

This interpretation is in good agreement with that recommended in the Third Report of the Joint FAO/WHO Expert Committee on Brucellosis.<sup>d</sup>

In the first three dilutions, the samples from cows and heifers showed somewhat higher rates of agglutination than the samples from bulls, but at dilution 1 : 40 no marked difference between the groups was seen.

<sup>d</sup> *Wld Hlth Org. techn. Rep. Ser.*, 1958, 148

## An Investigation into the Causes of Death in Children in Four Rural Communities in Guatemala \*

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Published studies and the experience of health workers in Central America indicate that child deaths are exceedingly common from both diarrhoea of infectious origin and from malnutrition, particularly the severe protein deficiency of kwashiorkor.<sup>a, b, c</sup> Although the official vital statistics list many deaths due to diseases of the digestive system, few deaths are reported as due to any form of malnutrition. Preliminary investigations<sup>c, d</sup> in Central America suggest that deaths due to malnutrition are listed under other causes, so that the official statistics fail to reveal that kwashiorkor is a major public health problem among pre-school children and an important cause of death in this age-group. This in turn is because malnutrition only rarely is "diagnosed" by the laity who register most deaths in rural areas.

Only 13.7% of death certificates in Guatemala were medically certified in 1956; the remainder used information from relatives or friends interpreted by the town civil registrar. These are the data sent to the central office of vital statistics, and analysed, tabulated and forwarded to the international agencies concerned. To assist in their interpretation, the causes of death of children in four rural Guatemalan communities have been investigated and compared with those entered in the official vital statistics of the country.

\* This work was supported by a grant-in-aid from the World Health Organization. The report will also be published, in Spanish, in the *Boletín de la Oficina Sanitaria Panamericana*.

<sup>a</sup> Peña Chavarria, A., Sáenz Herrera, C. & Cordero-Carvajal, E. (1948) *Rev. méd. C. Rica*, No. 170

<sup>b</sup> Scrimshaw, N. S., Béhar, M., Pérez, C. & Viteri, F. (1955) *J. Pediat.*, 16, 378

<sup>c</sup> Autret, M. & Béhar, M. (1954) *Síndrome policarencial infantil (kwashiorkor) and its prevention in Central America*, Rome (FAO Nutritional Studies, No. 13)

<sup>d</sup> Scrimshaw, N. S., Béhar, M., Viteri, F., Arroyave, G. & Tejada, C. (1957) *Amer. J. Publ. Hlth.*, 47, 53

**Communities studied.** Four rural communities in the Guatemalan highlands near the department capital of Antigua were selected for study.

*San Antonio Aguas Calientes* is a village of 428 families and 1953 persons,<sup>e</sup> who are overwhelmingly Mayan Indian in appearance, language and customs. The women still wear traditional costumes and the village is famous for its hand weaving. With income from this handicraft, from work on neighbouring coffee plantations and from corn grown on land owned by most families, the village is relatively prosperous for an Indian community in Guatemala.<sup>f</sup>

*Santa Catarina Barahona* is an adjoining village of 187 families and 752 persons,<sup>e</sup> similar but economically poorer than the above.<sup>g</sup>

*Ciudad Vieja* is a small town, once the site of an early Spanish colonial capital of Central America. The population in the census of 1950 was 4284, with a projection for 1957 of 6208, including its "suburb" San Lorenzo el Cubo. The latter figure is used for mortality rates, but there is reason to believe it is an overestimate due to the departure of young people to live and work in Antigua and Guatemala City. This is the only town in which water is piped into some homes; most families still obtain their water from central fountains as in the smaller villages. The population is predominantly Mayan, although many of the women have abandoned traditional dress. The non-Indian population was officially estimated at 4230 in 1957. It is relatively prosperous among Guatemalan highland towns.

*San Lorenzo el Cubo* is a small Indian village of about 1200 inhabitants and is administratively part of Ciudad Vieja but constitutes a separate community about 1½ miles away. The people largely have abandoned Indian dress and customs, but include almost no non-Indian families. Most inhabitants work on surrounding coffee plantations and also cultivate small private corn plots on the steep slopes of nearby hills. Their economic status is intermediate between that of San Antonio and that of Santa Catarina.

These villages represent a range of conditions found in the villages and small towns of the Guatemalan highlands. In none of them is there as much poverty and malnutrition as has been observed in several other rural highland villages in which INCAP has worked.<sup>h, i</sup> The crude death-rates are strikingly similar to those given in the census figures for the entire country and are better than those for the rural population as a whole. Free clinical and hospital medical care is available in Antigua, five to seven miles away, but is rarely taken advantage of by the inhabitants of these communities. Most medical treatment is by non-professional pharmacists or by native healers.

**Procedure.** A young woman resident of Ciudad Vieja, with experience in experimental field programmes in the area, was given special instruction in the information needed for the classification of causes of death and assigned to investigate each death under 15 years of age reported to the municipal authorities. A questionnaire, which provided space for information regarding the family, disease history, treatment given and by whom

<sup>e</sup> According to a house-to-house census by INCAP field workers in early 1957

<sup>f</sup> Flores, M. & Reh, E. (1955) *Bol. Ofic. sanit. panamer.*, Suppl. 2, p. 149

<sup>g</sup> Flores, M., Flores, Z. & Meneses, B. (1957) *Arch. venez. Nutr.* (In press)

<sup>h</sup> Solien, N. & Scrimshaw, N. S. (1957) *J. trop. Pediat.*, 3, 99

<sup>i</sup> Flores, M. & Reh, E. (1955) *Bol. Ofic. sanit. panamer.*, Suppl. 2, p. 163

and for what, the opinion of the parents and other observers as to the cause of death and the exact nature of all symptoms, was drawn up to guide her. She inquired regarding fever, convulsions, cough, coryza, nausea, vomiting, frequency and nature of diarrhoea, occurrence of parasites, oedema, anorexia and other symptoms. The investigation was begun as soon as a child was reported to have died and was not concluded until as much relevant information as required or practical was obtained. The worker was instructed to view the body whenever possible to report oedema, wasting, dehydration, and skin and hair changes; seriously ill children were occasionally seen before death.

One of the authors discussed weekly with this field worker each new or pending report and indicated when further information was needed. It was not practical for a physician to investigate the cases because insistence on medical care from him would have disrupted the study. Although the initial inquiry was generally made within 48 hours of death, there was no fixed limit to the number of interviews per death and an effort was made to keep these in the nature of informal visits.

In order to obtain accurate information as to the recording of these deaths in the national and international vital statistics, the diagnoses written in the civil register by the town clerks were copied and taken to the central statistical office in Guatemala City for routine coding.

**Crude mortality.** The age distribution of deaths in the four villages in each of the years 1956 and 1957 is given in Table 1. It can be seen that 58% occurred in children under five years of age.

TABLE 1. DEATHS IN FOUR HIGHLAND VILLAGES IN GUATEMALA  
BY AGE, 1956 AND 1957

Age	1956	1957	Total	Percentage of total
Under 1 year	51	46	97	27
1-4 years	55	54	109	31
5-9 years	6	8	14	4
10-14 years	0	2	2	1
15 years and over	70	61	131	37
Total	182	171	353	100

The mortality rates per 1000 population for the four villages in 1956 and 1957 are compared with those for the whole of Guatemala in 1955 (taken from the official statistics) in the tabulation below.

	<i>Four villages (1956-57)</i>	<i>Entire country (1955)</i>
Total mortality rate . . . . .	19.8	20.3
Mortality rate in age-group 1-4 years . . . . .	50.3	42.1
Infant mortality rate. . . . .	136.8	101.4

The total mortality rates were very similar, both being of the order of 20 per 1000. The infant mortality rate and the mortality rate in the 1-4 age-group were extraordinarily high; both these rates were slightly higher in the villages studied than in the entire country, presumably because the official vital statistics for Guatemala include the large cities where conditions are somewhat better for young children.

It should be noted that the mortality rates given in the above tabulation imply that approximately one-third of the children born alive die before reaching five years of age. Analysis of the causes of this high mortality, particularly in the 1-4 age-group, is a principal objective of this study.

**Diagnostic criteria.** The causes of death were tabulated in seven groups based on the International Statistical Classification of Diseases, Injuries and Causes of Death.<sup>J</sup> Congenital deformities and diseases occurring in the first 28 days after birth were included in the group "Congenital malformations and diseases peculiar to early infancy" (750-776).

Within the category "Diseases of the respiratory system" (470-527) were listed cases with a short history of fever, cough, coryza, difficulty in breathing and related symptoms. An example of such a case which the parents considered to have died of a "lung cold" is as follows:

D.V., a 6-month-old male; 4 living and 4 dead siblings; breast-fed with no supplementary feeding; one-week illness characterized by fever, coryza, coughing and shortness of breath.

The great majority of deaths classified as "Diseases of the digestive system" (530-587) were interpreted as infectious diarrhoea. Their course was usually short and severe and characterized by profuse diarrhoea, often with mucus and blood, and frequently accompanied by fever, vomiting, terminal dehydration and even convulsions. An example of a child in this group considered by the parents to have been struck by an "evil eye" is as follows:

B.C., a 9-month-old male; 2 living and 2 dead siblings; breast-fed with no supplementary feeding; 24-hour illness characterized by fever, vomiting, diarrhoea with approximately 10 liquid, very bloody stools and abdominal cramps.

The group of "Infective and parasitic diseases" (001-138) included children dying with a history suggesting acute systemic infections. Many had febrile episodes followed by weeks of coughing and respiratory difficulties considered to be due to whooping cough. This disease is well known and the parents' diagnosis of this condition was usually accurate. Other cases in this category suggested measles or other acute exanthemata. The example which follows was considered by us and by the parents to represent whooping cough:

F.C., a 7-year-old male; one sibling with whooping cough; one-month illness characterized by fever, coryza, coughing, shortness of breath and personality change. Other whooping-cough cases in the village.

<sup>J</sup> World Health Organization (1948) *Manual of the International Statistical Classification of Diseases, Injuries, and Causes of Death*, Geneva, 2 vols.

A striking finding of the present study was that many young children had the characteristic signs and symptoms of kwashiorkor at the time of their death. When no other primary cause was present at death, these children were listed in the category "Other specified causes". No other use is made of this category except for two cases of severe undernutrition or "marasmus". While most of the children listed as dying due to kwashiorkor had the classical signs of this syndrome at death, it may be questioned whether kwashiorkor was the primary or a contributing cause. Autopsies of hospitalized children dying with kwashiorkor have shown bronchopneumonia present as a terminal episode in 70% of the cases, and no specific anatomical cause in most of the remaining 30%.<sup>k</sup> Thus when the kwashiorkor syndrome is present, other primary causes of death are not ordinarily found at autopsy. Nevertheless, as the discussion will emphasize, it is our belief that many of these cases of kwashiorkor would not have developed without the precipitating stress of diarrhoeal or other infectious diseases.

TABLE 2. FINDINGS IN 40 DEATHS WITH KWASHIORKOR IN FOUR HIGHLAND VILLAGES IN GUATEMALA, 1956 AND 1957

Findings	Number of cases	Percentage of cases
Oedema	40	100
Weight markedly low for age	40	100
Diarrhoea	39	98
Apathy and/or irritability	37	92
Anorexia	37	92
Characteristic skin and/or hair changes	33	82
Duration of illness:		
under 1 month	3	8
1 - <2 months	8	20
2 - <4 months	15	38
4 months and over	14	35

Waterlow & Scrimshaw<sup>l</sup> have stressed the importance for comparative purposes of providing a frequency table of signs and symptoms of kwashiorkor in specific studies. As summarized in Table 2, in 40 deaths with kwashiorkor in the villages studied, oedema and retarded growth and

<sup>k</sup> Tejada, C., Béhar, M. & Cofiño, E. (1956) *Rev. Col. méd. Guatemala*, 7, 134

<sup>l</sup> Waterlow, J. C. & Scrimshaw, N. S. (1957) *Bull. Wild Hlth Org.*, 16, 458

development were observed in all, and apathy, anorexia and characteristic skin and hair changes were noted in most. Diarrhoea, which is an almost constant finding in studies of kwashiorkor,<sup>m</sup> was reported in all but one case. In general, this diarrhoea was chronic and mild, at least in the later stages of the illness. In the following example of death attributed by us to kwashiorkor the parents stated that the child died from an "infection".

M.A., an 18-month-old female; considered to have been ill from time breast feeding discontinued at 6 months because of a "scare" to the mother. Diet of starch gruel and barley water with one glass of reconstituted powdered whole milk daily. Marked loss of weight, oedema, characteristic skin and hair changes, apathy and anorexia. Nausea and vomiting, 8-10 yellowish-green diarrhoeal stools daily with mucus and *Ascaris* but no blood.

When reasonable doubt remained after exhausting all practicable means of getting more information, the death was classified under "Ill-defined or unknown causes" (780-795); it was not possible to investigate seven of the deaths listed in the civil register. There are, of course, serious limitations and possible errors in a study of this kind. For example, some cases in which pulmonary tuberculosis was strongly suspected were classified under "Diseases of the respiratory system" (470-527) rather than under "Infective and parasitic diseases" (001-138) because of the impossibility of making a definite diagnosis. Also some of the cases classified as whooping cough may have been other respiratory infections. It is not likely, however, that errors of this type could substantially change the public health implications of the findings.

**Tabulation of causes of death.** The causes of death encountered in 222 children, aged 0 through 14 years, who died during 1956 and 1957 in the four villages are shown in Table 3. In the first column the causes of death are classified according to the national vital statistics. It should be emphasized that, with the exception of one child who died in a hospital at Antigua, none of these deaths was certified by a physician and that the town clerk wrote down his own interpretation of the cause of death, based on the opinion of a relative or family friend. The second column lists the deaths as classified in the present investigation and differs markedly from the first in several important categories.

Our analysis of the causes of death by age-group is given in Table 4. As might be expected, most of the children with congenital abnormalities died during the first month and these deaths were grouped with the other neonatal deaths. The largest number of deaths due to respiratory disease occurred between one month and one year. Digestive diseases, or more specifically infectious diarrhoea, were concentrated in the first and second years of life, as were deaths from whooping cough and other specific infections. No deaths from kwashiorkor occurred under one year and the largest numbers occurred in the second and third years of life.

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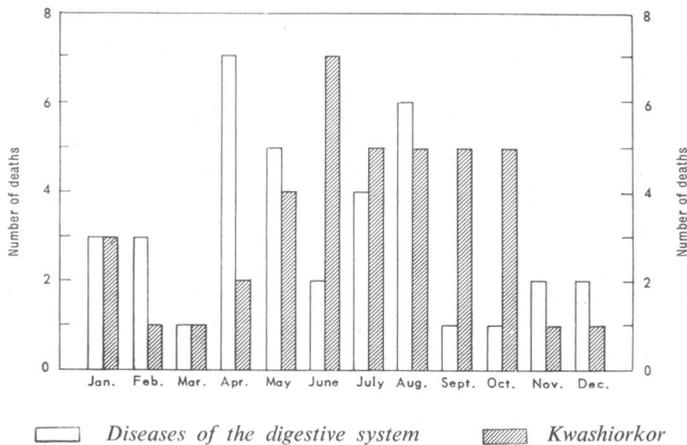
<sup>m</sup> Scrimshaw, N. S., Béhar, M., Arroyave, G., Viteri, F. & Tejada, C. (1956) *Fed. Proc.*, 15, 977

**TABLE 3. CAUSES OF DEATH OF CHILDREN UNDER 15 YEARS OF AGE IN FOUR HIGHLAND VILLAGES IN GUATEMALA, 1956 AND 1957**

Cause	Official vital statistics	INCAP investigation
Congenital malformations and diseases peculiar to early infancy	43	49
Diseases of the respiratory system	35	42
Diseases of the digestive system	21	37
Infective and parasitic diseases:		
whooping cough	12	17
intestinal parasites	58	0
other	9	10
Other specified causes:		
kwashiorkor	0	40
other deficiency disease	1 *	3
other	2	0
Ill-defined or unknown	41	17
Not investigated	0	7
Total . . .	222	222

\* Died in a hospital in Antigua, Guatemala

**MONTHLY DISTRIBUTION OF DEATHS FROM DISEASES OF THE DIGESTIVE SYSTEM AND FROM KWASHIORKOR IN FOUR HIGHLAND VILLAGES IN GUATEMALA DURING 1956 AND 1957**



**TABLE 4. CAUSES OF DEATH BY AGE IN CHILDREN UNDER 15 IN FOUR HIGHLAND VILLAGES IN GUATEMALA, 1956 AND 1957**

Cause	Months		Years					Total
	under 1	1-11	1	2	3	4	5-14	
Congenital malformations and diseases peculiar to early infancy	43	4	1	0	0	1	0	49
Diseases of the respiratory system	0	23	8	3	0	4	4	42
Diseases of the digestive system	0	11 *	17	5	2	1	1	37
Infective and parasitic diseases:								
whooping cough	0	7	4	1	2	0	3	17
intestinal parasites	0	0	0	0	0	0	0	0
other	0	2	4	2	1	0	1	10
Other specified causes:								
kwashiorkor	0	0	16	12	6	4	2	40
other deficiency disease	0	1	2	0	0	0	0	3
other	0	0	0	0	0	0	0	0
Ill-defined or unknown	0	4	6	1	3	0	3	17
Not investigated	1	0	3	0	0	0	3	7
Total . . . . .	44	52	61	24	14	10	17	222

\* 4 in 1-5 month age-group and 7 in 6-11 month age-group

**Seasonal distribution of deaths due to kwashiorkor and diarrhoeal disease.** The figure on page 1099 illustrates the tendency for deaths from diarrhoeal disease to be concentrated during April through August, and deaths from kwashiorkor to be more frequent in the months from May through October. This tendency for kwashiorkor deaths to reach a peak later than those from infectious diarrhoea has been noted in the General Hospital in Guatemala City.<sup>n</sup> It has been interpreted as suggesting that during the season in which diarrhoeal disease is prevalent, cases of kwashiorkor are precipitated by the added stress of the diarrhoea. Both clinical histories<sup>b, c, d,</sup> and metabolic studies of the effect of diarrhoea on nitrogen metabolism support this hypothesis.<sup>o</sup>

**Discussion.** As illustrated in Table 5, the official vital statistics show Guatemala to have one of the highest total mortality rates in the world. The infant mortality rate, too, is very high, but it is the mortality rate for

<sup>n</sup> Verhoestraete, L. J. & Puffer, R. R. (1958) *Bull. Wld Hlth Org.*, 19, 23

<sup>o</sup> Robinson, U., Béhar, M., Viteri, F., Arroyave, G. & Scrimshaw, N. S. (1957) *J. trop Pediat.*, 2, 217

TABLE 5. COMPARISON OF MORTALITY RATES (PER 1000) AND RATIOS\* IN SELECTED COUNTRIES

Country	Total ** (1953)	Infant *** (1952)	Specific *** 1-4 years (1952)	Ratio (Infant: 1-4 years)
Guatemala	23.2	101.4 †	42.1 †	2
El Salvador	14.7	85.5	36.7	2
Mexico	15.9	89.8	24.7	4
Venezuela	9.9	78.9	12.5	6
Chile	13.2	133.6	11.2	12
Sweden	9.7	20.0	1.1	18
USA	9.6	28.4	1.4	20
Belgium	12.1	44.8	1.7	26

\* Infant mortality rate divided by mortality rate in age-group 1-4 years

\*\* Data from: World Health Organization (1956) *Annual epidemiological and vital statistics, 1953*, Geneva

\*\*\* Data from: Verhoestraete, L. J. (1956) *Amer. J. publ. Hlth*, 46, 19

† Data for 1955 from the Vital Statistics Department, Guatemala

children aged 1-4 years that is so particularly striking in comparison with such countries as Sweden, the USA and Belgium.

The high mortality in children under one year reflects the poor socio-economic conditions and sanitary practices prevailing in the area and the lack of adequate programmes of maternal and child care. Since most of these children are breast-fed, nutritional deficiency does not play a major role in this age-group, except in the occasional case of a child whose mother's milk is insufficient and who develops marasmus from virtual starvation. After weaning, at about one year of age, the diet of the child is usually grossly inadequate in protein and fatal kwashiorkor is common. Furthermore, the poor nutritional status of the children is believed to be a secondary factor in many, if not most, of the deaths due to other causes.

Although deaths from massive infestation with intestinal parasites can occur, we did not consider any of the deaths in this study to have been due to this cause, despite the large number attributed to intestinal parasites in the official records. The explanation of the latter is obvious from a consideration of local beliefs with regard to illness; the signs and symptoms characteristic of kwashiorkor are usually considered by the local people to be caused by worms, as is almost any other change in the child's health not clearly due to a common communicable disease. This belief is strengthened and perpetuated by the frequent finding of *Ascaris* in the stools of children with diarrhoea.<sup>p</sup> In such cases the death is described as due to "worms", "worm attack", "worm fever", and by other similar expressions.

<sup>p</sup> Aguirre, F. (1952) *Rev. Juven. méd. Guatemala*, 73, 34

The official vital statistics show diarrhoeal disease and intestinal parasitism to be responsible for a major proportion of deaths in children between one and four years of age, but fail to assign appropriate importance to nutritional deficiencies. Although the data indicate the need for expanded campaigns for environmental sanitation, it should be realized that such programmes, while important, attack only part of the problem. It is necessary for workers in the fields of both communicable disease and nutrition to recognize the synergism by which infectious diarrhoea in a protein-deficient child has either immediate or delayed fatal consequences, which would not perhaps have resulted from either disease factor alone. The lesson from this study is not that environmental sanitation is less important than is currently believed, but rather that nutrition must also receive attention in the public health programmes if the mortality in the younger age-groups in countries like Guatemala is to be brought within acceptable limits.

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The authors express their appreciation to Dr Miguel A. Guzmán, Chief of the Division of Statistics of INCAP, for assisting in the preparation of the manuscript.

### **Resistance to DDT in *Anopheles stephensi* in southern Iraq \***

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In October/November 1957, the WHO Advisory Team on Malaria Eradication No. 2 made a study of the susceptibility to insecticides of *Anopheles stephensi* in southern Iraq. A summary of the results is presented in the accompanying tables.

The demonstration of strong DDT resistance both in adults and in larvae calls for some comment. The village of Om-el-Resas, opposite Abadan, has had irregular treatment with DDT larvicide since about 1947 (precise information not available), and with DDT imagocide since 1954. There is, therefore, a considerable history of exposure to DDT and the development of resistance is not entirely unexpected. Table I shows that there is no resistance to dieldrin in adults ( $LC_{50}$  approx. 0.1%), and it will be seen from Table 2 that the  $LC_{50}$  for larvae must lie well below 0.004 p.p.m., the lowest concentration we tested.

The village of Moawiya has been sprayed with DDT imagocide since 1956 and, as far as is known, no DDT has ever been used for larviciding.

Al Zeiad was sprayed for the first time with DDT in April 1957. It lies some 35 km east of Nassriya and 15 km west of Garmat Beni Said, the

\* Extract from a paper presented to the Technical Meeting on Malaria Eradication held by the WHO Regional Office for the Eastern Mediterranean from 7 to 12 December 1957 in Baghdad, Iraq