Porto Rico Review of Public Health
and
Tropical Medicine

Official Bulletin of the Department of Health and the School of Tropical Medicine
Published monthly by the Department of Health of Porto Rico

VOL. III SAN JUAN, P. R., MARCH 1928 NO. 9

DIARRHEA AND ENTERITIS IN PORTO RICO

I. AN EPIDEMIOLOGICAL STUDY

By EARLE B. PHELPS,
Professor of Sanitary Science, Columbia University, and Visiting Lecturer,
School of Tropical Medicine of the University of Porto Rico
under the auspices of Columbia University

The most frequent cause of death in Porto Rico during recent years has been diarrhea and enteritis under two years of age. Next in order of prevalence come tuberculosis, "rickets",* and diarrhea and enteritis in the ages two years and over. If the last-named item be combined with the first, to make this cause of death statistically comparable with the others, the annual deaths from diarrhea and enteritis during the two-year period, July 1923 to June 1925, reached a total of 383 per 100,000. During the same period the death rate for tuberculosis (all forms) was 213, and for bronchopneumonia, the next most frequent cause of death, omitting the ill-defined "rickets", 102.

Such a situation would quite naturally attract the attention of a visitor whose major interest is the environment as it relates to human health and well-being and, more particularly, the relation of water and food supplies to intestinal disease. The present paper contains the results of a brief study of the statistics of this disease, or group of diseases, begun in the course of a visit to Porto Rico in 1927. Some of the facts here presented were used in a course of lectures given at the School of Tropical Medicine at that time and at the conclusion of the course the general problem of the epidemiology of diarrhea and enteritis as it occurs in Porto Rico, was sub-divided and distributed among various members of the class as projects for original investigations and reports. Many of the re-

* A special commission sent to Porto Rico in 1927 by the Bureau of Child Welfare of the U. S. Department of Labor found that rickets was practically non-existent on the Island, thus confirming the opinion maintained by the Department of Health. (See P. R. HEALTH REVIEW, Vol. I, No. 1.) The Department then issued a statement that hereafter "rickets" would not be accepted as a certified cause of death. The designation had come to be loosely used here for cases of malnutrition in infants.—EDITOR.

ports, which were later turned in, contained material of evident interest and value and it is hoped that this material may be published in a later number of this journal. No final conclusion has been reached, but the material that has been brought together seems worth preserving as a definite contribution to one of the important health problems of Porto Rico.

The present paper is purely statistical and introductory. Its object is to determine certain of the characteristics of diarrhea and enteritis as reported in the vital statistics without further questions at this time as to the entity, or otherwise, of the disease group in question, and without raising too serious doubts as to the accuracy of the statistics themselves. The first of these matters will be discussed at greater length in one of the subsequent papers, and concerning the second, it can only be hoped there is at least a sufficient uniformity of procedure as to diagnosis and reporting throughout the Island that, in the mass of statistics that will be used, minor irregularities will not lead to serious error. By comparison of these data with similar data from certain typical areas in the continental United States we may also throw some additional light upon the quality of the diagnosis.

PREVALENCE AND TREND

The relative prevalence of diarrhea and enteritis in recent years has already been indicated. It will be of interest to examine the records and to note what, if any, changes have occurred. Here the shortcomings of diagnosis are especially likely to interfere with a correct conclusion. A progressive change in medical opinion or practice may be quite sufficient, in the absence of any other cause, to produce an apparent progressive change in a death rate. The records, however, show a picture which it is difficult to explain upon the basis of diagnostic practice. The data given in the 1924–25 report of the Commissioner of Health have been brought together in Fig. 1, upper, upper line. There was a fairly steady increase in death rate from 1910 to 1917 followed by an equally steady decline to 1925.

The two straight lines through the broken line of death rates are the trends, computed mathematically for the two periods 1910–1918 and 1917–1925. They eliminate annual fluctuations and show the general tendency of the rate to change continuously. During the first period the trend of the death rate was upward at an annual rate of twenty deaths per 100,000 per annum. During the second period it was downward at an annual rate of 15 deaths per 100,000 per

annum. These trend lines, rather than the annual death rates, measure the results of a gradual change in conditions, either for better or for worse and are best adapted for comparison with other factors having periodic variations, such as climatic change, economic conditions, etc., which may be suspected of exerting an influence upon the death rate.

A comparison with the typhoid fever data for the same period has

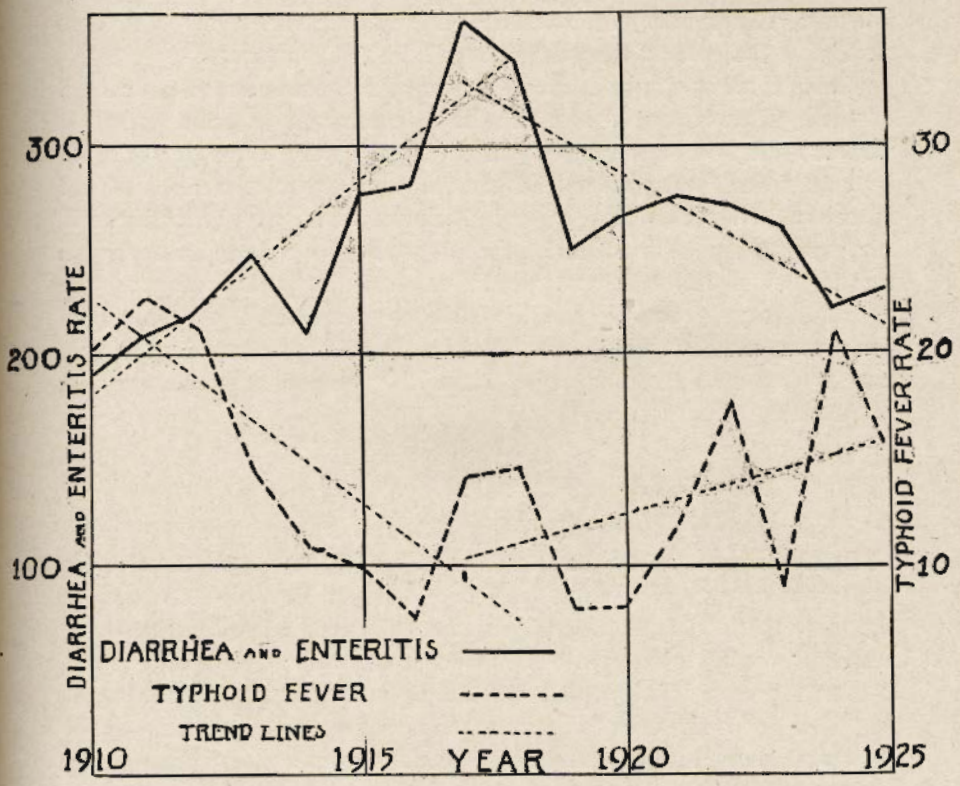

FIG. 1.—Deaths (per 100,000 population) from Diarrhea and Enteritis under two years and from Typhoid Fever, 1900 to 1925, and computed trends of death rates, for two nine-year periods. (Data from Report of the Commissioner of Health of Porto Rico, 1925.)

also been made upon this diagram, lower line. It will be noted that the trends are directly opposite, suggesting that some general condition which may influence enteritis in one direction, influences typhoid fever in the opposite direction. But a closer study of the diagram shows an even more significant detail. Despite the general reverse

nature of the trends, the individual yearly variations above and below the trend line are in general of the same nature; that is, when enteritis rises, typhoid fever generally rises also, measuring in each case from the trend lines. This fact is shown more clearly in Fig. 2 in which the departures from the trend lines are plotted. It is apparent that annual fluctuations in the two diseases, typhoid fever and diarrhea and enteritis, as distinguished from their longtime trends, run rather closely parallel. During the last three years, however, the tendency to oscillate in opposite directions, noted so clearly in the case of the general trend, is again apparent.

Such a picture may indicate a compound cause for one or both of these diseases, one factor of which is common to them both. It would result, for example, if water supply were a major cause of typhoid fever, and one of the contributory or associated causes of enteritis. Then the changing conditions of water supply, influenced, for example, by seasons, and rainfall, would be reflected directly in the typhoid-fever rate and would also modify the course of the enteritis from its major trend, the latter determined by some such cause as economic conditions. The significance of these facts will be brought out in a later paper in which the relation of water supplies to enteritis is more fully studied.

AGE DISTRIBUTION

In accordance with standard practice the Commissioner of Health of Porto Rico lists diarrhea and enteritis as two items, the first under two years of age, and the second, two years and over. Reference to the more detailed figures of the reports on infant mortality, however, makes it possible to distribute the total deaths into age groups, 0–1, 1–2, 2–5, and over 5. The population of the various age groups involved has been determined within a reasonable degree of approximation by the usual procedure of deducting the deaths under one year of age from the births for the year and recording the resulting figure as the population entering the second year. A similar process gives the population entering the third and sixth years respectively and from the population thus determined a mid-period population for each age group has been taken by the method of arithmetical mean. The population in Porto Rico is fairly stable so that this operation may be performed upon the combined data for the years 1918 to 1925 and populations thus obtained have been used as a basis for computing average death rates in the three age groups concerned. The data shown in Table I have been computed in this way. By way

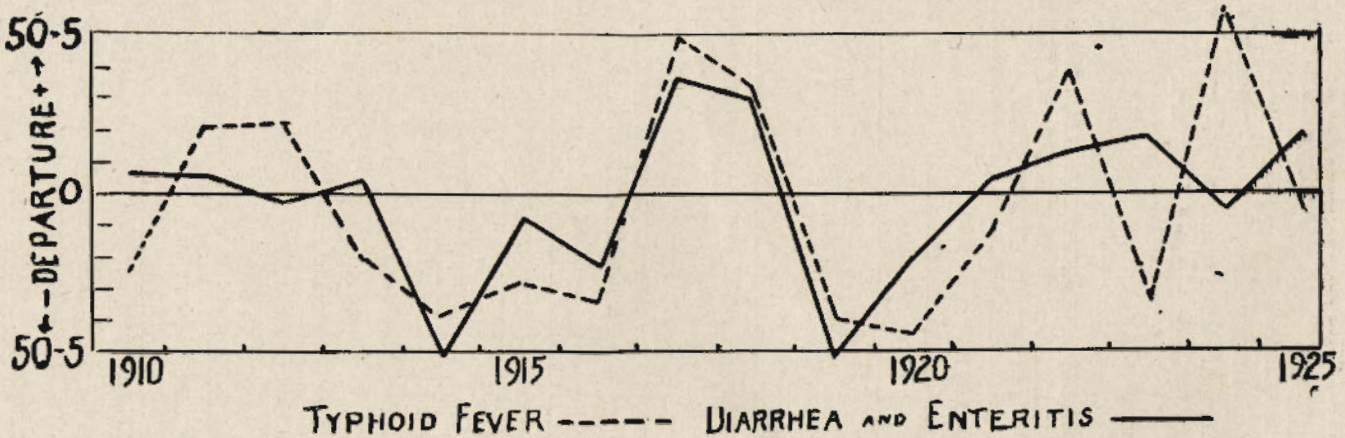

FIG. 2.—Deaths (per 100,000 population) from Diarrhea and Enteritis under two years and from Typhoid Fever, 1910 to 1925. Departures from the trend line. (Data from Fig. 1.)

of comparison the death rates for the same age groups from all causes have likewise been computed. The fifth column shows the relation between deaths from enteritis and those from all causes. Enteritis is clearly a disease of early infancy. It is reported as the cause of thirty-two per cent of all deaths under two years and twenty-four per cent of all deaths between two and five years.

TABLE I

POPULATIONS, DEATHS AND DEATH RATES FROM ALL CAUSES AND FROM DIARRHEA AND ENTERITIS, BY CERTAIN AGE GROUPS, IN PORTO RICO

Age group	Population (thousand)	Deaths		Proportion (E) to (A) (Per cent)	Death Rate (Per 1,000)	
		(A)	(E)		(A)	(E)
0-1	48	7,500	2,300	31	156	49
1-2	42	3,300	1,100	33	79	26
2-5	118	3,000	750	24	25	6
Over 5	1,150	.....	940	.....	.....	0.8

(A) All causes of death. (E) Diarrhea and enteritis.

TABLE II

DIARRHEA AND ENTERITIS IN PORTO RICO AND IN CONTINENTAL UNITED STATES

Death Rates and Percentage Distribution of Deaths by Certain Age Groups

Age group	Death rate per 1,000		Percentage distribution of death	
	United States 1920	Porto Rico 1918-25	United States 1920	Porto Rico 1918-25
0-1	13	49	65	45
1-2	3	26	16	22
2-5	0.5	6	7	15
Over 5	0.05	0.8	12	18

Table II shows the death rates and the distribution of deaths among the various age groups in per cent of the total enteritis deaths. For comparison similar data are given for the continental United States. It is seen that the disease is even more localized in the earlier years of life in the United States than in Porto Rico, indicating perhaps, a somewhat more restricted clinical definition. The difference, however, is not great enough to justify an assumption that the data deal with distinctly different things. The actual death rates are noticeably higher in Porto Rico.

This latter fact is brought out more in detail in Table III, showing death rates for ten years from diarrhea and enteritis under two years from the United States Registration Area, and the cities of Boston, Chicago, New Orleans, and San Juan (six years only). Comparison between the data of Chicago and of New Orleans shows that climate is not in any sense a controlling factor, although exerting an influence. The progressive improvement in the United States as a whole and in each of the cities except San Juan gives promise of what may be reasonably expected in Porto Rico.

TABLE III

DIARRHEA AND ENTERITIS UNDER TWO YEARS OF AGE

(Death Rates per 1,000 Living Children Under Two)

For U. S. Registration Area, (I); and the cities of Boston, (II); Chicago, (III); New Orleans, (IV), and San Juan, (V)

Year	I	II	III	IV	V (Year beginning July 1)
1915	14	17	29	23	.....
1916	15	14	31	22	.....
1917	15	16	29	28	.....
1918	13	17	29	23	45
1919	11	18	25	14	55
1920	10	14	22	14	.....
1921	10	8	18	16	41
1922	7	8	12	15	.....
1923	7	6	19	12	44
1924	6	6	10	18	48
1925	.....	.....	.....	.....	49

SEASONAL DISTRIBUTION

The seasonal distribution of a disease frequently furnishes a clue to its nature and origin. The essential data concerning this characteristic and covering the period, July 1918 to June 1925, except for one year, 1922–1923, are set forth in Table IV. The table shows the average number of deaths for each month and also the monthly value expressed as a percentage of the average annual value. The data have been slightly corrected for the months of June and July to offset what seems to have been the practice of closing the books for the current year at the end of the third week of June and transferring the deaths for the remainder of June into the July of the subsequent fiscal year. One-fifth of the reported July figure has therefore been deducted from that month and added to the June figure.*

* This correction is based upon a study of the seasonal distribution of deaths during the period in question, from all causes other than enteritis.

TABLE IV

DIARRHEA AND ENTERITIS IN PORTO RICO

Deaths by Months, and Percentage Distribution of Annual Deaths by Months, Period July 1918–June 1925 except 1922–23

Month	Deaths (average)		Per cent of annual deaths	
	Under 2 years	2 years and over	Under 2 years	2 years and over
January	285	142	8.7	8.4
February	254	120	7.5	7.1
March	255	133	7.5	7.9
April	252	114	7.5	6.8
May	264	124	7.8	7.3
June	319	149	9.4	8.9
July	314	160	9.3	9.5
August	312	169	9.2	10.0
September	253	139	7.5	8.3
October	275	149	8.2	8.9
November	282	140	8.4	8.3
December	304	151	9.0	9.0
Total	3,369	1,690	100 0	100.0

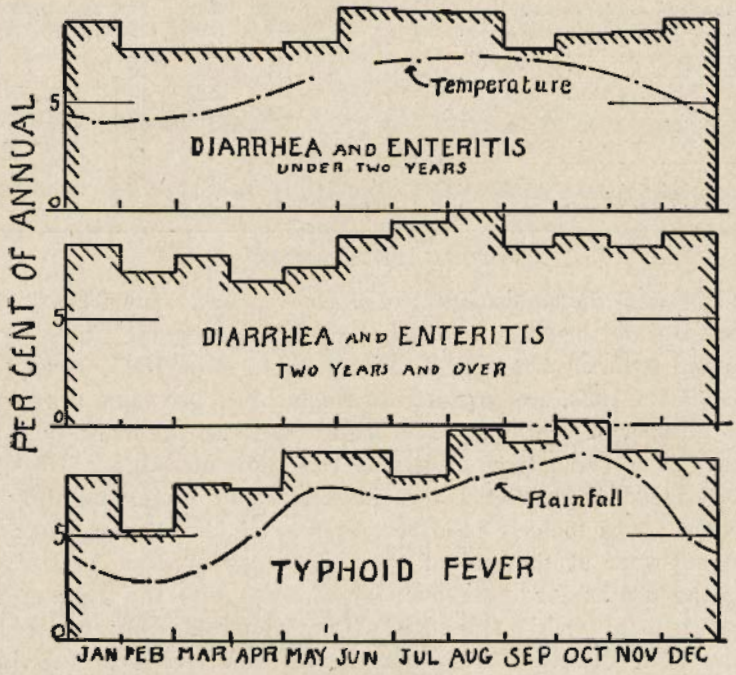

FIG. 3.—Seasonal Distribution of Deaths from Diarrhea and Enteritis, and from Typhoid Fever, in Porto Rico, 1908 to 1925. (Data from Table 4.) Also normal rainfall and temperature curves. (Data from United States Weather Bureau Climatological Data, Porto Rico Station, Vol. XXII, No. 13.)

In Fig. 3 the data of Table IV, last two columns, are shown in graphic form together with similar data for typhoid fever in Porto Rico. The primary purpose of this comparison is to determine what, if any, similarity exists between the seasonal distributions of these two diseases. The significance of this comparison, however, is somewhat greater.

In view of certain rather unique circumstances prevailing in Porto Rico it seems reasonably certain that, except for small epidemics of local origin, typhoid fever in the Island is largely waterborne. This opinion is based primarily upon the noticeable absence of flies and upon the practice of boiling all milk used for food. It is further supported by the rather striking relation between the seasonal distribution of typhoid fever deaths and the curve of normal (average) rainfall. In order to bring out this relation the rainfall data, as given by the United States Weather Bureau, have been added to Fig. 3.

If this conclusion regarding the major cause of typhoid fever in Porto Rico be sound, then it is significant that there is a close similarity between the typhoid fever curve and that for diarrhea and enteritis, over two years, and, to a lesser extent, that for diarrhea and enteritis under two years.

In the latter case, however, it appears that the relation is somewhat obscured or modified by another factor. The normal temperature data have been plotted on this diagram. The death rate curve is related, apparently, to both temperature and rainfall.

GEOGRAPHICAL DISTRIBUTION

One of the outstanding features of diarrhea and enteritis in Porto Rico is its noticeably uneven distribution among the various sections of the Island. This appears in a rough way if the municipalities be classified by their location on, or near, the north, east, south, or west coast respectively, or in the central section. The eastern and western coasts have the highest death rates, the central island the lowest, and about half the former, while the northern and southern coasts are intermediate and about equal.

A somewhat more detailed study of this geographical distribution was therefore undertaken. Death rates for the municipalities were separately computed and then a combined death rate was found for groups of contiguous municipalities in which the rate was approximately the same. The data used in the compilation are for the

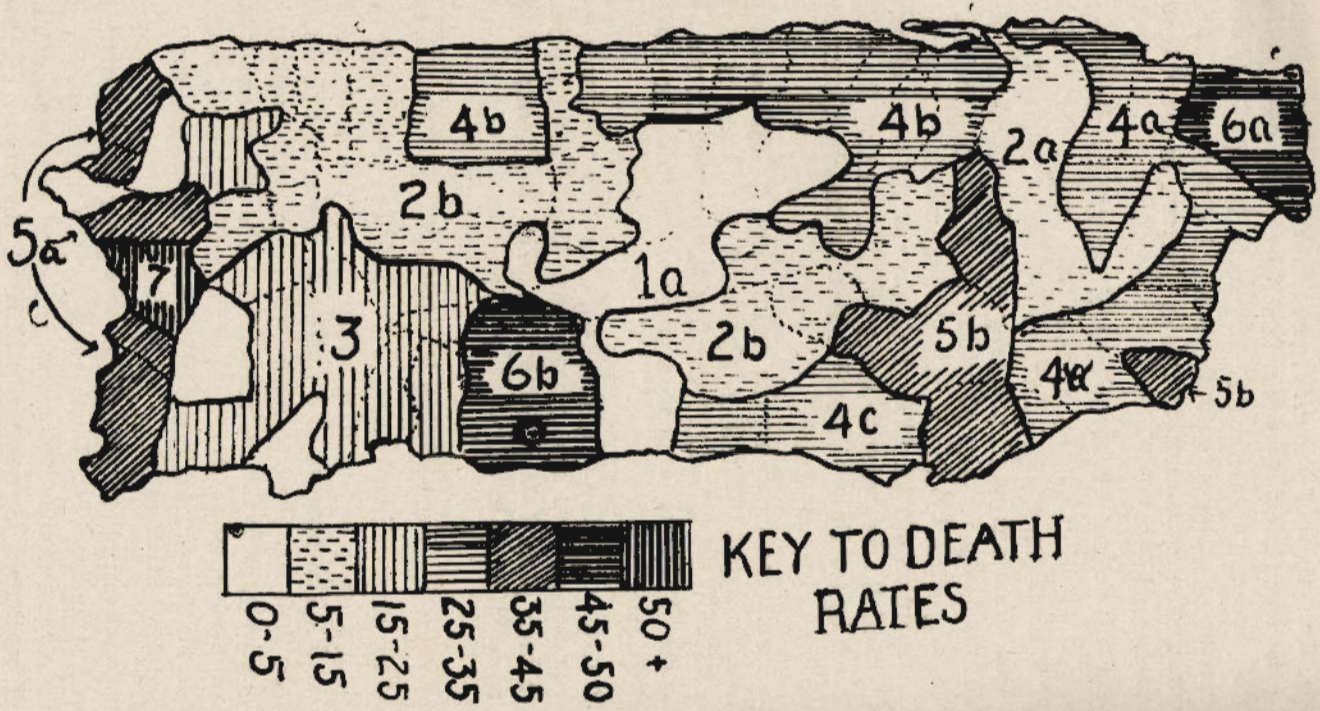

FIG. 4.—Geographical Distribution of Diarrhea and Enteritis in Porto Rico for the year 1921–1922. (Data from Table 5.)

single year 1921–22 which appears to be typical. The results of this study are shown in Table V and graphically in the diagram, Fig. 4.

TABLE V

DEATH RATES FROM DIARRHEA AND ENTERITIS IN PORTO RICO ARRANGED BY GEOGRAPHIC ZONES

Zone No.	Population under five thousand	Death rates	Municipalities
1 (a)	15.1	3.0 - .4	Barros, Corozal, Jayuya, Juana Díaz, Morovis, Naranjito
1 (b)	1.7	4.0 -1.5	Guánica
.....	1.8	2.0 -1.0	Las Marías
.....	2.8	3.0 -1.0	Moca
.....	1.5	3.0 -1.4	Rincón
2 (a)	12.0	9.0 -1.0	Caralina, Gurabo, Las Piedras, San Lorenzo, Trujillo Alto
2 (b)	41.2	11.0 - .5	Aibonito, Aguas Buenas, Barranquitas, Camuy, Ciales, Coamo, Cidra, Hatillo, Isabela, Lares, Utuado, Villalba, Quebradillas, Barceloneta
3.....	19.8	19.0 -1.0	Adjuntas, Guayanilla, Lajas, Maricao, Peñuelas, Sabana Grande, San Sebastián, Yauco
4 (a)	20.5	26.0 -1.0	Arroyo, Humacao, Juncos, Loíza, Naguabo, Patillas, Río Grande, Yabucoa
4 (b)	42.3	27.0 -1.0	Arecibo, Bayamón, Comerío, Dorado, Guaynabo, Manatí, Río Piedras, San Juan, Toa Alta, Toa Baja, Vega Alta, Vega Baja
4 (c)	27.0	28.0 -3.0	Salinas, Santa Isabel
5 (a)	13.0	38.0 -2.0	Aguadilla, Aguada, Añasco, Cabo Rojo, Hormigueros
5 (b)	13 5	43.0 -2.0	Cayey, Cagnas, Guayama, Maunabo
6 (a)	4.3	48.0 -3.0	Ceiba, Fajardo, Luquillo
6 (b)	9.0	48.0 -2.0	Ponce
7.....	5.3	53.0 -3.0	Mayagüez

* The deaths for all ages (about 80 per cent relative rates only) are compared with populations under five.

It is quite evident, especially from the diagram, that the high and low death rates of individual municipalities are not scattered over the Island indiscriminately but that there are zones consisting of considerable numbers of municipalities contiguous or nearly so, which have similar death rates. In brief, the diagram looks like a topographic map with mountain peaks and valleys, the elevations of which correspond to the death rates in question.

There is not, however, any clearly discernable relation between this relief map of death rates and any of the physical, agricultural, or economic characteristics of the regions. It is clear, for example, that the diagram is not a topographic map of Porto Rico. The zone of lowest rates, 1 (*a*), extends through the central section of the Island

in a generally north and south direction from Juana Díaz on the south coast through the mountainous municipality of Barros and including Morovis, Corozal, and Naranjito in the central section of the northern slope. Similarly it will be noted that many of the other zones extend over regions that are quite diverse in their relation to the coast and to the mountains and presumably equally diverse in matters of temperature, precipitation, and other meteorological factors. The three highest points are located on the extreme eastern and western coasts and near the center of the southern coast respectively. Large areas to the south of the main divide and along the shore are similar in their death rates to equally large areas along the northern shore where climate, altitude and meteorological conditions are distinctly different (zone 4).

This same situation apparently applies to the agricultural differences with their associated labor and economic factors. While in a general way the sugar-growing section, eastern, southern, and western coasts, contains the high points, it also contains some of the lowest. The tobacco section centering about Cidra covers a wide range of death rates, zones 2 (*a*), 2 (*b*), 4 (*b*) and 5 (*b*), as does the coffee-growing section of the west central part of the Island, 1 (*a*) 2(*b*) and (3), and the fruit-growing sections along the northern coast 2(*b*) and 4(*b*).

Whatever may be the causes of the geographical grouping of the areas of high and low enteritis death rates, they are not matters of altitude, climate or agricultural characteristics.

SUMMARY

The disease, or group of diseases, classified as diarrhea and enteritis in the vital statistics of Porto Rico, is the principal cause of death in the Island. It is a disease of infants for the most part but is less sharply associated with the first year of life than is the disease of the same title in the continental United States.

The time trend of the death rate (under two years) was steadily upward from 1910 to 1917, and has since been steadily downward. This is distinctly opposite to the time trend of typhoid fever. The annual departures above or below the normal trend values, however, are strikingly similar in the two diseases.

Seasonally, the distribution differs somewhat as between the age groups under two years and over two years. In both there is a distinct association between seasonal death rates and normal rainfall.

This association is more apparent in the age group over two years in which the seasonal curve of deaths resembles closely the curve of typhoid-fever deaths. In the younger age group, the association with rainfall is somewhat obscured by association with temperature, a feature which likewise characterizes the disease in the continental United States.

There is a distinct tendency toward geographical grouping of municipalities with high and low death rates, and this grouping is not related in any simple manner with topographical, climatological, or agricultural characteristics.