EPIDEMIOLOGY OF PROTEIN MALNUTRITION

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PROTEIN MALNUTRITION is at present one of the most serious nutritional problems encountered in tropical and subtropical areas. Its effects are well recognized when its manifestations are severe, as in the case of small children in the postweaning period suffering from kwashiorkor. Less dramatic, and consequently less apparent, manifestations of protein malnutrition can be found at all ages. From the point of view of public health these less recognized forms are much more important because of their greater prevalence and because of their impact on health, capacity for work, and mental well-being.

The prevalence of kwashiorkor is an index of the much more widespread problem of protein malnutrition, and will be used in this sense here. Therefore, when we discuss the epidemiology of kwashiorkor, we include the magnitude of the more generalized condition.

The areas of the world in which, to our knowledge, kwashiorkor has been reported, are:

1. *Africa:* Algeria, Angola, Basutoland, Belgian Congo, Cameroons, Egypt, French Equatorial Africa, French West Africa, Gambia, Gold Coast, Kenya, Morocco, Mozambique, Nigeria, Nyasaland, Rhodesia, Ruanda-Urundi, Tanganyika, Tunisia, Uganda, Union of South Africa.

En: "Human Nutrition Historic and Scientific. Ed. por Iago Galdston. New York, International Universities Press, Inc., 1960, p. 257-273. Institute of Social and Historical Medicine, The New York Academy of Medicine, Monograph III.

Publicación INCAP I-129.

2. *America:* Argentina, Bolivia, Brazil, British Guiana, Chile, Colombia, Costa Rica, Cuba, Ecuador, El Salvador, Guatemala, Haiti, Honduras, Jamaica, Mexico, Netherlands Antilles, Nicaragua, Panama, Peru, Puerto Rico, Trinidad, Uruguay, Venezuela.

3. *Asia:* Ceylon, China, India, Indochina, Indonesia, Iraq, Japan, Jordan, Lebanon, Malaya, Philippines, Thailand.

4. *Europe*[1]*:* France, Greece, Hungary, Italy, Spain.

5. *Oceania:* Fiji, New Caledonia, Papua.

It has not been possible, however, to establish even approximately the prevalence of the syndrome for any region, since all reports are based almost exclusively on hospital cases and there is no way of estimating the number of children dying without medical attention and, therefore, not reported as kwashiorkor cases. In addition, it should be mentioned that, even in hospitals, the death certificates or clinical diagnoses often emphasize intercurrent diseases such as pneumonia or gastrointestinal disturbances, ignoring the state of malnutrition.

Recently the Institute of Nutrition of Central America and Panama (INCAP) has investigated, through visits to the home and interviews with the parents, all deaths that occurred during a two-year period in children up to 15 years of age in four rural communities of the Guatemalan highlands (3). It was found that of a total of 109 children who died between the ages of one to four years, 40 presented the signs and symptoms of kwashiorkor. This would indicate that the syndrome occurs in a fatal form in about 3 per cent of the estimated one-to-four-year-old child population in the communities studied. It should be added that these villages were not among those with the worst medical and social conditions or the most serious nutritional problems.

[1] Sporadic cases.

In Haiti, Jelliffe (17) has recently reported that in children one to three years of age "The prevalence of kwashiorkor . . . varied from 3.0 to 16.4 per cent, with an average for the whole survey of 6.5 per cent." His observations were not limited to fatal cases as in the INCAP studies.

Variations and Similarities in Clinical Descriptions

Almost all workers who are familiar with the problem agree at present on the fundamental characteristics of kwashiorkor (31), and the definition given by the third Joint FAO/WHO Expert Committee on Nutrition is in accord with the generally accepted criteria (18). Their description is as follows:

> Kwashiorkor commonly occurs in infants and young children who have been fed on a diet low in protein and composed mainly of foods rich in carbohydrate. The main clinical features are failure of growth, retarded development, wasting of muscles, loss of appetite, mental apathy, oedema, dyspigmentation of hair and skin, diarrhoea, and the presence of undigested food in the stools. Subcutaneous fat is often well retained. There may be signs of associated vitamin deficiency. In the blood there is a reduction in the concentration of albumen and of certain enzymes. The characteristic pathological features are fatty infiltration of the liver and atrophy of the pancreas and of other glands concerned with exocrine secretion, together with a diminution in the amount of pancreatic enzymes in the duodenal juice. The disease responds well to treatment with skim milk.

It should be recognized that no one of the characteristics nentioned can be considered pathognomonic, that the ab-ence of any one characteristic does not prevent making the liagnosis, and that all may be present in varying degrees or combinations. As Brock (4) has stated, the condition is eally a disease spectrum rather than a specific disease. There

are, accordingly, marked variations in the clinical picture from one region to another and even within the same region. Some of the factors responsible for these differences are considered below.

Although it is generally agreed that the primary cause of kwashiorkor is a lack of protein, it is recognized that this deficiency may be accompanied by a variable degree of caloric deficiency. In some cases, e.g., those described in Jamaica, the marked protein deficiency is found in children with an adequate or even excessive caloric intake (16). In the latter case the children present the characteristic alterations of kwashiorkor: edema, skin lesions, hair changes, apathy, gastrointestinal disorders, fatty liver, hypoproteinemia, and a marked deficiency of their digestive enzymes. They do retain, however, a considerable amount of adipose tissue and may even be obese. This is known as the "sugar baby" type of kwashiorkor and can be considered the purest form of protein malnutrition.

At the other extreme is the child with such a marked caloric deficiency that proteins no longer constitute the limiting factor in the diet; in other words, the diet is balanced in its calorie-protein relation but is not quantitatively adequate. This is often the case with children fed primarily or entirely with very small quantities of milk. Even though there is a marked protein deficiency, the clinical picture of kwashiorkor is not present; instead, such a child shows a severe height-weight deficit, extreme thinness, and no subcutaneous fat. Muscular wasting is evident, but the child is generally alert and has a good appetite. Fatty liver does not develop and serum proteins and digestive enzymes are not markedly reduced and may be within normal values: this is the clinical picture of marasmus.

The great majority of children diagnosed as having kwashiorkor in Africa, India, or Central America represents intermediate forms between the two extremes of the sugar baby type and marasmus. They present characteristics of both and are the result of a diet with a more or less severe caloric deficit but with a still greater reduction in protein intake.

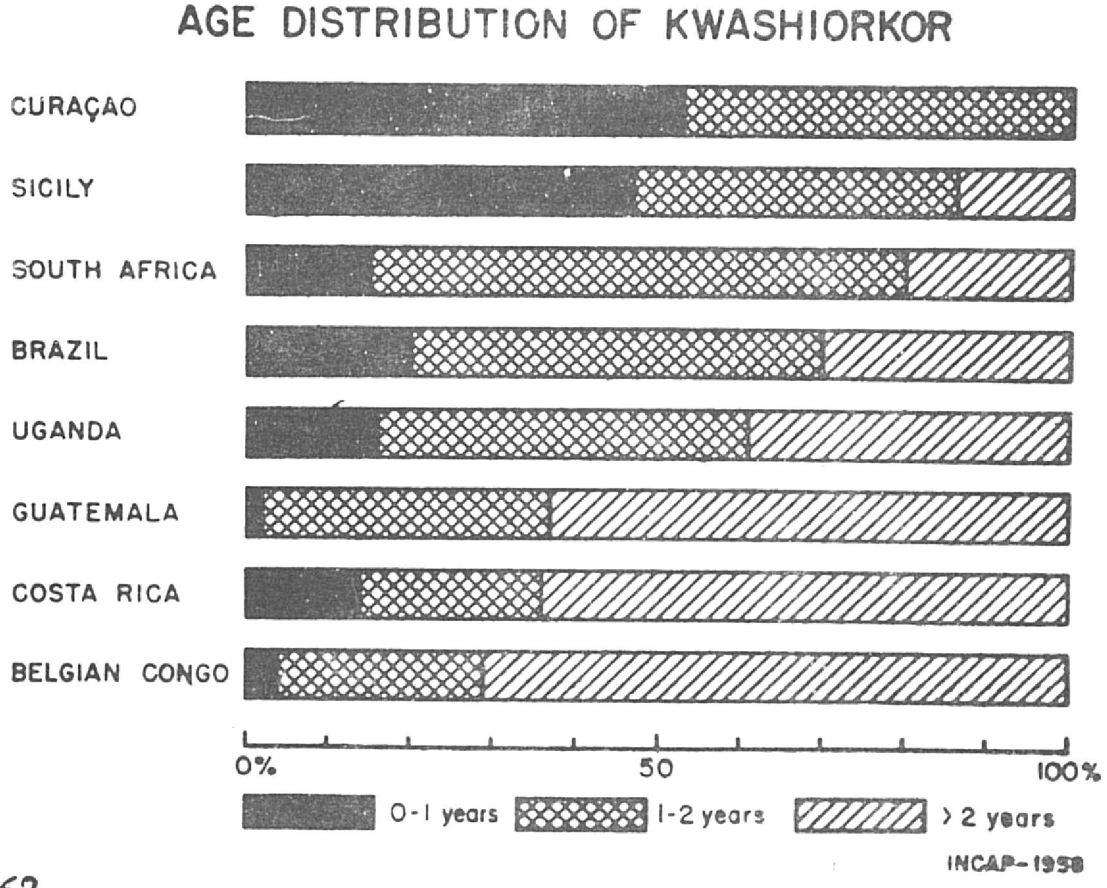
Differences in the clinical picture observed in different localities may be due also to the variability of superimposed vitamin or mineral deficiencies. In Indonesia, for example, it is common to observe severe ocular lesions of vitamin A deficiency in kwashiorkor (20). In some regions of India a megaloblastic anemia due to a vitamin B_{12} deficiency complicates the picture of kwashiorkor (19). In areas where hookworm exists or where there are other conditions that may result in a loss of iron, the anemia is predominantly of the microcytic hypochromic type. In many cases the causes for the regional variations have not been sufficiently studied to identify the specific factors involved.

Some of the vitamin deficiencies that are observed in kwashiorkor do not seem to be due to a deficient intake, but seem rather to be secondary to a protein deficiency. For example, blood serum vitamin A values are reduced even in regions in which the vitamin A activity of the diet appears adequate. This seems to be due largely to disturbances in the absorption of fat, probably because of the lowered enzyme activity resulting from the severe protein deficiency (1, 15, 27, 29).

Finally, the clinical picture of kwashiorkor may vary according to the age at which it occurs. Differences in age of occurrence are in turn due to differences in weaning practices and the dietary habits of the preschool child. This is illustrated by the data presented in Figure 1. Of the 34

cases reported by Van der Sar (28) in Curaçao, all were children under two years of age. A similar situation was reported by Gerbasi (14) in Sicily who found that 31 of 36 cases were children under two years of age. In a study of 205 cases, Pretorius et al. (22) in South Africa reported that 20 per cent occurred in children over two years of age, and the majority of these were between two and three years of age. Even among the cases under two years reported by these authors, more occurred in children of one to two years of age, in contrast with the situation in Italy and in Curaçao where the prevalence seems to be about the same for the one- and two-year age groups. This seems to be related to a habitually later weaning in South Africa. According to these authors, the disease generally develops within one to six months after weaning. In Uganda, Davies (9) reports a situation similar to that in South Africa.

FIGURE 1



In Central America the prevalence is also greater after the age of two. Of 100 cases studied by us in Guatemala, 63 occurred in children over two years of age, while only 2 cases occurred in children under one. Peña Chavarría et al. (21) analyzed 236 cases in Costa Rica and found that 64 per cent occurred in children over two years of age. They reported that the percentage of cases found in children under one (14 per cent) was much greater than that observed in a previous study, a difference which they attribute principally to an increase in early weaning. Another important epidemiological fact in Guatemala is the relatively high prevalence of cases in children over five years of age.

In the Belgian Congo the majority, 56 of 79 cases reported by DeMaeyer (10), also occurred in children over two years old. The situation seems to be similar in India. Although we were unable to obtain complete information, Venkatachalam et al. (30) report that 48 per cent of their cases occurred in children over three years of age. This would seem to indicate that the majority occurred in children over two.

The situation in Brazil seems to be more nearly like that of Africa than of Central America. Waterlow and Vergara (32) studied 50 cases of which 35 occurred in children under two years of age. The reports by other authors in the same area are in agreement with this observation which indicates that, in general, nearly two thirds of the cases occur at this age. The dietary habits in Brazil, with a great consumption of cassava and weaning usually before one year of age, follow the African pattern more closely than that of Central America.

Basic Epidemiology

An analysis of the usual weight curve of children in the areas where kwashiorkor occurs and of the conditions that

precipitate the appearance of clinical cases of marasmus or kwashiorkor helps in understanding the main points in the epidemiology of protein malnutrition, at least as far as young children are concerned. In Central America, as in most other kwashiorkor regions, the average weight of children at birth does not differ greatly from that considered normal in areas where the problem of protein malnutrition does not exist. The children are usually breast-fed, without any adequate supplementary feeding, at least during the first year of life. They progress quite satisfactorily for the first six months, but at this time their growth begins to lag behind that of well-nourished children. After the first year the rate of growth is reduced even further, remaining practically stationary until four or five years of age when they start once again to grow at the same rate as well-nourished children. After about five years of age their growth curve runs parallel to that of well-nourished controls, with a retardation of two to four years. Although the supplementary food the child receives toward the end of lactation varies from one region to another, it tends to be mainly of vegetable origin, rich in carbohydrates and very poor in proteins, and frequently deficient in various other nutrients. The small amounts of proteins in these diets are usually of low biological value and difficult to digest. In Central America the child does not participate in the usual family diet until he is four or five years old; at this time his protein intake improves.

The reasons for keeping preschool children on the diets described are not primarily economic or the result of limited availability of food. They are rather the consequence of ignorance of the nutritional needs of the child and the ways of satisfying them, conditioned by prejudices and taboos concerning the use of certain foods for the small child.

If for some reason the mother is unable to breast-feed her child during the first months of life, it is common practice to feed him very diluted milk or simply "rice water" or some other very thin starchy gruel. The child then loses weight rapidly, consuming his own tissues, and finally reaches the marasmic stage of caloric deficiency. If the child receives highly starchy foods, and especially if infection is also present, kwashiorkor may be produced as the result of an imbalance between the caloric and protein intake.

The children who do not have these problems and who survive the first year of life appear apathetic and small but not necessarily thin, because the reduction of weight is more or less proportional to that of height. Some in whom the condition is more serious may show slight changes in their hair, which becomes dry, breakable, falls out easily, and may also be depigmented. Later the apathy is accentuated; the child loses his appetite, frequently suffers diarrheal episodes, and may present discrete maleolar edema. This condition, found in a large proportion of children between one and four years of age living in areas where protein malnutrition is prevalent, has been called prekwashiorkor by some investigators. From the point of view of public health, this condition constitutes a very grave problem which in general has not received enough attention either because it goes unnoticed or because it lacks the drama of kwashiorkor. Among these children, infection takes a heavy toll.

Interrelation of Protein Malnutrition with Infection

In tropical and subtropical areas where protein malnutrition is prevalent, infections are particularly likely to constitute a serious problem. Unfortunately, public health programs designed to reduce parasitic and other infectious diseases frequently concentrate entirely on environmental

tion. Like many other investigators, we have observed that the most common cause of death in children with kwashiorkor is a severe bronchopneumonia unaccompanied by the usual manifestations of defense reactions to the infection (26).

On the other hand, a vicious circle is closed when infections maintain or aggravate the precarious nutritional status of these badly nourished individuals. It is known that fever increases metabolic demands and that organisms already in a deficient nutritional state have more difficulty recovering in a satisfactory manner. Simultaneously with this increase in nutritional demands there may be a decrease in absorption, particularly when diarrhea occurs. Furthermore, there is generally a significant increase in urinary nitrogen excretion, presumably as a result of tissue destruction (25). If, in addition, we recall that there is a reduction in the intake as a consequence of anorexia, without taking into consideration the reductions to which the sick are frequently submitted through dietary-therapeutic errors, we will have a more complete idea of the damage these infectious processes may cause in populations already basically malnourished. This is why most authors recognize infectious processes as precipitating factors in kwashiorkor or in children who are in the state of chronic protein malnutrition already described. In our experience we have found that even banal respiratory infections may interfere with the nutritional recovery of kwashiorkor cases.

Role of Diarrheal Diseases in Precipitating Kwashiorkor

Special emphasis needs to be placed on the role of diarrhea as a factor responsible for protein malnutrition. This condition is very common in the areas in which kwashiorkor

occurs. Studies done by INCAP in two rural villages of the Guatemalan highlands have shown that 70 per cent of the children under five years of age suffered from one or more episodes of diarrhea during a one-year period and that for these children the average number of episodes for that year was about three.

In the majority of instances these diarrheal processes have the characteristics of an infectious diarrhea. By stool cultures a prevalence of 6 per cent of Shigella in children has been found in several Guatemalan towns, including the two mentioned above. Comparative studies in children with and without diarrhea, however, do not show a marked difference in the positivity of stool examinations for either Shigella or other organisms considered pathogenic, and for intestinal parasites. Ramos-Alvarez and Sabin (23) have recently reported isolating a large variety of enteroviruses (ECHO, coxsackie A and B, polioviruses) and a small number of adenoviruses in 50 per cent of diarrheal cases in Cincinnati, Ohio and found shigella and salmonella in only 9 per cent of the cases. If a similar situation prevails in Guatemala, the failure to find a better correlation between the isolation of pathogenic bacteria and the occurrence of diarrhea can thus be accounted for and a marked effect on net nitrogen retention can be predicted. It is of interest to note that apart from diarrheal disease, the other infection most often associated with the precipitation of kwashiorkor is another virus disease, measles (11).

In addition to its physiological effects on nitrogen absorption and excretion, diarrheal and other infections play an important direct role since it is precisely these cases in which the greatest dietetic errors are committed as intended therapy. Through fear of the diarrhea, these children are often completely deprived of the scant sources of protein

they have been receiving and are submitted to drastic diets based exclusively on starches. This was the major etiologic factor in the development of "starchy food dystrophy" as first recognized by Czerny and Keller (8) in Germany.

Besides contributing to a state of chronic protein malnutrition, diarrhea frequently constitutes the precipitating factor of the severe forms. In our experience in Central America at least three fourths of the cases of kwashiorkor seem to have started with an acute episode of diarrhea of an apparently infectious nature. When a severe deficiency is established, however, the diarrhea constitutes a symptom in the clinical picture and disappears rapidly with adequate dietetic treatment. Although several authors report similar experiences in different areas, Gerbasi's (13) observations in Italy are particularly striking. He considers that an inadequate protein intake plays a secondary etiopathogenic role in comparison to that of infectious diarrhea. In a series of 20 cases Gerbasi found that only 7 children could be considered to have been on an inadequate protein diet, but that 18 had a history of infectious diarrhea. One cannot help but wonder if, as a consequence of the diarrhea, the protein intake was not reduced, leaving a preponderantly starchy diet. In our experience—similar to the majority of cases reported by Gerbasi—if a child, especially under two years of age, suffers from a prolonged diarrheal process but continues to receive a diet with an adequate protein/calorie relation, he develops the clinical picture of marasmus rather than that of kwashiorkor.

Summary

The factors responsible for protein malnutrition in the majority of the tropical and subtropical areas are:

1. Scarcity of protein-rich foods of high biological value.

2. Ignorance of the mothers regarding the nutritional needs of their children and the ways of satisfying those needs.

3. Prejudices or faulty habits in dietary practices especially in regard to small children.

4. Very low purchasing power.

5. Poor sanitary conditions and hygiene leading to heavy infestation with parasites and frequent infections.

6. Insufficient productive capacity of a population due both to the failure to employ modern agricultural techniques, and often also to weakness and apathy associated with endemic disease.

All these factors are intimately related and each in turn contributes to the maintenance of the others. The suppression of any one factor would benefit the others as in a chain reaction, but only when substantial progress is made in correcting all these problems will the great majority of the world's population be able to share in the technical and health gains of the more highly developed nations, and thus rise above the poverty, ignorance, disease, and early death which now befall them.

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