Reprinted from AMERICAN JOURNAL OF TROPICAL MEDICINE AND HYGIENE
Vol. 11, No. 3, pp. 401-409 May, 1962

STUDIES OF DIARRHEAL DISEASE IN CENTRAL AMERICA

IV. DEMOGRAPHIC DISTRIBUTIONS OF ACUTE DIARRHEAL DISEASE IN TWO RURAL POPULATIONS OF THE GUATEMALAN HIGHLANDS*

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The present paper reports the results of a prospective-type field study of cases and deaths from acute diarrheal disease in the Guatemalan highlands. The information on deaths was supplemented by officially recorded fatalities of preceding and subsequent years in the villages concerned, and was further enlarged by comparable data for the country of Guatemala and for other countries of the hemisphere. The study is one of a series designed to determine the relationship between acute infectious diseases and the protein deficiency disease, kwashiorkor.[1, 2]

An earlier bacteriological survey[3] of Guatemalan children, aged 10 years or less, demonstrated a prevalence of 6.0 per cent for *Shigella* and only 0.2 per cent for *Salmonella*. A subsequent study of 201 patients with acute endemic diarrheal disease,[4] aged 1 to 5 years, showed 13.4 per cent of cases to be associated with *Shigella*, and again a *Shigella* carrier rate of 6.0 per cent among children without diarrhea who served as controls. The frequency of bacillary dysentery among patients with acute diarrhea was less than anticipated from the existing carrier rates.

Cultures of feces at a particular point in time in a population where diarrhea is prevalent demonstrate the bacterial flora of the moment but in themselves may have little further significance.[5] A more sophisticated epidemiology than prevalence surveys is required if the diarrheas of children in Guatemala are to be related to the state of nutrition and to the aggravation of existing nutritional disease, if endemic and epidemic differences in diarrheal disorders are to be recognized, and if the intestinal disorders of childhood are to be associated with those of the general population.

Granted the inadequacies and inaccuracies of official records of mortality,[6] reported deaths still provide the only readily available index of the past and present occurrence of diarrheal disease. The prospective type of field study, extending over sufficient time and with a suitable population, is necessary to determine the true incidence of cases and deaths. This study makes use of both sources of information. Deaths are analyzed first. An account then follows of organized field studies in two highland populations of Guatemala to measure, by direct observation, the nature and extent of morbidity from diarrheal disease.

Reported deaths from diarrheal disease. Deaths recorded in the various local jurisdictions of Guatemala, and subsequently assembled in national and international vital statistics, show "gastritis, duodenitis, enteritis and colitis, except diarrhea of the newborn" to be the first cause of death. Table 1 lists the ten leading causes, eight of them primarily infectious diseases, for the year 1956 when the crude death rate was 20.6 per 1,000 population.[7] In striking contrast, no infectious process was among the first five causes of death in the United States for that year, and only the combination of influenza and pneumonia was in the first ten.

Official lists of causes of death in Guatemala, where fatalities are mainly without medical certification, correctly emphasize the outstanding importance of diarrheal disease but fail completely to show either the concurrent frequency of deaths from kwashiorkor or the extent to which the synergism of infection and malnutrition is responsible for the excessive mortality. In a study of 222 deaths of children aged 0 to 14 years in four highland Indian communities,[8] the official classification of causes of death was: kwashiorkor, none; diarrheal disease 9.5%; and intestinal parasites 26%. Field investigation of the same 222 deaths showed causes of death to

* This study was supported in part by the Pan American Health Organization and the World Health Organization.

Many members of the professional and technical staff of INCAP participated in the general field studies of which this investigation was a part. Special acknowledgement is made to Antonio Munoz, Romeo de Leon, Virginia Pierce, Miguel A. Guzman and Martha de Leon.

INCAP Publication I-214

TABLE 1

*Ten leading causes of death in Guatemala, as officially reported, 1956**

Cause of death	Deaths	
	Number	Deaths per 100,000 population
Gastritis, Enteritis, etc. (543, 571–572)†	8808	270.3
Influenza and Pneumonia (480–483, 490–493)	8124	249.4
Malaria (110–117)	6831	209.7
Certain diseases of early infancy (760–776)	5802	178.1
Infection by helminths (123–130)‡	5057	155.2
Whooping Cough (056)	2926	89.8
Dysentery, all forms (045–048)	2790	85.6
Bronchitis (500–502)	2123	65.2
Measles (085)	1481	45.5
Other diseases of the digestive system (530–539, 542, 544, 545, 573–587)	1413	43.4

* Pan American Sanitary Bureau Regional Office of the World Health Organization, 1958. Summary of four-year reports on health conditions in the Americas. Washington, D.C. Scientific Publication No. 40.

† The numbers correspond to those of the international Classification of Diseases, Injuries and Deaths, World Health Organization, Geneva, Switzerland, 1955.

‡ Deaths classified as due to helminths by non-medical registrars usually refer to children with the signs and symptoms of kwashiorkor.

be: kwashiorkor, 18%; diarrheal disease 16%; and intestinal parasites, none.

Most other countries of the Americas, and pre-industrial countries in general, experience excessively high death rates from diarrheal disease of infants and pre-school children, compared with the United States and Western Europe. Representative figures are given in Table 2. Clinical, field, and laboratory experience[2, 9] indicates that in varying degree all technically under-developed countries have the problem of a synergistic relationship between malnutrition and infection in their child population. With allowance for the unreliability of statistics on deaths from infectious diseases in these countries, the reported high death rates for measles and chicken pox illustrate the situation. These common communicable diseases of childhood presumably occur with similar frequency in most countries, and yet the 1955 mortality for measles in Mexico was 160 times greater than in the United States. In Guatemala, with extremely incomplete reporting, the death rate was listed as 45.5 per 100,000 population per year, or 227 times the rate in the United States.[7]

Guatemala's particular problem becomes evident in the deaths from diarrheal disease among young children past the first year of life. At ages 1 to 4 years, the Guatemalan rates exceed those of all other countries of the Americas. The neighboring nations of Central America also have exceptionally high rates. The greatest contrast is between Canada, with 5.2 annual deaths per 100,000 children of these ages, and Guatemala with a frequency of 956. An improved understanding of the true occurrence of childhood diarrheal disease in relation to deaths from that cause and from kwashiorkor is of direct practical importance.

The INCAP study of causes of death previously cited[8] confirmed the importance of diarrheal disease as a primary cause of death and as a common precipitating factor for most cases of kwashiorkor. The investigation was limited to highland communities. Death rates for diarrheal disease in Guatemala, as presented in Table 3, are almost 50% greater in lowland areas, an observation consistent with the previously determined infection rates for *Shigella*.[3] The table also shows that deaths are far more common in urban than in rural areas. Although the frequency of diarrheal episodes among children in highland villages, described later in this paper, is exceedingly high, the death rates suggest that the incidence must be still greater on the Pacific slope, in lowland parts of the country, and in cities generally.

The usefulness of analyses of mortality is apparent from the foregoing, especially when interpretation is aided by field studies to determine the reliability of the official reports. However, the low fatality of most diarrheal episodes makes deaths a poor index of the epidemiological behavior of this disease. Furthermore, the frequent recurrence of diarrheal disease in the same individual within relatively brief intervals gives this group of diseases added significance in accounting for the excessive crude death rates of a country like Guatemala. Morbidity studies thus become essential to an understanding of the problem, especially in relation to the concept

TABLE 2

*Deaths and annual death rates from diarrheal disease for infants under 1 year and for children 1 to 4 years old, in selected countries of the Americas, 1956**

Countries	Children under 1 year†		Children 1 to 4 years‡	
	Number deaths	Deaths per 1,000 live births	Number deaths	Deaths per 100,000 population
Central America				
Costa Rica	926	18.0	239	189.2
El Salvador§	1972	18.8	2255	867.2
Guatemala§	1948	12.5	4092	955.9
Nicaragua	890	16.9	281	179.8
Panama	340	9.4	143	126.1
South America				
Argentina	2383	5.2	530	32.9
Brazil	6873	38.0	2320	442.3
Chile	4341	17.2	1140	166.9
Columbia	9934	18.4	6211	368.5
Ecuador§	1349	32.5	808	717.5
Paraguay	135	6.1	94	45.7
Peru‖	1764	6.1	1836	192.3
Venezuela	3588	12.9	1676	219.9
North America				
Canada	695	1.5	81	5.2
Mexico§	25074	18.2	28529	784.2
United States§	4730	1.2	650	4.4
The Caribbean				
Barbados	68	9.6	9	42.9
Dominican Republic§	1499	14.3	990	282.1
Jamaica¶	402	7.5	180	117.0
Martinique	59	6.0	27	91.0
Puerto Rico§	1199	15.1	377	124.7
Trinidad & Tobago	317	11.5	68	79.3
Windward Islands§	93	25.8	51	583.7

* Source: Pan American Sanitary Bureau Regional Office of the World Health Organization, 1958. Summary of four-year reports on health conditions in the Americas. Washington, D.C. Scientific Publication No. 40.

† Diseases of the digestive tract.

‡ Gastritis, duodenitis, enteritis and colitis, except diarrhea of the new-born.

§ 1955.

‖ 1953.

¶ 1954.

that kwashiorkor results from the combined effects of a grossly deficient diet and the stress of repeated infections. The sections that follow describe the first studies of this kind carried out in the area.

FIELD STUDY METHODS

The field investigation was planned to obtain information on the occurrence and distribution of acute diarrheal disease among pre-school children of rural areas in Guatemala. The population studied was from four villages in the central highlands, Department of Sacatepeguez. Two relatively small communities, Santo Tomas Milpas Altas with 694 residents and Santa Lucia Milpas Altas with 470, were observed from March 1956 through February 1957. The villages are on the same plateau about 2 miles apart and some 20 miles from Guatemala City, their main market center. They were judged to be fairly representative of highland Indian communities.

Two larger villages in the same Department, Santa Catarina Barahona with 752 people and San Antonio Aguas Calientes with 2,395, were

TABLE 3

*Deaths and death rates from diarrheal disease by geographic division and by urban and rural residence, Guatemala, 1959**

	Population	Acute diarrheal disease	
		Number deaths	Deaths per 100,000 population
TOTAL	3,649,858	9,826	269.2
Lowland and coastal	1,467,241	4,819	328.4
Highland	2,182,617	5,007	229.4
Urban	912,464	3,789	415.2
Rural	2,737,394	6,037	220.5

* Source: Direccion General de Estadistica, Guatemala, 1960

the sites of a second series of observations beginning in November 1957 and ending in February 1959. These two communities adjoin each other in a small valley. The populations are predominantly Indian, and the trading center is Antigua rather than Guatemala City, which is 30 miles away. San Antonio Aguas Calientes has a home weaving industry and a limited amount of land available for planting vegetables and corn. Santa Catarina Barahona is among the poorer villages in the Department.

As a first step in the study, a census was taken of each village and maps were prepared, dividing the area into sectors of such size that each family could be visited once every 2 weeks. Young women experienced in field work through previous INCAP programs were given special instruction regarding the collection of data on diarrheal disease. They averaged about 15 home visits daily during the first 5 days of the week, with Saturdays reserved for families absent from home or not seen for other reasons during the regular calls. About 20 to 30 minutes were allotted for each household visit. Field workers recorded the cases of diarrhea which had occurred during the preceding fortnight, their clinical nature, their date of onset and duration, and the number and character of the stools. An epidemiologist visited the village at least once a week to help overcome technical difficulties incident to collecting and processing the data, and to observe the general nature of the prevailing diarrheas and dysenteries.

An illness was accepted as a case of diarrhea if a child under 1 year of age had 5 or more liquid or semi-liquid stools within a 24-hour period, or if children beyond that age had 3 or more such stools. A patient was considered as a new case only if 2 weeks had passed since the end of a preceding episode. The clinical classification recognized three grades of severity. Mild cases were those lasting 3 days or less. Illnesses of more than 3 days duration were judged to be moderate. Any acute intestinal disorder meeting the stated minimal requirements but characterized by blood and mucus in the stools was classed as severe.

RESULTS

Two villages were studied for 12 months and two others during a subsequent 16 month period. Because in both instances they were adjoining communities of similar character, and also because greater numbers were an advantage in analysis, each of the two sets of villages is treated as a single population. No further combination was made because the two populations were studied in different years, and because the first set of villages proved to be in the ascending phase of an eventually well-marked epidemic of diarrheal disease, while the second was observed at the end of such an outbreak. The phase in the two epidemic cycles during which observations were made is illustrated in Figure 1. For convenience the first situation is designated epidemic, and the second endemic although it did not long remain so; a fresh outbreak developed within a few months after the study ended.

Table 4 shows that the annual incidence of cases of diarrheal disease in the villages experiencing an epidemic was 135.4 per 100 children of the specified ages per year; the second population, under endemic conditions, had a rate of 40.7. A seasonal increase under endemic conditions began in January and was prolonged through May (Figure 2). For the villages with an epidemic, the seasonal increase of the second year began earlier, in October, and continued irregularly to a high point in February, the last month of observations. In both situations, rates reached a low point early in the rainy season.

The morbidity from acute diarrheal disease, as presented in Table 4, was greatest among children in the second year of life, irrespective of epidemic or endemic conditions. Infants less than 6 months old had relatively low rates. The

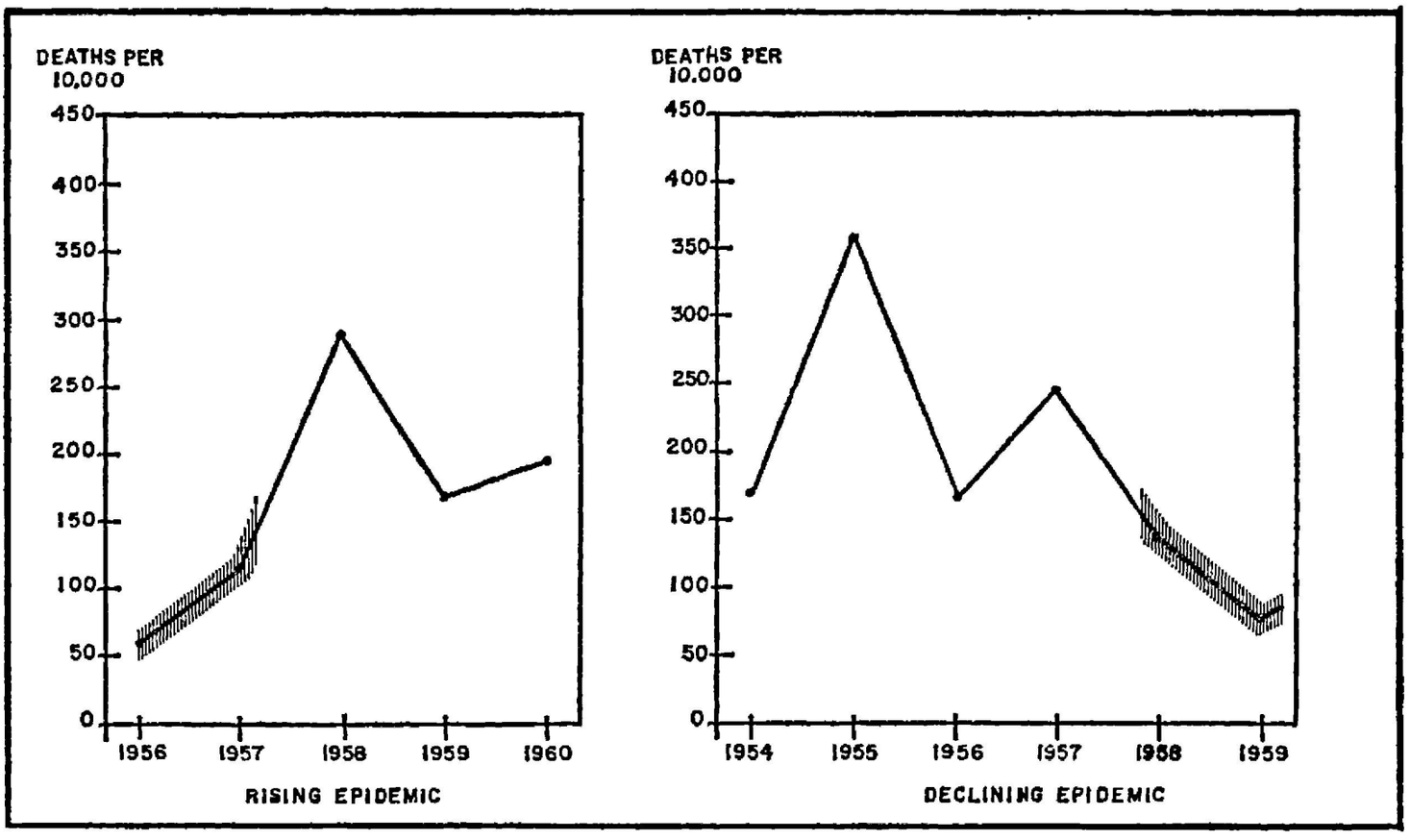

FIG. 1. Two epidemics in rural Guatemalan populations as measured by deaths. Shaded areas show period of field studies of incidence.

TABLE 4

Incidence of acute diarrheal disease among pre-school children in two highland populations of Guatemala, the first in the initial phase of an epidemic (1956–1957) and the second during a declining (independent) epidemic (1957–1959)

Age	Rising epidemic (1956–1957)			Declining epidemic (1957–1959)		
	Population	No. cases	Cases per 100 persons of the specified age per year	Population	No. cases	Cases per 100 persons of the specified age per year
TOTAL	241	321	133.2	576	302	39.3
0–5 months	33	32	97.0	59	15	19.1
6–11 months	18	49	272.2	61	50	61.5
1 year	31	94	303.2	104	90	64.9
2 years	40	77	192.5	82	70	64.0
3 years	29	35	120.7	90	41	34.2
4 years	47	15	31.9	81	19	17.6
5 years	43	19	44.2	99	17	12.9

increase in the second 6 months was abrupt, reaching a level not far from that of children in their second year. Age-specific rates continued high during the third year of life, the values being about half those of the peak period during the second year. Thereafter incidence declined. The average for older pre-school children of 4 and 5 years was less than at any other age in early childhood. Attack rates were numerically greater for females than for males in both the epidemic and the endemic series, although the observed differences were not statistically significant.

Since it was usual for an individual child less than 3 years old to have repeated attacks of acute diarrheal disease in the course of a year, annual incidence rates, as shown in Table 4, do not portray the complete situation in respect to susceptibility and resistance to the disease.

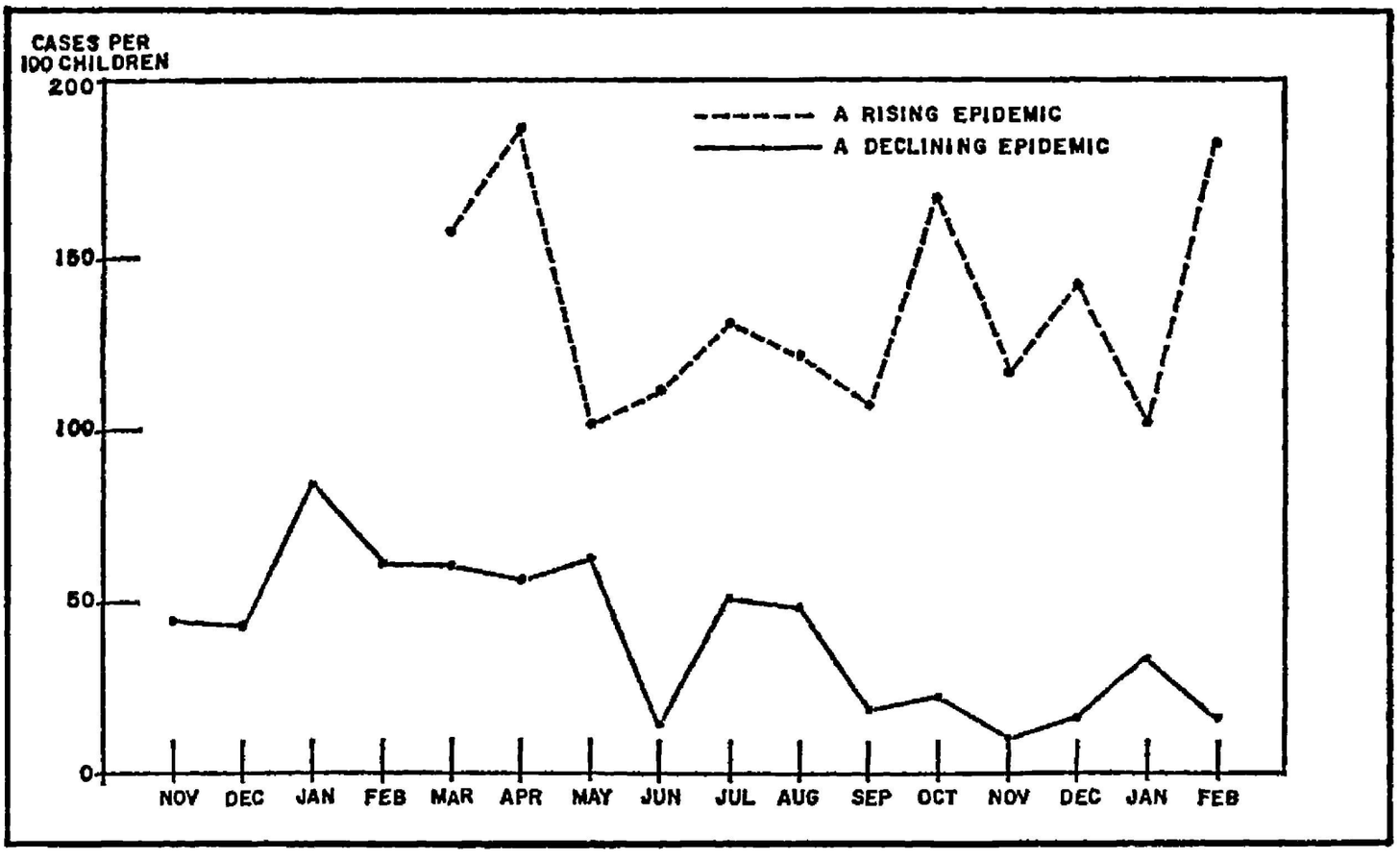

FIG. 2. Cases of diarrheal disease in children 0 to 5 years of age in two rural populations during rising and declining epidemics, by months, Guatemala 1956–1957 and 1957–1959.

TABLE 5

Attacks of acute diarrheal disease per child per year in a rural Guatemalan highland population during a rising epidemic, by age, 1957–1959

Age	Number Children	Cases per child during one year											
		None		1		2		3		4		5–8	
		Number	Per Cent	Number	Per Cent	Number	Per Cent	Number	Per Cent	Number	Per Cent	Number	Per Cent
0–5 months	33	15	45.5	8	24.2	5	15.2	2	6.1	3	9.1	0	0
6–11 months	18	2	11.1	3	16.7	2	11.1	2	11.1	5	27.8	4	22.2
1 year	31	0	0	10	32.2	7	22.6	4	12.9	6	19.4	4	12.9
2 years	40	6	15.0	14	35.0	11	27.5	4	10.0	3	7.5	2	5.0
3 years	29	14	48.3	8	27.6	2	6.9	2	6.9	0	0	3	10.3
4 years	47	37	78.7	7	14.9	1	2.1	1	2.1	1	2.1	0	0
5 years	43	34	79.1	5	11.6	1	2.3	1	2.3	0	0	2	4.6
TOTAL	241	108	44.8	55	22.8	29	12.0	16	6.6	18	7.5	15	6.2

Table 5 presents children of the two villages involved in a rising epidemic according to age and the number of attacks they had in the course of a year. Two-thirds of children less than 1 year old experienced diarrhea, while every child in the second year of life had at least one attack. Conditions thereafter improved, so that for children 4 and 5 years old, the chances of a bout of diarrhea during the year were about one in five. In all, 133 of 237 children had one or more attacks during the year, and one child suffered no less than eight. With lower community attack rates in the second group of villages under endemic conditions, multiple diarrheal illnesses during a year were fewer although the relative frequency by age was similar.

The analyses thus far made have been based on acute diarrheal disease of all forms meeting

TABLE 6

Age-specific death rates for acute diarrheal disease per 10,000 children per year, 4 rural villages, Guatemala, 1954–1960

Age	Accumulated population 1954–1960	Accumulated deaths 1954–1960	Age-specific death rates per 10,000 children per year
TOTAL	7467	137	183.5
Under 1 year	1388	28	201.7
1 year	1207	41	339.7
2 years	1259	33	262.1
3 years	1268	27	212.9
4 years	1216	4	32.9
5 years	1129	4	35.4

the previously stated requirements. Epidemiologically and in relation to kwashiorkor, it is useful to know whether or not the epidemic disease is of greater severity than the endemic. Clinically, it is important to learn what relation exists between initial severity and the extent of disability or the likelihood of a fatal result. Severe cases were no more frequent proportionately in the epidemic than in the endemic series. In both, about one-fourth of the patients had a severe infection; one-half had a moderate clinical reaction; and the remaining quarter a mild attack. Children at ages 6 to 17 months had proportionately more severe infections than at other ages.

The mortality from acute diarrheal disease was 126 per 10,000 children under 6 years of age per year, an uncertain figure because of the small numbers. With similar reservations, the case fatality was close to 1 per cent. The observed mortality approximated the usual rates in official reports for the country as a whole; for example, 95 per 10,000 for children of the same ages in 1955; and yet it was measurably less than the long-term experience of these two populations. Both communities were studied under what were assumed to be endemic conditions; although they were close to that, they are better identified as interepidemic. Under local conditions epidemics are almost certain to occur at relatively short intervals. The expected result over any appreciable period of years is thus an average mortality rate materially higher than that observed during the study. Proof that such epidemics characterized these particular villages is seen in Figure 1.

According to the deaths officially recorded in the village registers, the average mortality attributable to diarrheal disease for the population studied during an incipient epidemic was 181 per 10,000 pre-school children per year during the period 1954 to 1960, and 185 for the villages observed in the end phase of an outbreak. Despite the observed differences in annual case incidence during the study period due to the contrasting epidemiologic situations, the average over a term of years, as judged by reported deaths, was much the same in the two populations. Total deaths for the 7 years in the two populations are combined in Table 6 because the death rates were so much the same. The data show a similar age distribution in reported mortality and in observed morbidity.

These observations add to existing evidence that the frequency of deaths from diarrheal disease among young children of Guatemala is high. They also support the assumption that long-term average annual case rates are materially greater than the results reported here, which are from an interepidemic period.

DISCUSSION

In so far as deaths may be taken as a measure of cases, there is little doubt that the diarrheas of childhood in Guatemala are exceptionally numerous especially among infants 6 to 18 months old. This is the usual age of weaning. Two and three-year old children also suffer heavily.

With increasing evidence that kwashiorkor is precipitated by the diarrheas and the dysenteries, along with other infectious diseases, the need is for better knowledge of the frequency of attack and of the degree of severity of diarrheal disease capable of producing that result. Bi-monthly visits to all homes in four rural villages during a year gave the first reliable information for Guatemala.

Clinical experience and bacteriological studies suggest that epidemics are frequent and that they may occur in any season. Acute diarrheal disease, as well as such common infectious diseases as chicken pox, typhoid fever and many others, are fluctuating endemic diseases. They may occur regularly in a given population either in small numbers, the usual endemic situation, or at higher levels, then termed hyperendemic. In both circumstances the usual curve of behavior is

punctuated from time to time by an epidemic. This may occur at fairly regular intervals as with measles or whooping cough, or irregularly as with diphtheria and many others.

The investigations described here were started in two populations under what appeared to be ordinary endemic conditions. Subsequent events proved that the first population was entering upon an epidemic which in the course of two years developed to appreciable proportions. Another protracted epidemic had ended a few months before the studies started. The second population was discovered to be in the descending phase of an epidemic during the year in which observations were made. Within a few months after the study ended, a fresh outbreak is known to have started. As judged by this experience, one epidemic tends to follow another at relatively short intervals in these village populations. The epidemiologic pattern might be better characterized as fluctuating epidemicity rather than fluctuating endemicity.

The incidence of acute diarrheal disease differed greatly in the two situations studied. For the village population in the course of a rising epidemic, the annual incidence of cases was 135 per 100 children of ages 5 years or less, while in the second population, in the declining phase of an epidemic, the incidence was 41. Neither circumstance was wholly typical of an endemic situation. As also indicated by the mortality statistics, the common age of attack was in late infancy and early childhood with more females affected than males.

No discernible differences in general severity were detected between endemic and epidemic situations; in both circumstances attack rates and numbers of severe cases were highest among children 6 to 17 months old. Thus, most of the diarrhea, including most of the severe illness, coincides with the time in life when kwashiorkor makes its appearance. In the epidemic situation none of the 1-year old children escaped an attack of diarrhea during the year of observations, and only 15% of the 2-year olds.

A larger study, in length of time or in numbers or both, and a group of validated deaths determined by case study, are necessary to obtain mortality rates expressive of total deaths from diarrheal disease. In particular, the mortality under ordinary endemic conditions and the variations that characterize epidemic situations need further investigation. Knowing expected death rates from diarrheal disease under various circumstances, investigators could make more nearly factual estimates from reported deaths as to whether a community was currently experiencing an endemic, hyperendemic, or an epidemic situation. A similar knowledge of case fatality would permit estimates of numbers of cases.

SUMMARY

Officially reported death rates from acute diarrheal disease for children in the first year of life show Guatemala to occupy a middle position among countries of the Americas. For the age group 1 to 4 years, the rates exceed those of any other. Distribution of deaths by months and years suggest recurring outbreaks of acute diarrhea, closely spaced, of varying size, of relatively long duration, and of an epidemiologic pattern consistent with spread by contact infection. The recorded causes of deaths should be interpreted as actually due to a synergism between infection and malnutrition.

Field studies of a Guatemalan highland child population aged less than 6 years established an annual case incidence of acute diarrheal disease that ranged from 135 per 100 pre-school children during a beginning epidemic to 41 per 100 during a more or less endemic period at the end of an outbreak. Repeated attacks in the same child in the course of a year occurred in both situations, but more frequently as general incidence increased. Attack rates were greatest at ages 6 through 17 months and continued at excessive levels during the second and third years of life. Frequency of attack and severity of illness coincided with the ages at which kwashiorkor is commonest.

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