5,508	8,568	0	0	0.0	0
<i>15-19 years</i>						
Upper.....	3,978	4,095	0	0	0.0	0
Upper-middle.....	7,008	4,608	1	0	14.27	.66
Lower-middle.....	6,201	3,393	0	1	0.0	0
Lower.....	7,905	3,978	0	0	0.0	0
<i>20-39 years</i>						
Upper.....	19,188	1,638	2	0	10.42	.17
Upper-middle.....	36,096	2,016	1	0	2.77	.06
Lower-middle.....	30,654	1,170	0	0	0.0	0
Lower.....	20,961	1,275	0	0	0.0	0
Total.....			72	7		38.59

¹ Vaccine effectiveness = $\frac{\text{expected cases} - \text{observed cases}}{\text{expected cases}} = \frac{38.59 - 7.00}{38.59} = 81.86$.

² Estimated population as of Jan. 1, 1960.

18 were under 6 months. Of these 18 patients under 6 months of age, 3 were less than 3 months. There is no ready explanation for the finding that the age-specific attack rate for boys from 6 to 11 months of age was twice that of girls. As previously mentioned, two-thirds of the patients under 1 year of age were boys, and attack rates in boys were higher than those in girls through 7 years of age. This higher percentage of males does not differ from other reported epidemics.

The mild character of the disease in those under 15 years of age during the 1960 epidemic is in accord with studies by Sheplan who described 341 cases occurring in Puerto Rico before 1942 (7). His findings indicated that most patients were ambulatory and that in the majority only one lower limb was affected. Severe involvement of the hip or trunk was quite rare, and no evidence of bulbar involvement was found. This also agrees with the findings of Melnick during the first epidemic of poliomyelitis in British Guiana, which occurred in 1957 (19). The disease, as recognized, was mild, with no deaths and no respiratory cases. In 1943, El Salvador suffered an epidemic of 61 paralytic cases, of which only 4 cases showed bulbar involvement (20). Ten years later, in 1953, El Salvador suffered an outbreak of 78 cases, with only 2 cases reported with bulbar involvement (21).

Although only 11 percent of the 1960 cases in Puerto Rico were classified as bulbar, 49 percent of those with severe disability or fatal outcome had bulbar involvement. Of the seven adult patients, five died and one was severely disabled. Thus, the disease in adults in an advanced tropical area may take a severe form compared with that in the younger age groups.

Before the widespread use of Salk vaccine, poliomyelitis attacked widespread areas, with higher attack rates among upper socioeconomic groups than among lower socioeconomic groups (22, 23). The lower socioeconomic groups, with early exposure to poliovirus, escaped the major manifestations of this disease. This was especially true in slum areas of developing countries (24). Since the use of Salk vaccine, sharp concentrations with high attack rates have been reported among the less well-vaccinated lower socioeconomic groups.

Langmuir has reported this changing pattern of poliomyelitis in the United States (25). A pattern of sharp concentrations among lower socioeconomic groups, particularly among Negroes, has occurred in at least four U.S. urban epidemics since 1955. The better vaccinated upper socioeconomic groups were spared, and there was some evidence that high levels of vaccination might also have had an influence on limiting the community spread of poliovirus (26, 27).

In Israel, the attack rate in Jews was reported to be 100 times that in the Arab population before Salk vaccine (18). Since 1957, vaccine acceptance has been greater in the Jewish population and attack rates have been higher among the Arabs (28).

Puerto Rico may be the first tropical area where a higher attack rate has been demonstrated in the less well vaccinated lower socioeconomic group. Thus, the artificial immunity induced by Salk vaccination in upper socioeconomic groups seems to have protected these groups to a greater extent than natural immunity has protected the lower socioeconomic segment of the population.

Before the protection of vaccine was available, high attack rates among adult nonindigenous populations were observed many times in underdeveloped and developing areas where the age distribution of poliomyelitis was predominantly infantile (29-32). Very few cases were reported among non-Latin persons during the 1960 Puerto Rico epidemic. With few exceptions, the non-Latin population in Puerto Rico fell into the better vaccinated upper socioeconomic group.

Many investigators from nations in the Northern Hemisphere have recently reported on the efficacy of inactivated (Salk) vaccine in their respective countries (33). The vaccine studies in San Juan provided the first opportunity to estimate the efficacy of Salk vaccine in a tropical area. The estimated effectiveness of 82 percent for three or more doses of vaccine in San Juan compares favorably with the results reported from these other nations. The San Juan estimates, adjusted for age and socioeconomic status, are similar to the estimates of effectiveness made for the 1959 poliomyelitis epidemics in Des Moines, Iowa, and Kansas

City, Mo., and the 1960 Providence, R.I., epidemic (22, 34). With oral poliovaccine coming into wider use in most developing countries, San Juan may have provided the only measurable test of the efficacy of Salk vaccine in a tropical area.

Summary

Puerto Rico experienced the most severe outbreak of poliomyelitis of any occurring in the Western Hemisphere in 1960. The 495 paralytic cases represented one of the largest epidemics in the island's history.

The epidemic began in late January, reached a peak in mid-June, and then declined during the late summer and early fall months. No seasonal pattern of poliomyelitis has been established in Puerto Rico.

Type 1 poliovirus was identified early in the widespread epidemic, which involved 68 of 76 municipalities. The initial cases occurred in late January and were followed by a radial spread with first Ponce and then the San Juan area serving as focal points.

The age distribution was predominantly infantile; approximately 90 percent of the cases occurred in children under 5 years of age. There was a greater proportion of cases among males; highest attack rates occurred in the age group 6 to 11 months. Eighty-three percent of the cases were in unvaccinated individuals; only 6 percent were in persons who had received three or more doses of Salk vaccine.

The disease was found to be relatively mild in the younger age groups with little bulbar involvement. Among the few adult patients, the disease was very severe.

Special studies in San Juan, the capital and largest city, demonstrated the highest attack rate in the lower socioeconomic segment of the population. The effectiveness of Salk vaccine, adjusted for age and socioeconomic status, was found to be 82 percent for three or more doses.

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Bibliography on Cycads

A bibliography on the chemistry of cycads, palmlike trees whose raw seeds may have carcinogenic properties, has been compiled by Dr. Marjorie Grant Whiting of the National Institute of Neurological Diseases and Blindness, Public Health Service. It lists 68 articles published since 1900 in various countries and includes *Chemistry Abstract* references whenever available. The suggestion that the high incidence of amyotrophic lateral sclerosis in inhabitants of Guam might be associated with ingestion of raw cycad seeds sparked current interest in this plant. A conference, held at the National Institutes of Health to discuss the toxicity of cycads, was reported in the July 1962 issue of *Public Health Reports*. A second conference was held in August 1962.

Copies of the bibliography may be obtained through the Epidemiology Branch of the National Institute of Neurological Diseases and Blindness, Public Health Service.