Mortality in Infancy and Early Childhood and its Relation to Malnutrition *

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The infant mortality rate, that is, the number of deaths per 1000 live births in infants under one year, has come to be regarded as a vitally important index of the health of a country and especially of the state of development and efficiency of its health services. It strongly influences the total death rate, since in any given year a large percentage of all deaths occur in infants. This fact was recognized for the first time in the 17th century by a London draper called Graunt, who examined in his spare time the very crude data in the «Bills of Mortality» produced by different London parishes and was surprised to find that the majority of deaths recorded were those of infants and young children. As a result of his pioneer observations he was elected a member of the Royal Society, with the enthusiastic support of its patron, King Charles II.

All the developed countries, and a steadily increasing number of developing countries, today publish infant mortality rates, which, of course, vary widely in accuracy. The published rates range from about 13 to 180 per 1000 live births, the lowest current rate being that of Sweden, which was reported in 1965 as 13.4. In a few backward communities rates as high as 500 per 1000 live births are on record. In developed countries, with efficient health services, a rate just above or below 20 is now the general rule. Whatever the infant mortality rate, deaths in the first month of life — the neonatal period — contribute a large fraction of total infant mortality and, within this neonatal period, the first week of life is the most dangerous. These early neonatal deaths, due mainly to causes such as immatur-

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ity, congenital abnormalities and birth injuries, represent the «hard core» of infant mortality which is the most difficult to influence by public health action. Neonatal mortality remains high whatever the scope and efficiency of maternal and child health services, but there is a striking difference in the *proportion* of total infant mortality contributed by neonatal mortality in the developed and underdeveloped countries which are, in general, countries with low and high infant mortality rates respectively. In the United States, for example, about 70 per cent of all infant deaths occur in the first four weeks of life, and the remaining 30 per cent in the post-neonatal period, i.e., the 11 months from one month to 12 months of age. In the underdeveloped countries, these percentages are different: deaths in the post-neonatal period often represent 60 rather than 20 to 30 per cent of total infant mortality. The ratio of neonatal to post-neonatal deaths in countries in Western and Northern Europe and North America is about 2:1. In most technically underdeveloped countries, it is about 2:3. In Turkey in 1962, a year in which the infant mortality rate was estimated at 165, there were three post-neonatal deaths for each two neonatal deaths. It has been pointed out [1] that this ratio is as significant as the total infant mortality rate itself. Deaths in the post-neonatal period are largely preventable; during this period the factors of malnutrition and infection become increasingly operative as causes of death, which can be countered to a large extent by ordinary public health measures.

In many countries the death rate in the one to four year age group is included in the annual reports of public health departments. This group is sometimes called the «preschool age group,» not very appropriately since children often do not go to school until they are six or seven. In this period of life the death rate in the underdeveloped countries is often 30 to 40 times higher than the rate in developed countries. A point of great importance is that deaths are not evenly distributed throughout the period: the majority occur in the one to two year age group.

I had occasion to visit the islands of the West Indies a few years ago on behalf of WHO and FAO, my task being to study problems of nutrition and suggest measures for preventing malnutrition. It was well known that serious malnutrition in infants and young children was prevalent in the Caribbean, which was fully confirmed by my visits to hospitals and out-patient clinics in different territories. The malnutrition to be seen was mostly of the marasmic type, classical kwashiorkor being much less common. As part of the

inquiry, I attempted to correlate the clinical evidence of the frequency of malnutrition with available vital statistics. It happens that vital statistics in the Caribbean are fairly good: the islands are small, with populations of manageable size, and public health services have existed for a considerable number of years. With the help of WHO, I obtained the data reproduced in Table 1.[2]

TABLE 1

MORTALITY IN INFANCY AND EARLY CHILDHOOD IN GRENADA, ST. KITTS AND THE U.S.A.

Age	Deaths per 1000			Ratio	
	Grenada 1961 - 62	St. Kitts 1960 - 62	U.S.A. 1959	Grenada/ U.S.A.	St. Kitts/ U.S.A.
Under 1 month	15.4	29.7	19.0	0.8	1.5
1-2 months	4.7	4.9	3.0	1.5	1.6
3-5 months	10.3	19.4	2.4	4.4	8.1
6-8 months	15.4	18.8	1.2	10.4	15.9
9-11 months	19.2	18.3	0.7	26.2	25.1
12-23 months	33.0	35.9	1.7	18.8	23.3
24-35 months	7.0	7.9	1.0	6.6	7.4
36-47 months	3.0	2.2	0.8	3.9	2.8
48-59 months	1.0	2.4	0.7	1.5	3.5

Grenada and St. Kitts are two small islands with populations of about 90,000 and 60,000 respectively. The most striking aspect of Table 1 is the high mortality in these islands between one and two years, as compared with mortality during this period of life in the U.S.A., which is almost negligible. Mortality in the six to 12 month age group was also considerably greater than in the U.S.A. After two years the mortality in the islands rapidly declined, and by the fifth year of life it was not greatly in excess of the mortality in the U.S.A.

What are the main causes of the peak in mortality in the Caribbean between six months and two years? Special field investigations would be needed to answer this question precisely, but certain highly suggestive facts are available. In the mortality returns, deaths ascribed to gastroenteritis, which is a leading cause of death in the Caribbean according to these returns, show a similar trend in timing. The majority of deaths from gastroenteritis (85 per cent or over) occur in children under five years, and within this age group there is a concentration of mortality between six months and two

years. The mortality statistics provide little direct information about malnutrition as a cause of death and its prevalence at different ages. Deaths in children which are primarily due to malnutrition are commonly ascribed to terminal conditions, such as bronchopneumonia. However, in one of the islands, St. Lucia, malnutrition was made a notifiable condition in 1962, and the age incidence of the cases reported ran parallel with the mortality figures, i.e., the majority fell in the six month to two year age group. The following statement, relating to a number of Caribbean islands, appeared in a WHO report in 1963:

> In some of these islands, more than 50 per cent of the total deaths occur by two years of age. It has been demonstrated that the greatest risk in childhood begins at about six months of age and ends at the end of the second year of life... The two main causes of death in this age group are gastroenteritis and malnutrition.

This statement seems fully justified. I would, however, extend it in two directions. First, I believe that malnutrition and gastroenteritis, in the Caribbean and elsewhere in the world, are almost inseparable conditions, both clinically and statistically, and that for practical purposes they can be regarded as a single syndrome. This concept has found expression in the term «weanling diarrhea,» coined by Gordon and his colleagues.[3] not perhaps a very satisfactory term, though it is difficult to think of a better one. The concept itself is, however, likely to prove of great significance in preventive pediatrics. Secondly, the malnutrition-gastroenteritis complex may be an important cause of death in infants *under* the age of six months. Table 1 shows that there is a considerable mortality between three and five months in the two Caribbean islands. In the Caribbean, weaning often begins as early as three months, when breast milk tends to be replaced by starchy food mixtures and by diluted processed milk prepared in an insanitary way and given in dirty feeding bottles. The result is the appearance of the malnutrition-gastroenteritis complex by the fourth or fifth month of life.

The timing and extent of mortality in the early period of life depend to a large degree on feeding practices—particularly the duration of breast feeding — and on the hazard of infection. When breast feeding is prolonged, the timing of mortality may differ somewhat from current rates observed in the Caribbean. There will be fewer deaths in infancy in the post-perinatal period, particularly between one to six months, and high mortality may extend into the third year. This is the situation in a number of African countries.

I now propose to present some vital statistics from various parts of the world for consideration in the light of these observations and speculations. First, Table 2 shows mortality in infants and in children between the ages of one and four years in a number of countries.

TABLE 2

MORTALITY IN INFANTS AND THE ONE TO FOUR YEAR AGE GROUP IN CERTAIN COUNTRIES

Country	Date	Infant* a	One to four years** b
Egypt	1961	139.0	33.8
Guatemala	1963	92.9	23.9
Philippines	1963	72.1	8.8
Portugal	1961	77.5	6.9
Canada	1961	25.2	1.0
England and Wales	1891	148.6	45.0

* Per 1000 live births.
** Per 1000 population aged one to four years.

Points of interest in Table 2 are the relatively high death rates between one and four years in Egypt and Guatemala and the low rate in Canada, which is typical of the developed countries generally. The percentage a/b was 34 in Egypt and four in Canada. I have included figures for England and Wales in 1891, a date at which England was very much an underdeveloped country from the standpoint of health.

TABLE 3

MORTALITY IN INFANTS AND THE ONE TO TWO YEAR AGE GROUP IN CERTAIN COUNTRIES

Country	Date	Infant	One to Two Years*
Punjab, India	1957-59	187	72
Guatemala (rural)	1958-64	100	52
Mauritius	1961	62	17
Romania	1963	52	7
Sweden	1963	15	1
England and Wales	1961	21	2

* Per 1000 population in this age group.

Table 3 compares infant mortality and mortality between one and two years of age in countries at different stages of development. The number of developing countries where even the roughest figures of mortality in the second year of life are available is small, but it appears that the number of deaths in this period is often from one third to one half the number of infant deaths. In the developed countries the child passes into a very safe period of life when it has attained 12 months of age, but this is not the situation in the greater part of the world.

Figures for England and Wales in 1961 are included in Table 3. By that date, as compared with 1891, England had become a highly developed country in the field of health, though slightly behind Sweden in this respect.

TABLE 4

MORTALITY IN INFANTS AND CHILDREN UP TO FIVE YEARS OF AGE*

Country	Date	Age in Months				
		0-12	13-24	25-36	37-48	49-60
Punjab, India	1951-59	186.9	72.2	21.0	8.1	3.9
Grenada, W. Indies	1961-62	79.0	33.3	7.0	3.0	1.0
U.S.A.	1959	25.2	1.7	1.0	0.8	0.7
England and Wales	1961	21.4	1.5	1.0	0.7	0.6
England and Wales	1901	151.3	46.7	17.1	11.4	8.4

* Per 1000 per year.

Table 4 brings out the fact that mortality between one and five years of age is concentrated in the second year of life. A yearly decline throughout this period is the general rule, though in some developing countries, as I have already mentioned, mortality may remain fairly high between two and three; i.e., in the third year of life. It is evident that grouping together the four years from 12 months to the fifth birthday, calling this the «preschool age period,» and designating the children between these ages as «preschool children,» conceals the wide differences in mortality in the different years.

It is only recently that low levels of mortality in infancy and the second year of life have been attained in the developed countries. In Table 5 are some figures from England and Wales, covering more than a century, which I obtained from the Registrar General's Office in London. In 1891, less than 80 years ago, the infant mortality

TABLE 5

COMPARISON OF MORTALITY RATES IN ENGLAND AND WALES, 1841 - 1961

Year	Infants	One to Two Years*
1841	145	64
1851	154	66
1861	153	74
1871	158	69
1881	130	51
1891	149	61
1901	151	47
1911	130	42
1921	83	19
1931	66	16
1951	30	2
1961	21	2

* Per 1000 population aged one year.

rate in England and Wales was 148 and the death rate between one and two, per 1000 population aged one, was no less than 61. The latter rate fell sharply between 1911 and 1921, and in 1961 was very low. The fall in the two rates ran almost parallel until 1931, after which they diverged, because the intractable neonatal mortality continued to influence the infant mortality rate; in 1961 about 75 per cent of infant mortality in England and Wales occurred during the first month of life. I think it is justifiable to assume that much the same factors have influenced the post-neonatal death rate and the death rate between one and two years, but it would be difficult or impossible to decide which of a variety of factors has been the most important. They include the establishment of maternal and child health centers, which began in the first decade of the century, improvements in sanitation, better housing, better infant and child feeding practices and higher levels of education accompanying a general rise in living standards. I personally believe that nutrition was the most important factor, but know no way of proving this. Even to outline the changes in infant and child feeding practices which have taken place in England and other countries during the present century would require a lecture to itself.

In preparing this lecture for delivery in Ankara, I had hoped to include some infant and child mortality figures relating to Turkey for purposes of comparison. I had some difficulty in finding such figures; however, some valuable material was presented at the recent CENTO Nutrition Conference in Pakistan in a paper by Dr. Ayşe

Baysal which appears in this publication. The last Demographic Survey showed an average infant mortality rate of 154 and a mortality rate of 40 per 1000 in the period one to four years. Table 6 shows some figures for provincial capitals in 1950-1951. These are no doubt incomplete, but they do bring out the fact that in Turkey there was a high mortality in the one to two and two to three year age groups. No doubt further information on trends in infant and child mortality in Turkey will soon be made available.

TABLE 6

MORTALITY IN CHILDREN UNDER FIVE YEARS OF AGE IN TURKEY*

Age in Months	Deaths
0-12	108
13-24	39
25-36	26
37-48	12
49-60	7

* From 63 provincial capitals, 1950-51.

A quotation from a paper by John E. Gordon and his colleagues,[1] from which I have already drawn a good deal of material, will make a suitable conclusion. I should like to add that Gordon, who is now working in the Department of Nutrition and Food Science, Massachusetts Institute of Technology, has made outstanding contributions in the field with which this lecture is concerned.

> Second year death rates in a less developed country commonly rival the infant mortality of the region, especially that part of infant mortality after the neonatal first four weeks where causes of death characteristically are individual and distinct. After age six and through the second year, the main causes of death are infectious disease and malnutrition. At that time protein-calorie malnutrition is at its height and a deteriorating nutritional state favors frequency and severity of infection. The almost universal practice of breast feeding no longer meets nutritional needs and supplementary feeding is ordinarily inadequate.

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