

## KWASHIORKOR IN AFRICA \*

J. F. BROCK, D.M., F.R.C.P.

*Professor of the Practice of Medicine, University of Cape Town,  
 Union of South Africa*

*Consultant in Nutrition, World Health Organization*

M. AUTRET, D<sup>r</sup> Pharm.

*Chief, Area and Field Branch, Nutrition Division,  
 Food and Agriculture Organization*

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## INTRODUCTION

This report is the result of a recommendation made by the Joint FAO/WHO Expert Committee on Nutrition at its first session in Geneva in October 1949. The relevant passage in the committee's report reads as follows :

" One of the most widespread nutritional disorders in tropical and subtropical areas is a syndrome at present ill-defined known by various names such as ' kwashiorkor ', malignant malnutrition, polydeficiency disease, ' m'buaki ', syndrome dépigmentation-oedème, infantile pellagra, etc. The committee is satisfied that this condition is not identical with classical pellagra, and suggests that the name ' infantile pellagra ' should not be used for this syndrome. It appears that the highest incidence of the disease occurs in infants and young children and that the mortality-rates in some parts of Africa are disturbingly high.

" There is considerable evidence to suggest that this syndrome is associated with the development of cirrhotic changes in the livers of many individuals who survive the acute forms of the disease. Cirrhosis of the liver in some form has been found in a significant number of adults in some parts of Africa and central America where kwashiorkor occurs in infants and children. The possible relationship of this cirrhosis to the development of primary carcinoma of the liver, a not uncommon condition in some of these areas, must also be recognized.

" The committee adopted the following resolution :

" The Joint FAO/WHO Expert Committee on Nutrition

RECOMMENDS that WHO conduct an inquiry into the various features of kwashiorkor including a clinical investigation in the areas where the condition occurs. The object of such an investigation should be to define the clinical features and to study the food habits of the population, with particular reference to diet during pregnancy, lactation, infancy, and early childhood. The inquiry should be extended to areas in which the disease does not occur but in which the diet is apparently similar to that of areas in which the disease is found. This may help to establish a correlation between food habits and the occurrence of the disease—its incidence—and define the part played by other factors, such as tropical parasitism, in determining the variations in clinical manifestations." <sup>75</sup>

The Inter-African Conference on Food and Nutrition (Conférence interafricaine sur l'Alimentation et la Nutrition <sup>14</sup>), which met in Dschang in the French Cameroons a few weeks before the meeting of the joint committee, also considered the problem of kwashiorkor. It discussed the symptomatology, age incidence, and etiology of the syndrome, drew attention to its high incidence in Africa, and emphasized the need for further intensive investigations.

In accordance with the joint committee's recommendation, WHO invited one of us (Brock) to visit a number of territories in Africa to collect information on the epidemiology of kwashiorkor. Subsequently, WHO asked FAO to co-operate in the survey and FAO responded by

sending a member of the staff of the Nutrition Division (Autret) to undertake this task. The two members of the team visited together a large number of territories in Africa and the present report is a joint contribution.

The main points put forward by the joint committee include the following :

- (1) Kwashiorkor is a syndrome, at present ill-defined, known by various names.
- (2) It is said to be one of the most widespread nutritional disorders in tropical and subtropical countries.
- (3) The highest incidence is said to be in infants and young children.
- (4) Mortality-rates in some parts of Africa are disturbingly high.
- (5) Cirrhosis occurs in adults in areas where kwashiorkor occurs in infants and young children.
- (6) There is a possible relationship between these cirrhotic changes and the occurrence of primary carcinoma of the liver.

The joint committee recommended an inquiry covering the following :

- (1) A definition of the clinical features.
- (2) Determination of the incidence of the syndrome.
- (3) Study of the food habits of the populations among which it does and does not occur, with particular reference to diet during pregnancy, lactation, infancy, and early childhood, in order to establish a relation between food habits and its incidence.
- (4) Study of the part played by other factors such as tropical parasitism.

The survey made by the authors was in conformity with these suggestions. In addition, attention was given to treatment and to preventive measures.

#### **Scope of Present Inquiry**

The survey was carried out during the period from mid-October to mid-December 1950. It was confined to Africa South of the Sahara and covered a broad zone of central or tropical Africa from Zanzibar at approximately longitude 39°E. and latitude 6°S. to Dakar at approximately longitude 17°W. and latitude 15°N. These two points mark the limits of latitude and longitude within which it was carried out. The following territories or countries were visited : Kenya, Uganda, Ruanda-Urundi, Belgian Congo, French Equatorial Africa (Middle Congo), Nigeria, Gold Coast, Liberia, Gambia, and French West Africa (Senegal).

In addition to the information obtained in this study, further information was available to one of us (Brock) as the result of previous experience of the syndrome in the Union of South Africa. This experience extended from Cape Town (longitude 18°E. and latitude 34°S. approximately) to Durban (longitude 31°E. and latitude 30°S. approximately) and Pretoria (longitude 28°E. and latitude 26°S.). Johannesburg is included in this triangle.

### Method of Inquiry

In each territory the Director of Medical Services or his representative or equivalent was interviewed and information sought from the staff and in the files of the Health Department. In some territories there are medical schools and institutes of medical research, which were also visited. Inquiries were made of medical officers engaged in administration, clinical work, and research, including African assistant medical officers.

Where possible the directors or staffs of departments or institutes of agriculture, veterinary science, and fisheries were interviewed. Information was also obtained from the field staffs of these departments.

Data relevant to the survey were gathered in discussions and talks with the following : hospital assistants ; male and female nurses ; health visitors ; sanitary inspectors ; African chiefs and local administrators ; missionaries ; schoolteachers ; schoolchildren and parents at dispensaries and in rural homes.

In the different territories visits were made to : hospitals in the principal centres ; urban and rural dispensaries (especially those which include child-welfare clinics) ; schools for African children, at which special attention was given to classes for children under the age of 10 years ; urban and rural markets ; urban and rural homes.

Time did not allow extensive visits to rural and "bush" areas, but a certain number of these, accessible to the main centres, were visited.

In searching for material, inquiries were made about nutrition and malnutrition in general, with special reference to kwashiorkor or related syndromes which might be recognized locally by other names. In particular inquiry was always made for : (a) nutritional oedema ; (b) dyspigmentation of skin or hair associated with nutritional deficiency ; (c) liver disease of unknown or obscure etiology or nature ; and (d) hypoalbuminaemia.

The inquiry was limited to a tour of two months. In spite of its brevity, a great deal of ground was covered and it is believed that the observations made were not superficial. They must, however—together with the conclusions reached—be regarded as tentative. There was seldom an opportunity to confirm observations and statements relating to one particular territory by further inquiry, and the comments and opinions of people interviewed could often be recorded on paper only after an interval of 12 to 24 hours. Wrong impressions (e.g., with regard to the prevalence of the syndrome) may have been gained because of the influence of season or because of the particular selection of areas visited or material collected, imposed by the shortness of the survey. Moreover, it was sometimes felt that the views of people with long experience in a particular area were open to question because they did not conform with comparable experience from other areas. It is obviously risky to question such views, and this



was done only when experience from other areas yielded evidence which appeared to require a different interpretation.

## 1. MEDICAL ASPECTS OF KWASHIORKOR

### 1.1 Definition, and Description of Individual Clinical Characters

As a result of the experience gained in the survey, combined with knowledge of world literature, a tentative definition is offered. It is recognized that the syndrome cannot at present be accurately defined and that it merges into other nutritional syndromes, such as marasmus and Mehl-nährschaden, but it is felt that its prevalence and importance justify a tentative definition as follows :

A nutritional syndrome (or syndromes) found among indigenous Africans in which characteristically there occurs :

- (a) retarded growth in the late breast-feeding, weaning, and post-weaning ages,<sup>a</sup> with
- (b) alterations in skin and hair pigmentation,
- (c) oedema,
- (d) fatty infiltration, cellular necrosis, or fibrosis of the liver,
- (e) a heavy mortality in the absence of proper dietary treatment, and
- (f) the frequent association of a variety of dermatoses.

Some combination of the above features appears to be fundamental ; other clinical features are so frequent as to be dominant if not fundamental. These are :

1. Retardation of growth at the late breast-feeding, weaning, and post-weaning ages. This character is fundamental, but is of course also common to such conditions as undernutrition (lack of calories), marasmus, and atrophy, which cannot be included under the name of kwashiorkor.

2. Dyspigmentation of the hair and to a lesser extent of the skin. This character, which is discussed later in detail, needs to be very carefully defined. The dyspigmentation is often faint and may sometimes be entirely absent.

3. Oedema usually associated with hypoalbuminaemia.

4. Pathological changes in the liver which include one or more of the following : fatty infiltration, necrosis, and fibrosis.

5. A heavy mortality if the syndrome is untreated or incorrectly treated.

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<sup>a</sup> Trowell, after a study of 1,000 cases of kwashiorkor described in 20 papers, reports the age incidence as follows :

0-4 months, nil ; 4-6 months, 1% ; 6-12 months, 15%  
 1-2 years, 45% ; 2-3 years, 24% ; 3-4 years, 8% ; 4-5 years, 4%  
 5-15 years, 3%  
 96% of the cases are in the age-period 6 months to 5 years.

**FIG. 1. GROUP OF KWASHIORKOR CASES SHOWING TYPICAL SYMPTOMS**

Note oedema, pot-belly, miserable expression, altered hair texture (second child from left), and dyspigmented hair (child on extreme left).

6. Nutritional dermatosis. This occurs in a variety of patterns but may be absent.

7. Gastro-intestinal disorders. These are variable and include one or more of the following : anorexia, digestive upset, diarrhoea, mild steatorrhoea.

8. Peevishness and mental apathy.

9. Mild normocytic or slightly macrocytic anaemia. The anaemia is commonly severe when the syndrome is complicated by parasitic infestation. If there is chronic blood-loss, particularly from ankylostomiasis, the anaemia may become hypochromic.

10. Atrophy of the acini of the pancreas, resulting in decline in the enzymatic activity of the duodenal contents.

The foregoing criteria require further discussion. In this report the term "kwashiorkor" is applied to a syndrome occurring (*a*) in Africa, and (*b*) in the pre- and post-weaning child. It is recognized that a very similar or even identical syndrome occurs in other continents and indeed reports have already come from other continents under this name. For the purpose of this report, however, the syndrome has been personally observed only in the African continent where the name was originally coined from a language of the Gold Coast Colony. If an identical syndrome is encountered in other continents the name may be justifiably used there. It is our opinion, however, that the Mehl-nährschaden of Czerny & Keller,<sup>15</sup> although obviously very closely related to kwashiorkor, should not be

included under the latter name. The reason for this view is discussed in an ensuing section on dyspigmentation (section 1.1.2) in which it is pointed out that etymologically the name "kwashiorkor" is inevitably linked with the concept of dyspigmentation.

A syndrome very similar to kwashiorkor is undoubtedly encountered in other age-groups and even in adults. H. C. Trowell (personal communication) and Pieraerts<sup>58</sup> have described a number of cases occurring in lactating women. These cases are obviously closely related to kwashiorkor, but we would suggest that, for the present, it is best to confine the term to cases occurring in the late breast-feeding, weaning, and post-weaning periods.

The ten characters listed above will now be discussed separately.

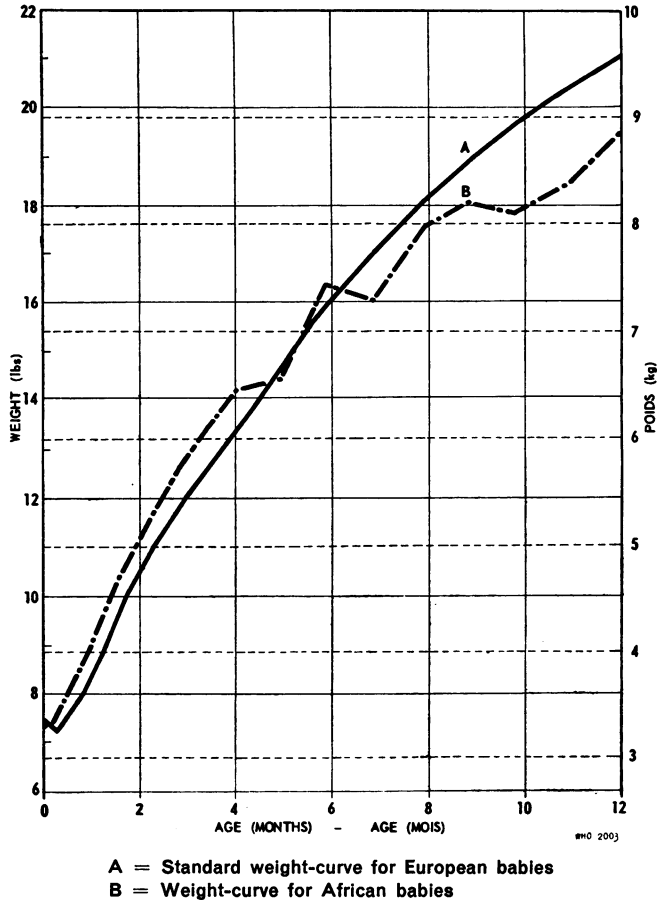
### 1.1.1 *Retardation of growth*

Growth charts have been determined and averaged for large numbers of infants and children in Kampala and have been compared with accepted European growth charts (Hebe Welbourn—personal communication). Weight during the first nine months is more or less the same as in Europeans, but from about nine months a deviation starts; the weight-curve shows the maximum retardation in comparison with European standards in the second to the fourth years and has not caught up these standards by the end of the fifth year of life (see fig. 2 and 3). No similar composite growth charts were seen in any other territory although they may well exist. Numbers of individual growth charts were seen at other centres and there was a general impression, throughout the area surveyed, that there is general retardation of growth similar to that recorded at Kampala. The retardation applies both to stature and to weight but more severely to weight than to stature. In kwashiorkor growth retardation is fundamental. Trowell (personal communication) reports that he has never seen a case of the disease in which growth was not seriously retarded. In spite, however, of this retardation the infant with kwashiorkor commonly does not look emaciated or starved. His subcutaneous fat is often quite considerable and when there is early oedema he may give superficially an appearance of reasonably good nutrition, particularly if dermatosis is mild or absent. In the stage of recovery, when oedema has disappeared, it is usually obvious that there is gross atrophy or failure of development of muscles.

### 1.1.2 *Dyspigmentation*

This is the most difficult of the clinical aspects of kwashiorkor to discuss adequately. The term "depigmentation" is usually applied to reduction in the brown or black colour of the hair or skin of indigenous African people as compared with the pigmentation previously existing in the individual concerned. There may, however, be not only a reduction in the quantity of pigment present in these tissues, but also qualitative alteration

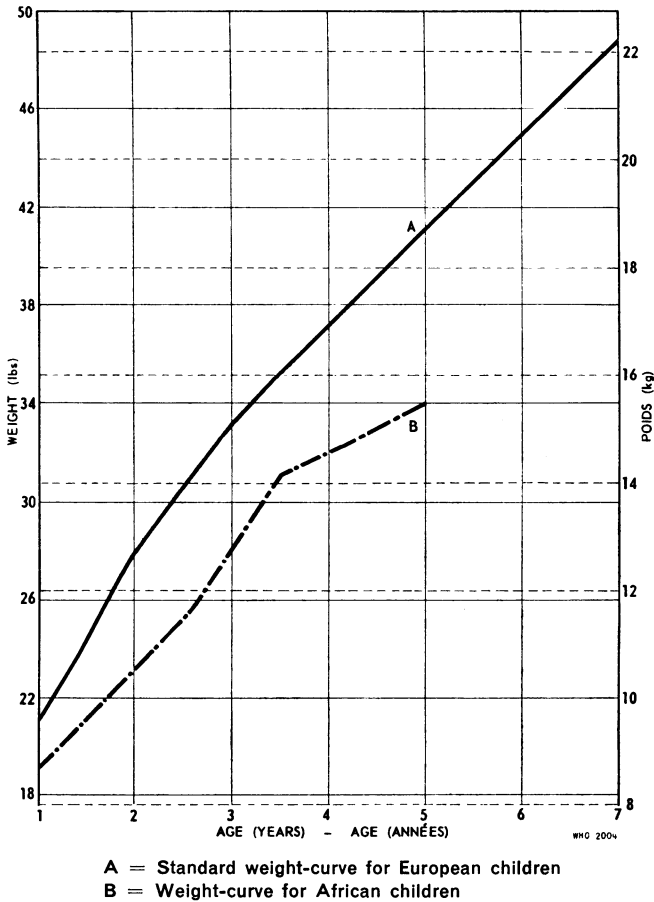
**FIG 2. WEIGHT OF AFRICAN BABIES (0-12 MONTHS) ATTENDING CLINICS IN KAMPALA AREA, UGANDA**



in pigment (dyspigmentation). The latter term has been used in this report to cover not only qualitative changes in pigment but also reduction in the brown or black colour of the skin or hair.

A light colour of the skin or hair in an African may be genetic in nature and may have existed unaltered since birth. Such genetic hypopigmentation appears to have two separate origins in Africa : (a) racial admixture with people of lighter colour such as Europeans and Arabs ; (b) as a mutation within a racial group which is ordinarily heavily pigmented. In its full form this latter constitutes albinism, but several examples were encountered in Africa of genetic dyspigmentation (hypopigmentation) resulting from mutation which were not severe enough to justify the term albinism. Some people referred to such examples as " half albinos ". Whether this term is legitimate or not, it is clear that genetic hypopigmentation occurs as a

FIG. 3. WEIGHT OF AFRICAN CHILDREN (1-5 YEARS) ATTENDING CLINICS IN KAMPALA AREA, UGANDA



mutation in darkly pigmented African people, and examples of its inheritance through three generations were encountered.

The evidence appeared conclusive that dyspigmentation of the skin of Africans does occur as a sign of nutritional deficiency. It may be patchy or diffuse. Diffuse dyspigmentation is so difficult to distinguish from genetic hypopigmentation that it should be diagnosed only when the supporting evidence is very strong. Trowell (personal communication) has put forward the idea that, if the face shows depigmentation in comparison with the covered parts of the trunk, this is presumptive evidence that it is dyspigmentation of nutritional origin. There seems little doubt that dyspigmentation particularly affecting the face does occur in the kwashiorkor syndrome, but on the other hand there is convincing evidence that relative hypopigmentation of the face compared with the covered part of the trunk

**FIG. 4. COMPARISON OF NORMAL AFRICAN HAIR AND DYSPIGMENTED HAIR**

Left : normal African hair ; right : dyspigmented hair (achromotrichia) ; centre : hair showing mild changes.

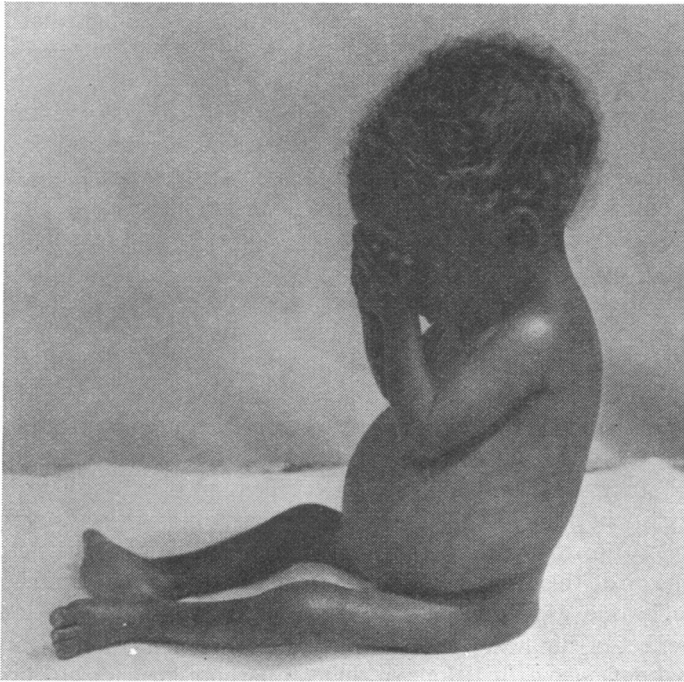
may occur as the result of a genetic factor in excellently nourished people. Examples supporting this latter view were found, particularly in the two small children of a Batussi chief in Ruandi-Urundi, who were in an excellent state of nutrition, and in the case of an African female doctor in the Gold Coast who came from a very privileged family and was obviously well-nourished.

The general conclusion was formed, therefore, that, while diffuse dyspigmentation of the skin occurs as a stigma of malnutrition, it is extremely difficult to distinguish it from genetic hypopigmentation.

In the case of the hair, the evidence that dyspigmentation is due to nutritional disorder is more convincing and widespread. It was seen in every territory surveyed in one form or another and with varying degrees of incidence. It takes several distinct forms. First, the hair may be dyspigmented without recognizable alteration in texture. Convincing examples of this were seen, particularly in Southern Nigeria and in the Gold Coast, both in children suffering from the kwashiorkor syndrome and in children who were malnourished to some degree but were not to be classed within the syndrome. A strong impression was also formed from observation by the roadside that this is a very common condition both in children and in adults.

The other principal form of nutritional dyspigmentation of the hair is associated with alteration in texture of the hair. The texture changes from the firm crinkly wool of the healthy African scalp to a finer more silky texture in which all or some of the curl is lost. In some cases of kwashiorkor this hair of altered texture is hardly, if at all, dyspigmented, but in a great majority of cases it is also dyspigmented. In some forms,

**FIG. 5. KWASHIORKOR CASE SHOWING DYSPIGMENTATION AND ALTERED TEXTURE OF HAIR, AND PHOTOPHOBIA**



apparently the milder ones, the dyspigmentation shows itself as a reddish hue. The alteration in structure and colour is often most clearly seen around the temples and over the anterior part of the vertex, producing a golden halo effect. In other cases the colour of the hair is either grey or even nearly white. The view is often expressed that the grey or white form is a more severe manifestation of kwashiorkor than the red. This may well be true but the evidence is not fully convincing.

It seems possible that there are at least three nutritional factors affecting hair colour and texture, at least one affecting texture, and possibly two affecting colour, one producing the reddish hue and another producing the grey or white. The term "achromotrichia" has been applied to the latter

form. It was attributed by Hughes<sup>38</sup> in Southern Nigeria to riboflavine deficiency, but the evidence for its association with ariboflavinosis seemed to be unsatisfactory. Through proper feeding both dyspigmentation and altered texture of the hair can be restored to normal, but naturally it may take six months or a year for new hair with normal structure and colour to grow. Dyspigmented hair with altered structure therefore sometimes persists long after the kwashiorkor syndrome has otherwise been cured.

Finally, there is genetic hypopigmentation of the hair the origin of which corresponds with the two forms of genetic hypopigmentation of the skin referred to above. Genetic hypopigmentation of the hair is always distinguishable from nutritional dyspigmentation by the fact that the skin is also hypopigmented and that the colour of the hair is the same at the roots and at the tips.

It has been stated that observation by the roadside gave the strong impression that dyspigmentation of the hair was common both in children and adults throughout Central Africa. It was seen to a striking degree in adult labourers working on surf boats in Accra harbour. The clinical appearances of these labourers were as follows: The dyspigmentation affected the tips of the hair and not the roots and was not associated with dyspigmentation of the skin. The hair had a reddish hue at the tips but as far as could be ascertained was black at the roots. Dyspigmentation seldom, if ever, affected the whole scalp, but this may have been due to differences in length of the hair on different parts of the scalp. The greyish-white appearance observed in the hair of some children with kwashiorkor was not seen in these adults. The texture was little, if at all, altered. Many of the labourers appeared to have an excellent physique and to be in an excellent state of nutrition and were evidently capable of doing a very heavy day's work. For these various reasons it seems questionable whether dyspigmentation of this type can be regarded as a sign of malnutrition.

There is one argument in favour of regarding this condition as an external effect of sun, wind, and salt water rather than as a manifestation of nutritional deficiency. It is known that on bathing-beaches in Europe and the southern-hemisphere countries, the tips of the hair of healthy and well-nourished Europeans become bleached by the long continued effect of sun, wind, and salt water.

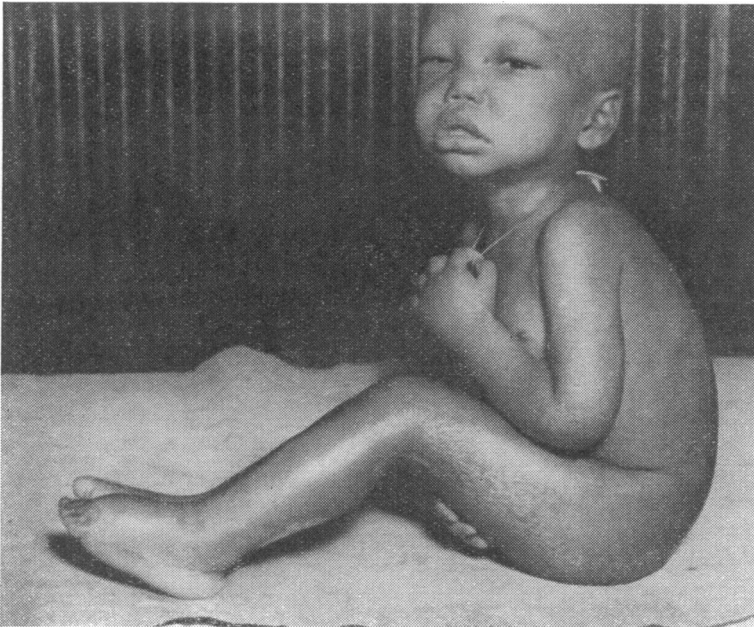
On the other hand, the condition as seen on Accra beach merges imperceptibly into similar types of reddish hair seen by the roadside all over Africa, including areas with a moist tropical climate. In Northern Nigeria a small group of children between the ages of five and seven, in an area which had recently been affected seriously by famine, had the same type of reddish hair. The parents of the children were asked whether this colour was natural and they unhesitatingly replied that it was an effect of the recent famine and that it would be restored to normal colour as their food improved. This opinion came from uneducated and ignorant peasants.



The precise significance of the different types of reddish hair seen in Central Africa undoubtedly requires further elucidation. At present it can be said with a fair degree of confidence that hair which is altered both in texture and in pigment—both the reddish and the greyish-white varieties—is almost certainly associated with protein deficiency. Hair which is dyspigmented at the tips to a reddish hue, without being altered in texture, is almost certainly also a result of malnutrition in the great majority of cases. It remains possible, however, that under the influence of sun, wind, and salt the tips of the hair in healthy and well-nourished Africans may become dyspigmented. This latter question must for the present be left open.

Such uncertainty is unfortunate, because the degree to which dyspigmentation can be taken as evidence of kwashiorkor is of vital significance

**FIG. 6. KWASHIORKOR CASE SHOWING OEDEMA OF LEGS AND FACE, AND DERMATOSIS OF THIGH, ARM, AND BACK**



in studying the frequency and importance of the syndrome in Africa and elsewhere. In a recent editorial in the *Lancet*<sup>40</sup> the statement is made that the term kwashiorkor “has the merit of neutrality: it offers no explanation and its use prejudices no issue”. This statement is not altogether correct because, as has already been pointed out, the term “kwashiorkor” is by etymology linked with the concept of dyspigmentation. Its meaning

“red boy” must obviously be linked with the concept of redness.<sup>18</sup> It is of interest that detailed inquiries at Kumasi, the capital of the Ashanti Kingdom, failed to reveal whether the concept of dyspigmentation was originally associated by the Ashanti people with the hair or the skin or with both.

The name “diboba” is used in the Belgian Congo (Pieraerts<sup>52</sup>). The authors understand that it is derived from “kuboba”, a word which is equivalent to “blettir” in French. The comparison here is with the colour of over-ripe fruit. In Pieraerts’ article the word applies both to skin and hair. A similar idea is expressed by Doucet<sup>19</sup> and Van Daele<sup>68</sup> in referring to the name “m’buaki” applied in the Belgian Congo to the same syndrome. Doucet says this name relates to “la teinte que prennent les fruits lors de leur maturité”. The title “les ‘enfants rouges’ du Cameroun” used by Lieurade<sup>44</sup> is also suggestive of the dyspigmentation.

Localized hyperpigmentation of the skin may also be included under the term “dyspigmentation”. Although this is usually part of a dermatosis, it can occur without palpable alteration in skin texture. Thus, in moderately pigmented “coloured people” in Cape Town, the initial lesion in the development of dermatosis is a localized hyperpigmentation which is followed by drying, scaling, and cracking of the epithelium. These epithelial changes may involve considerable areas of the skin or may occur in patches. They are never universal.

### 1.1.3 *Oedema and hypoalbuminaemia*

Almost without exception, when the serum albumin has been determined in oedematous cases of kwashiorkor, the level has been found markedly reduced.<sup>66</sup> In the area surveyed, serum albumin had been determined with frequency only at Kampala and at Leopoldville, so that it would be premature to say that throughout the area oedema and hypoalbuminaemia always go together. The evidence from the Union of South Africa and from many other parts of the world, however, confirms the almost invariable association of oedema and hypoalbuminaemia recorded in Kampala and Leopoldville. This is rather surprising, since recent work on human oedema and experimental deficiency oedema in animals suggests that the traditional link between hypoalbuminaemia and oedema, as expressed by Starling’s law, is by no means consistent. As further knowledge accumulates, it may happen that cases of oedematous kwashiorkor are discovered without hypoalbuminaemia, but as far as present information goes the association is very close. It must be emphasized that recordings of the total serum protein are of no value since there is often a compensatory rise in serum globulin which parallels the fall in serum albumin. In the area visited there is a tendency to regard this hyperglobulinaemia as a result of parasitic infestation, especially malaria, but it is encountered also in Johannesburg where the majority of cases of kwashiorkor have no malaria or other

parasitic infestation. The hyperglobulinaemia appears to be a result of liver damage.

#### 1.1.4 *Liver*

In the earliest descriptions of the syndrome, stress was laid upon fatty infiltration of the liver.<sup>4, 16, 32, 37</sup> Observers differ upon whether the liver is enlarged or normal in size, but practically all agree that at the postmortem examination it may be so infiltrated with fat that the normal structure of the liver is hardly recognizable. This point has been so thoroughly documented that it need not be stressed. Liver biopsy studies at Kampala and Johannesburg have shown disappearance of the fat as treatment is successfully carried out. So fundamental did this aspect of the syndrome appear to be that Waterlow,<sup>72</sup> in his study of a related syndrome in Jamaica, coined the term "fatty liver disease". It is therefore very surprising to learn that biopsy studies in the Gambia by J. Waterlow (personal communication) of infants with retarded growth and dyspigmented hair showed very little evidence of fatty infiltration, but showed definite evidence of fibrosis from the age of one year onwards.

So striking is the difference between the livers described at Fajara and those described elsewhere in Africa and in many other parts of the world, both at autopsy and from biopsy specimens, that the question must be asked seriously whether the cases at Fajara are not quite distinct from kwashiorkor. After seeing some of them and discussing the findings with B. S. Platt at Fajara, the writers were left with the impression that the main points which distinguish these cases clinically from classical kwashiorkor are (a) that the syndrome tends sometimes but not always to develop earlier, namely, during the age period 6-9 months and while the child is still feeding fully at the breast, and (b) that they occurred in a hyper-endemic malarial area.<sup>b</sup> Platt (personal communication) expressed the view that another difference is that in most other parts of Africa children are given carbohydrate of some sort as a supplement to breast feeding from quite an early age; in Jamaica also, where fatty livers occur, carbohydrate in the form of sugar is extensively used as a supplement to breast milk. He states that the average infant in the Gambia receives little, if any, supplement to breast milk for the first four to six months of life. This explanation is certainly reasonable, if it is correct that the Gambia is the only area in Africa where breast milk is not supplemented during the first six months of life. This was not the impression gained by the authors from conversations in many parts of Africa on the weaning habits of African children. Evidence was certainly obtained to support Platt's view that in the eastern half of the African continent there is a tendency to supplement

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<sup>b</sup> Waterlow has since written from the West Indies (personal communication) that, in his opinion, the cases in the Gambia from which he obtained his autopsy and biopsy material should not be regarded as kwashiorkor but as nearer to marasmus.

breast milk with carbohydrate at an early age. But supplementary feeding before six months is very unusual in many parts of Western Africa where fatty liver is common. In the Gold Coast, Mrs. du Sautoy (personal communication) reports definitely that "so far as I know the children are not given any other food than breast milk during the first six months".

The question of the late sequential effects of kwashiorkor on the liver and its possible relationship to adult cirrhosis and primary carcinoma of the liver is so large a subject that it will be discussed separately in section 1.3.

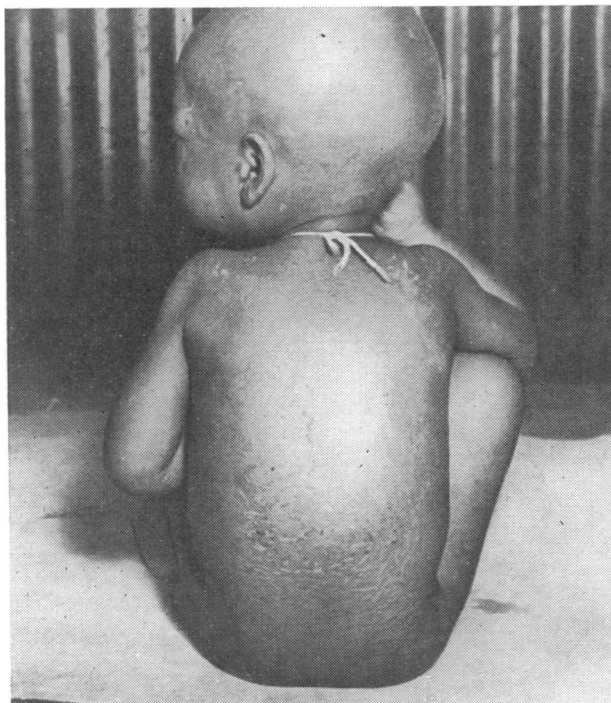
#### 1.1.5 *Mortality*

All observers are agreed that until very recently the mortality was heavy in the fully developed syndrome and particularly in the cases with oedema. There was evidence from biopsy study, particularly at Kampala and Johannesburg, that these well-developed forms with heavy mortality had extremely fatty livers, and it was generally assumed that the heavy mortality was due to an irreversible change in the liver. However, Waterlow, who coined the name "fatty liver disease" for a closely related syndrome in the British West Indies, recently studied in the Gambia liver biopsy specimens from a number of marasmic infants including some exhibiting a syndrome closely related to or identical with kwashiorkor. In hardly any of these cases was the liver found to be fatty, but in the majority there was well-developed fibrosis even at an early age. It has been suggested recently by Platt (personal communication) that the mortality was due, in some of these infants, to over-treatment of malaria and that such children tolerate only very small doses of antimalarial drugs. Whatever may be the interpretation of the findings in the Gambia, it may be observed that the mortality was heavy in oedematous cases of kwashiorkor in Johannesburg and Pretoria, where no tropical parasites are encountered. In these two centres the mortality was between 30% and 40% until recently.

The mortality recorded by other workers in Africa was never less than 30% until recently, and in some centres went up to 90% or even higher. Pieraerts in the Belgian Congo reports that the mortality is 100% in the absence of his method of treatment with consecutive subcutaneous injections of human plasma. Since the introduction of skim milk, preferably in the form of reconstituted lactic acid skim-milk powder, the mortality has fallen very rapidly in South Africa and was recently reported by Walt et al.<sup>71</sup> in Durban to be 2.8%, exclusive of cases dying in the first 24 hours.

#### 1.1.6 *Dermatosis*

This term is used to cover generally all the alterations in the skin encountered in association with kwashiorkor. It sometimes includes visible but impalpable dyspigmentation as a precursor or sequel to palpable dermatosis. Wide difference of opinion has arisen with regard to this aspect

**FIG. 7. KWASHIORKOR CASE SHOWING DERMATOSIS OF BACK**

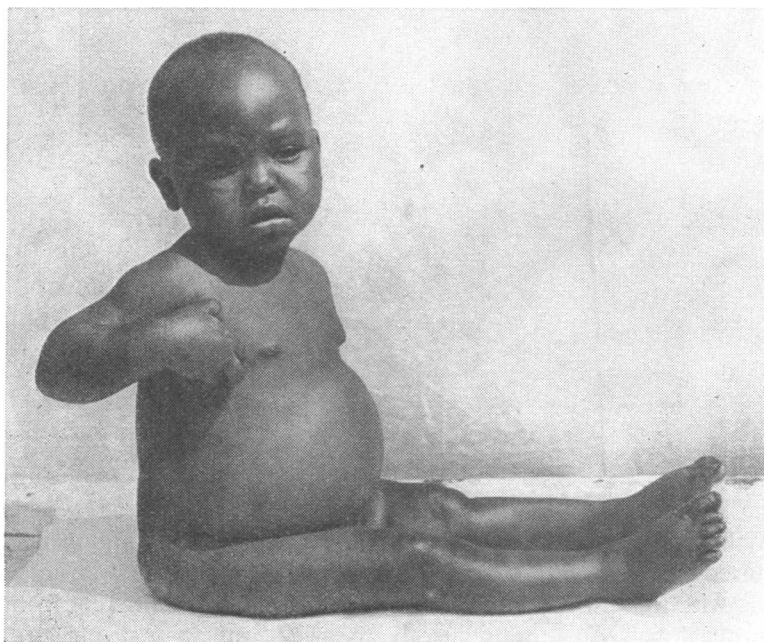
of the kwashiorkor syndrome. In the original description of kwashiorkor by Williams,<sup>74</sup> the dermatosis was clearly described and arguments were advanced for regarding it as non-pellagrous in origin. These were concerned chiefly with the distribution which was held to be quite different from that of classical pellagra. Subsequently the view was very strongly pressed by Stannus<sup>62</sup> that the dermatosis was pellagrous in origin and, in his earlier writings, Trowell accepted and repeated this view. It was accepted also by Kark<sup>39</sup> in South Africa and for some time kwashiorkor was referred to as infantile pellagra. Hughes<sup>38</sup> in Southern Nigeria pressed the view that the dermatosis was due to ariboflavinosis, but this has not been accepted. Vitamin-A deficiency has also been blamed in part for the dermatosis and Trowell (personal communication) has reported very low blood vitamin-A levels in cases in Kampala.

The experience of this survey leads inescapably to the conclusion that the dermatosis is not the same in different areas of Africa and therefore to the further conclusion that dermatosis is only an associated condition which probably may have several different origins and which is not an

integral part of the syndrome. The commonest form has been described by Trowell (personal communication) in the following terms :

“This eruption occurs as sharply defined black varnished patches on the areas exposed to irritation (napkin area, buttocks, back and so forth) but none appears on the areas exposed to sunlight (the hands and face) on which classical pellagra should appear. These black islands rapidly enlarge, tend to coalesce and then peel to disclose a white or pink area underneath. They undergo spontaneous peeling quite independently of any specific treatment but this usually only occurs if at the same time the case is improving.”

**FIG. 8. KWASHIORKOR CASE SHOWING POT-BELLY, OEDEMA OF LEGS, AND DERMATOSIS OF THIGH**

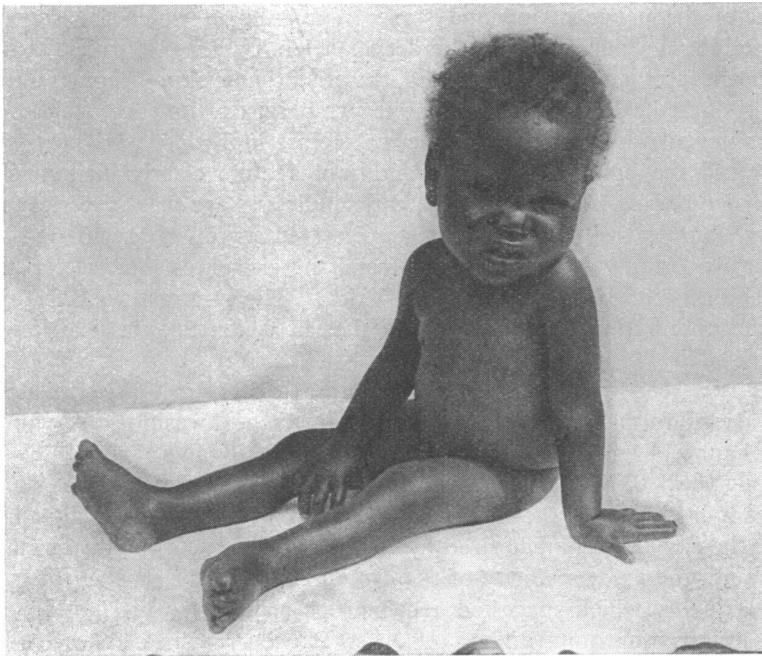


As seen in Cape Town in moderately pigmented “Cape coloured” children, the initial lesion is always hyperpigmented ; this hyperpigmentation is followed by drying, cracking, scaling, and peeling of the hyperpigmented epithelium which comes off sometimes in fine scales and sometimes in larger hyperpigmented plaques (“enamel-paint plaques”). The underlying skin has always lost its pigment and is soft and fragile. This most commonly occurs in the “napkin area” and the fragile skin is easily excoriated and secondarily infected. Lesions of this type encountered in Southern Nigeria were regarded by Hughes<sup>38</sup> as a manifestation of ariboflavinosis. However, cases seen during the present survey in Southern Nigeria and cases in that territory described by D. B. Jelliffe (personal

communication) were not distinguishable in appearance from cases described by Trowell in Uganda and cases seen at Cape Town by one of us.

During the present survey, cases in which there was an almost universal dry scaling dermatosis, approximating to an exfoliative dermatitis, were observed at Ibadan in Southern Nigeria and at Kumasi in the Gold Coast. Striking pictures showing similar lesions among the Kikuyu near Nairobi were also seen.

**FIG. 9. KWASHIORKOR CASE SHOWING MISERABLE EXPRESSION, ALTERED HAIR TEXTURE, OEDEMA OF LEGS, AND DERMATOSIS OF ABDOMEN**



On the other hand, the dermatosis in some cases was almost confined to the lower legs and had the appearance described by Platt<sup>55</sup> as "crackled skin". This is one of the commonest forms of dermatosis encountered throughout Africa and it is believed by many people to represent a normal skin texture in Africans. Evidence was, however, obtained during the survey that it is not found in really well-nourished Africans.

Undoubtedly climatic factors such as wind, sun, and cold air contribute to the creation of this and other forms of dermatosis. For example, in Northern Nigeria, in the harmattan season, the skin of almost every African is dry and shows a fine greyish desquamation. This condition, due to extraneous causes, is, however, quite clearly distinguishable in well-nourished people from dermatosis associated with malnutrition.

Another kind of dermatosis frequently seen is that which is referred to as elephant skin, and which is best seen on the extensor surface of the knees. The skin becomes greatly thickened and has a fissured appearance without necessarily showing any alteration in pigment. Sometimes, however, skin of similar texture in the same location is coloured jet-black. This was seen in several groups of children in famine areas in Northern Nigeria. In these children the skin was obviously hyperpigmented and was clinically indistinguishable from acanthosis nigricans.

Finally, a unique type of dermatosis was encountered at Dakar. This has been described by Bergeret.<sup>8, 9</sup> It occurs particularly in the flexural areas of the pelvic region and starts as a bulla in which the superficial epithelium is separated from the deeper layers by a non-purulent exudate. Then the epithelium ruptures and the underlying skin becomes infected and ulcerated. It is said to resemble pemphigus in its early stages. This resemblance was stressed by a dermatologist in Dakar who nevertheless expressed the opinion that the condition is quite clearly distinguishable from pemphigus. No case in the early bullous stage was seen during the survey, but several cases in the later ulcerated stage were seen. It is clear that this lesion is very different from the dermatosis characteristic of kwashiorkor as seen elsewhere in Africa. The contrast was heightened by the observation of one case in Dakar in which the classical lesion as described by Trowell was present.

It is agreed by Trowell and most other observers that dermatosis in its various forms is not an essential part of the kwashiorkor syndrome. In Johannesburg, Altmann<sup>3</sup> describes it as occurring in about half the cases. Among the Kikuyu at Fort Hall, north of Nairobi, Clark<sup>13</sup> has described two annual peaks in the incidence of kwashiorkor and states that in one peak the cases are characterized by oedema and in the other by dermatosis. Although the great majority of the cases of dermatosis seen in this survey had a quality which suggested a pellagrous origin, the distribution of the skin lesions was quite different from that occurring in classical pellagra. It is probably unwise to ascribe the dermatosis to deficiency of any one element in the diet. It is probably complex and varied as regards etiology. It should be regarded as a frequent but not essential part of the basic syndrome.

#### 1.1.7 *Gastro-intestinal disorders*

Cheilosis, angular stomatitis, and general stomatitis suggestive of pellagra or ariboflavinosis, are mentioned in the accounts of many writers and were commonly seen in this survey. They may represent the visible sign of pathological change lower down in the gastro-intestinal tract. The pathology of the tract in kwashiorkor has, however, not been clearly described, probably because of the difficulty of distinguishing postmortem from pathological changes. It is probable that there is atrophy of the



mucosa of the intestine, but owing to difficulties of interpretation arising from early postmortem autolysis this cannot be regarded as established. Stransky has recently been widely quoted as having found such atrophy, but the description, in his publication of 1950,<sup>64</sup> of the atrophy is not fully convincing and cannot be accepted without confirmation. Symptomatically variable and vague digestive upsets are frequently recorded. Diarrhoea is variable ; in most areas it is mild or absent unless there is a superimposed intestinal infection. In Dakar, however, the descriptions of Bergeret<sup>8</sup> stress diarrhoea as severe and often preceding the presentation of the case at a hospital or dispensary by six to eight weeks. The impression from the survey was that the duration and severity of the diarrhoea observed at Dakar were very unusual. This may possibly be related to the fact, put forward by several doctors in Dakar, that children consume adult food as soon as they start to supplement the yield from the breast and that the adult food contains curry and spices. A mild degree of steatorrhoea is encountered in some places, but where the diet is wholly or largely free from fat steatorrhoea is not reported.

It is notorious that the relation between dietary deficiency and gastro-intestinal upset, particularly diarrhoea, is that of a vicious circle. Nutritional deficiency can produce functional and structural changes in the gastro-intestinal tract and these can open up the way to bacterial and parasitic infestation which may aggravate the picture. The diarrhoea resulting from bacterial infection further interferes with the ability of the intestine to digest and assimilate.

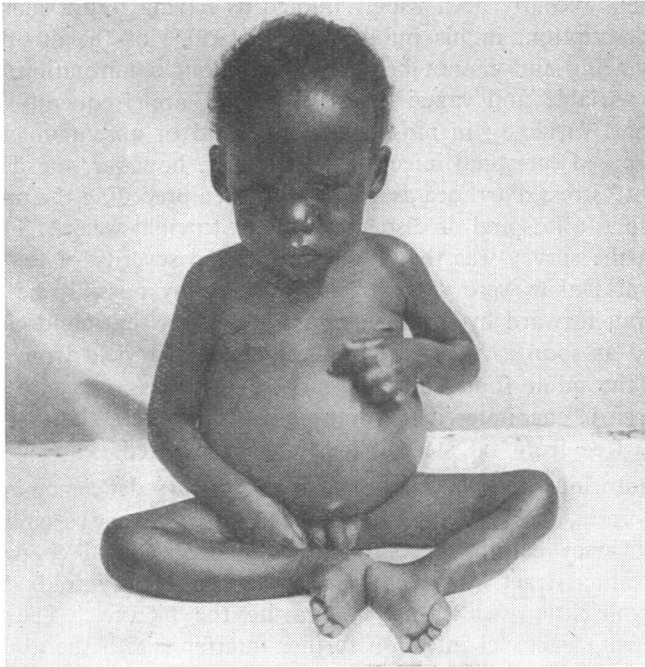
### 1.1.8 *Mental apathy*

This aspect of the clinical pattern of kwashiorkor has been neglected in most of the written descriptions of the syndrome although it is well known to all observers. It appears to have been taken for granted in the written descriptions. Clark,<sup>13</sup> working at Fort Hall among the Kikuyu people, has commented that

“The mental changes found in kwashiorkor are the most constant and probably one of the most important of all the changes seen, yet they appear to have attracted very little attention in the literature of the disease. They are, I think, far more constant, characteristic, and important than the skin changes about which so much has been written.

“A child with kwashiorkor is dull, apathetic, and miserable. It rarely screams or cries, a low miserable whimper is the only vocal sign of its wretchedness. We are all familiar with the African child who, terrified by the European doctor, fights and resists examination to the limit of its strength. Not so the kwashiorkor child ; it will rarely if ever resist examination in the least degree, and will never fight and scream —its apathy is too great. Children with kwashiorkor are so dull and apathetic that if put to sit in one place they will remain sitting there until lifted up again. They never, as do so many other children, go wandering off down the ward to investigate matters for themselves. If one can get a smile out of a child with kwashiorkor, one can assume it is well on the way to being cured.”

**FIG. 10. KWASHIORKOR CASE SHOWING POT-BELLY, OEDEMA OF LEGS, ALTERED HAIR TEXTURE, AND MENTAL APATHY**



The facial appearance of this mental state is very beautifully demonstrated in photographs shown to the authors by Clark. Trowell (personal communication) says : “ the mother unwraps a miserable imp who immediately grizzles and cries and avoids the light ”. He adds his impression of “ mental apathy until disturbed, then often irritability ”. After seeing cases of kwashiorkor throughout Africa and hearing descriptions from those who have studied the syndrome, the writers consider that the term “ peevish mental apathy ” aptly describes the mental state of the patient. The change from this state to impish humour and vitality which characterizes cases of cured kwashiorkor is most striking.

#### 1.1.9 *Anaemia*

It is agreed by most writers that when parasitic infestation is absent or slight, anaemia is usually mild. In Johannesburg and Pretoria, where tropical parasites are absent, the anaemia is usually mild and either normocytic or slightly macrocytic. On the other hand, where parasitic infestation is prominent, the anaemia may be very severe. Ankylostomiasis is often associated with kwashiorkor and in some areas is probably a contributory factor in etiology. The chronic blood-loss often renders the anaemia hypochromic as well as severe. In Nigeria it is held that

chronic haematuria from bilharziasis is more important than ankylostomiasis in producing hypochromic anaemia. Trowell<sup>65</sup> described "dimorphic anaemia" as characteristic of kwashiorkor at Kampala. Lehmann<sup>43</sup> has since attributed the dimorphism to the presence of reticulocytes. There can be little doubt that Lehmann is at least partly right, but his interpretation scarcely explains all the peculiarities of the anaemia associated with kwashiorkor. In several centres doubt was expressed whether Lehmann's theory is adequate to account for the apparent dimorphism of the anaemia of kwashiorkor. Price-Jones curves, shown to the authors by Charles at Leopoldville, from cases of kwashiorkor, had a strikingly biphasic shape and Charles maintained that the biphasic curve was not due to the presence of reticulocytes.

#### 1.1.10 *Pancreas and duodenal enzymes*

Davies,<sup>16</sup> working at Kampala, has described atrophy of the acini of the pancreas followed by fibrosis and has expressed the view, based on the production of fatty liver in dogs by pancreatectomy, that pancreatic atrophy must be the basic or fundamental lesion of kwashiorkor. The existence of this lesion has not yet been confirmed in Africa, except by other pathologists at Kampala. Véghelyi<sup>69</sup> has, however, found related lesions in the pancreas of protein-deficient infants in Budapest.

Thompson (personal communication), working with Trowell at Kampala, has shown that a striking diminution occurs in the enzymatic activity of the duodenal contents in infants with kwashiorkor. The diminution affects amylase, trypsin, and lipase, and activity returns to normal after the successful treatment of the condition. The same finding was reported by Véghelyi et al.<sup>70</sup> in cases of famine oedema in infants in the Budapest famine in the second World War. E. Charles (personal communication) at Leopoldville reported similar observations relating to trypsin and lipase in the duodenal contents. This secretory defect may link up on the one hand with pancreatic atrophy and on the other hand with the development of fatty infiltration of the liver.

#### 1.1.11 *Miscellaneous findings*

In the study of the syndrome, attention has hitherto been directed to the internal organs, principally to the liver and pancreas. It is likely, however, that protein deficiency would affect every organ of the body and evidence to support this assumption is slowly accumulating. Davies<sup>16</sup> has referred to a renal lesion and is working at present on a myocardial lesion for which he has suggested the name "endomyocardial necrosis". Testicular atrophy has been recorded, particularly in association with the adult cirrhosis of the African, but the authors found a difference of opinion on the frequency with which this occurs. The resemblance between

the histology of muscle from cases of kwashiorkor and from vitamin-E deficient rats has also been commented on (Platt—personal communication).

## 1.2 General Clinical Picture

It would have been very useful if it could have been stated that a minimum number of the above ten characters in various combinations constitute the basic clinical pattern of kwashiorkor. Unfortunately, the syndrome cannot at present be precisely defined. The fundamental group of signs is constituted by : (a) retarded growth in the late breast-feeding, weaning, and post-weaning phases, with (b) alterations in skin and hair pigmentation ; (c) oedema ; (d) fatty infiltration, cellular necrosis, or fibrosis of the liver ; (e) a heavy mortality if better protein is not supplied in the diet. A variety of dermatosis is commonly but not invariably associated with the syndrome.

Any clinical syndrome which includes these five characters and occurs in Africa can undoubtedly be called kwashiorkor. A similar syndrome occurring in other parts of the world might reasonably be called kwashiorkor. Retarded growth in the late breast-feeding, weaning, and post-weaning phases does not constitute kwashiorkor unless associated with other clinical features regarded as fundamental. There appears to be an imperceptible transition in clinical features from marasmus to kwashiorkor, and it is not possible at present to state where the borderline lies between these two syndromes.

An infantile syndrome of nutritional oedema with little or no alteration in skin and hair pigment has been described in European infants following the description of "Mehlnährschaden" by Czerny & Keller.<sup>15</sup> If, however, the term "kwashiorkor" is applied to such cases, it loses its etymological meaning.

Oedema is usually regarded as an essential feature of the syndrome but there is presumably a pre-oedematous phase in the evolution of the disease. Some authorities, e.g., Trowell, would apply the term "kwashiorkor" to cases in the pre-oedematous phase and contend that there are many pre-oedematous cases to be found for every oedematous case. Difficulties in accepting this concept have been discussed in the section on dyspigmentation (section 1.1.2). Some authorities may be critical of a diagnosis of kwashiorkor without fatty infiltration of the liver ; the reasons which have prompted the use of the term "fatty infiltration, cellular necrosis, or fibrosis of the liver" are, however, discussed in section 1.1.4. The heavy mortality in improperly treated cases led to the widespread use of the term "malignant malnutrition" suggested by Trowell. Recent experience of the very favourable effects of skim-milk powder in treatment seems to argue against use of this term.

It seems clear that dermatosis (apart from dyspigmentation) is not an essential component of the syndrome, although usually associated with it. The section on dermatosis (section 1.1.6) has indicated the great variety of patterns of dermatosis. Probably some of these patterns are due to associated deficiency of vitamins—such as riboflavine and niacin—not constituting a necessary part of the protein deficiency which is the etiological concept of kwashiorkor put forward in this report. Protein deficiency without deficiency of at least some vitamins is unlikely to occur under natural feeding conditions, but it is suggested that vitamin deficiency is not fundamental in the etiology of kwashiorkor. In the area surveyed manifest evidence of vitamin-A or thiamine deficiency was not seen in association with the basic syndrome, but it has been recorded as present in syndromes related to kwashiorkor and described in other parts of the world. According to the attitude adopted in this report, such cases should be regarded as kwashiorkor complicated by vitamin-A or thiamine deficiency, corresponding to cases in other areas complicated by riboflavine and niacin deficiency. It is recognized that this view is not yet firmly established ; it is put forward as a basis for consideration and further research.

It is possible that the dyspigmentation associated with kwashiorkor is a result of pantothenic-acid deficiency. If this proves to be correct then dyspigmentation will, like dermatosis, become an associated feature rather than part of the basic syndrome.

### **1.3 Nutritional Cirrhosis and Primary Carcinoma of the Liver**

It can be accepted as reasonably probable, from their world distribution, that cirrhosis and primary carcinoma of the liver on the one hand, and kwashiorkor on the other hand, are etiologically related. The evidence strongly suggests that both are due to dietary deficiency, particularly deficiency of protein. The evidence for this is well documented and it will not be discussed further here.

It is generally assumed that fibrosis or cirrhosis of the liver is a sequel to fatty infiltration. The evidence obtained during the present survey is not fully in keeping with that assumption. First, there is the finding of Walters and Waterlow in the nutrition unit at Fajara that, under the conditions existing in that area, fibrosis may precede, or develop without, a phase of fatty infiltration. For this reason the question has been raised whether the cases described by Walters and Waterlow can rightly be called "kwashiorkor".<sup>c</sup> On the other hand, there is some evidence that even where classical kwashiorkor does exist, the relationship between the syndrome and adult cirrhosis is not necessarily one of direct sequence. In support of this view is the evidence of F. J. Wright (personal communi-

<sup>c</sup> See footnote *b* on page 15.

cation) of Nairobi that cirrhosis and primary carcinoma of the liver are more common in the Wakamba people than in the Kikuyu people, whereas kwashiorkor is comparatively rare among the Wakamba and common among the Kikuyu. Wright reports also having seen one case of primary carcinoma of the liver in a Masai adult, although in general it is reported that primary carcinoma does not occur among the Masai who are largely meat-eaters and whose children do not have kwashiorkor. A survey in Nairobi, providing exact figures of the incidence of adult cirrhosis and primary carcinoma of the liver in the Kikuyu, Wakamba, and Masai tribes might be very illuminating.

At the present stage of our knowledge it would not be unreasonable to assume that deficiency of protein, or some factor closely associated with protein, is capable of causing fibrosis of the liver from an early age onwards. This fibrosis may appear and develop without the liver going through a phase of fatty infiltration. On the other hand, in most areas in Africa the stage of fatty infiltration precedes or runs *pari passu* with the development of fibrosis. The suggestion that fibrosis is related to protein depletion alone, while fatty infiltration is the result of a high carbohydrate intake, seems not unreasonable.

The incidence of cirrhosis of the liver is evidently very high indeed in the area surveyed. Davies and Trowell have expressed the view that in Kampala there is hardly an adult liver which does not show fibrosis to some degree, at least when examined microscopically. Davies is at present studying the pathology of the liver of the American negro to satisfy himself that the degree of fibrosis seen in Kampala is not a characteristic of the negro race. The authors understand that he has already reached the conclusion that this possibility can be excluded (Trowell—personal communication).

With regard to the cause of adult cirrhosis in the African region, there seem to be two main possibilities which would account for the very high incidence. The first is long-continued dietary deficiency in respect of protein or some closely related factor. The second is the long-continued effect of tropical parasites. Fernando et al.<sup>22</sup> concluded that in 48.8% of 43 patients in Ceylon for whom a detailed dietetic history was available, the cause of the cirrhosis appeared to be fatty infiltration of the liver due to lipotropic deficiency in the diet. At Fajara, Platt and MacGregor were inclined to stress the contribution of parasitic infestation, especially malaria, in the production of the early pathology of the liver. In Eastern Kenya and in many other parts of the region surveyed, bilharziasis is strongly suspected as a contributory factor in the production of adult cirrhosis. At present it is impossible to estimate the extent to which parasitic infestation contributes to adult cirrhosis in the area surveyed. By analogy with the situation in Johannesburg, however, where Gillman and Berman<sup>10a</sup> report a very high incidence of adult cirrhosis and primary carcinoma

of the liver, and where malaria, bilharziasis, and other tropical parasitic diseases can be ruled out as etiological factors in the great majority of cases, it seems reasonable to conclude that dietary deficiency is the most important cause of adult cirrhosis and therefore of primary carcinoma of the liver. This conclusion cannot be regarded as final, but there seems a considerable weight of evidence in its favour. If it be accepted, then protein deficiency in the diet of peoples in Africa becomes a problem of the most urgent and far-reaching importance. It may be that the adult cirrhosis is a sequel to kwashiorkor, but it seems more likely that kwashiorkor and adult cirrhosis are both sequelae of prolonged dietary protein deficiency and are not necessarily directly related to each other. In that case, kwashiorkor, important as it is in its own right, becomes of even more importance as a pointer to the occurrence of protein deficiency which is capable of interfering with the structure and function of the adult liver in the vast majority of Africans in the area surveyed and of causing a great volume of premature mortality and morbidity. It would not be too far-fetched to attribute to that protein deficiency, at least in part, the backwardness of the African people.

Implied in the foregoing remarks is the concept that protein deficiency, even if confined to the weaning and post-weaning phases of life, could produce irreversible damage in the liver and possibly in many other organs, and profoundly affect the future development of the individual. This possibility would, of course, be fortified by the fact that protein deficiency, though alleviated after the post-weaning phase of life, appears at least in a part of the African population to be permanent throughout life. The serious potentialities implicit in these remarks are not dealt with in this report, although their existence has not been overlooked. They have been referred to by Trowell in his concept of the "life flight" and we understand that a monograph is in preparation by Gillman & Gillman, which goes into some detail on this subject.<sup>d</sup>

#### 1.4 Frequency of the Syndrome

A correct approach to the problem of the incidence of kwashiorkor in Africa will depend upon a decision as to the earliest and mildest manifestation of the syndrome. If the term is used in its correct etymology there can be no doubt from the above clinical description that dyspigmentation of the hair should be regarded as the earliest and mildest recognizable manifestation, but it has been pointed out that it is difficult to distinguish depigmentation occurring in healthy and well-nourished adults under the influence of sun, wind, and rain, from dyspigmentation which is undoubtedly associated with malnutrition. It is likely, however, that

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<sup>d</sup> The publication of a book by Gillman & Gillman <sup>23</sup> was anticipated throughout the survey, but was seen for the first time only after this report had been completed. The views expressed in this book are therefore not reflected in the discussions in the present report.

dyspigmented hair in infants, particularly when occurring in moist tropical climates, is always endogenous in origin and probably due to nutritional causes.

If the term kwashiorkor is reserved for severe cases with arrested growth and development, oedema, dyspigmentation, and fatty liver at the post-weaning age, it is still an important syndrome. One can only guess at the number of severe classical cases of kwashiorkor in the African continent but it must at the most conservative estimate be a quite considerable number. Even a small incidence is important because of the high mortality and the possible or probable permanent damage done to the liver and because the condition is definitely preventable. It is evidently the opinion of Waterlow (personal communication) that many of the cases of infants with dyspigmented hair seen in the Gambia should be regarded as cases of marasmus and should not be called kwashiorkor. There is at least the possibility that nutritional dyspigmentation may be due to deficiency of some factor other than protein, e.g., pantothenic acid.

In discussing the milder cases of kwashiorkor, Trowell says that they are "so common that many doctors would regard it as almost normal that an African child in the second year of life should grow but little, have brown soft hair, a pale skin, and a low serum albumin. If this is a true appraisal of the situation, then in certain parts of Africa it is probable that the majority of the children in the second and third year of life suffer from kwashiorkor."

If nutritional dyspigmentation be accepted as the first and mildest expression of kwashiorkor, and as evidence of protein depletion, then indeed kwashiorkor presents a formidable problem, and it might be no exaggeration to say that in many parts of Central Africa "the majority of the children in the second and third year of life suffer from kwashiorkor". Unfortunately, final judgement on this point must be reserved until the true significance of dyspigmentation is understood.

### 1.5 Treatment

The treatment of kwashiorkor is well documented and is referred to in several sections of this report. It is intended merely to recapitulate here the most recent findings.

Altmann, in 1950,<sup>3</sup> reported that "Skim lactic acid milk was used as therapeutic formula to provide a high protein/low fat diet. Ventriculin and crude liver extract did not influence the course or prognosis." This opinion can be taken as representative of experience in the Union of South Africa of the treatment of cases free from tropical parasites. Altmann was also doubtful whether the use of any vitamin preparations was of value, provided a good all-round diet was slowly introduced after the first few weeks of treatment. Using a similar regimen, Walt et al.<sup>71</sup> report that mortality at Durban has been reduced to 2.8%, exclusive of cases



dying during the first 24 hours. Malaria and amoebiasis are endemic in the Durban area. Trowell (personal communication) comments that "there are really only two rules in treatment; firstly, to search diligently for any infection and to treat it vigorously however trivial it may be; secondly, to give really large amounts of milk protein and an adequate and varied diet. Naturally those whose digestive systems are weak cannot tolerate drastic changes in the diet."

The foregoing statement should probably be qualified by the statement that the milk protein should be in the form of skim milk. It appears that in the severe stages the children tolerate fat very poorly. The "adequate and varied diet" must be introduced gradually after the first two or three weeks of treatment with milk protein.

These simple rules about the treatment of kwashiorkor are not known and appreciated in many parts of the area surveyed, with the result that mortality is unnecessarily high and the period of hospitalization unnecessarily long. It is agreed that parasitic and infective diseases should be treated with all diligence, but Platt issues a warning against the use of antimalarial drugs in the usual dosage. His impression is that the younger children with kwashiorkor and malaria will not tolerate the full doses of antimalarial drugs regarded as appropriate for their age and are apt to collapse suddenly. In very severe cases in the first few days of treatment, the administration of human plasma, either intravenously, at a slow rate, into the bone-marrow (Bergeret) or subcutaneously in doses of 100 ml daily for ten consecutive days (Pieraerts) may be helpful.

## 2. KWASHIORKOR AND DIET

### 2.1 Food Consumption and Feeding Practices

Throughout tropical Africa there is a certain degree of uniformity in the dietary patterns of children and the methods of feeding them during the period of weaning. Nevertheless, there are a number of variations which depend on locality, race, tribe, agricultural methods, and the resources of the soil. It will be of value to consider both common features and differences, since they will throw light on the basic factors underlying the syndrome described under kwashiorkor and other names, and will help to explain variations in its clinical manifestations.

The dietary habits of adults must also be considered because the infant, as soon as it is weaned, has to exist on the food on which the family as a whole lives. It is during the critical period of weaning that the needs of the growing child are most exacting and least likely to be fulfilled. Further, account must be taken of the diet of mothers during pregnancy and lactation.

Throughout most of the region surveyed, children are usually given breast milk up to the age of two or three years, and in some exceptional

cases up to the age of five years. It is fairly obvious, however, that towards the latter part of this period the breast is little more than a comforter and cannot be an important source of food. The age period at which the breast ceases to make an important contribution to the food intake of the infant is difficult to establish. In some areas there is an impression that effective breast-feeding can be carried on for a period of a year to eighteen months, and some witnesses stated that yields of breast milk at eighteen months are often very good. It was not possible to confirm this statement and the authors incline to the view that such a situation is exceptional. The retardation in the growth of infants which usually begins at about six months and is pronounced at eight months, and the very poor state of nutrition of a large proportion of lactating women, would seem to support their view. An investigation of the amount of breast milk obtained by infants ranging in age from twelve to eighteen months made by Platt in the Gambia,<sup>56</sup> showed that this averaged about one ounce (28.4 ml) per hour or one pint (560 ml) per 24 hours, an amount which is clearly small. Bergouniou, who is familiar with West Africa, has made the following comment in an unpublished article to be presented to the Société de Pathologie exotique : "the yellowish liquid which the infant of 18 months to two years extracts with difficulty from a flaccid and empty breast is not of great value." However, even if the secretion of milk remains abundant at the time the infant has reached 18 months, calorie and protein requirements at this age are such that even a good yield of breast milk will not make a very large contribution to total requirements.

In many areas there is an impression that the quantity and quality of the milk decline significantly from six months onwards. In the Gambia there was clear evidence that dyspigmentation of the hair, and fibrosis of the liver as determined by biopsy, occurred from the age of six months onwards and even occasionally from the age of four months in children who were fed apparently exclusively from the breast. Platt<sup>56</sup> states that until the age of four months the weight-curve of African babies corresponds to that of English babies ; after this the former falls off in comparison with the latter. This suggests that human breast milk in the Gambia declines in quality from at least the six-month period of infancy if not from the four-month period and possibly earlier. It seems probable that the decline is in quality rather than in quantity, because breast-fed children of about six months with dyspigmented hair observed during the survey in numerous villages in this neighbourhood were certainly not grossly underweight and appeared to be moderately well nourished.

Other evidence has been obtained that the supply of breast milk sometimes becomes inadequate at an early stage of infancy. Vincent, working in Usumbura in Urundi, has reported (personal communication) that mother's milk often becomes insufficient towards the fourth and fifth month. Supplies of cow's milk are very small in the plains in this part of Africa

and such milk cannot be obtained by poor families. Vincent has therefore attempted, with some success, to supplement cow's milk with "milk" prepared from ground-nuts. Among certain pastoral tribes in Urundi, breast milk is supplemented as soon as the infant has reached the age of three months by cow's milk diluted with water.

The growth curves of infants in the Tshela region, Mayumbe, Belgian Congo, show the characteristic decline at the age of six months and suggest an insufficiency of breast milk and lack of suitable foods to replace it (Platel & Vandergoten<sup>54</sup>). Aubry<sup>5</sup> has stressed the fact that in St. Louis, Senegal, the yields of breast milk by lactating women are generally insufficient. Pieraerts<sup>53</sup> states that in the province of Kasai in the Belgian Congo the nutritional state of many lactating women is poor, and expresses the view that in the circumstances the quantity and quality of breast milk cannot be satisfactory.

**TABLE I. COMPOSITION OF MILK OF AFRICAN WOMEN COMPARED WITH THAT OF EUROPEAN WOMEN**

Period of lactation		African women			European women
		g per litre			g per litre
		maximum	minimum	average	average
10 days	fat	84.40	11.50	51.94	31.62
	casein and albumin	34.96	2.15	17.51	15.86
1 month	fat	89.60	27.40	52.40	
	casein and albumin	21.20	7.94	14.55	
2-9 months	fat	97.20	11.00	47.43	34.79
	casein and albumin	25.79	3.18	12.38	12.31

Some information is available on the composition of the milk of African women during various stages of lactation. In Dakar, Dufour & Gourry<sup>21</sup> have demonstrated the excessive richness in fat of the milk of African mothers, as shown in table I.

Delon<sup>17</sup> has recently reported a condition occurring among Moslem infants in Casablanca which she has called "la maladie œdémateuse du sevrage". The breast milk of a mother with an infant of twelve months suffering from what appears to be kwashiorkor was analysed and found to contain 5% of fat and 1.2% of proteins, indicating an abnormal fat-protein ratio.

In the Gold Coast, du Sautoy makes a clear and important distinction between food given for nourishment and food given as a "comforter". This applies both to breast milk and to supplementary foods. Putting the child to the breast from the age of two years onwards and even perhaps at earlier ages really means using the nipples largely as a comforter or dummy, although it is possible that small quantities of protein and even other nutrients are obtained (which may not be without influence on nutrition).

Throughout Africa (except among a very small group of civilized and educated Africans) breast feeding is given "on demand" rather than according to a time schedule. The practice of giving it "on demand" is often continued to a remarkably advanced age.

The period at which supplementary feeding begins varies considerably from region to region. It must be emphasized here that African infants after weaning pass abruptly to a diet composed of the ordinary foods of the family, which are mainly starchy foods and rarely or never include milk. This is in contrast with infants of western civilization who pass by degrees from a regime of breast milk to a mixed diet through the introduction into their diet of carefully prepared and selected foods specially suited to the growing organism, among which cow's milk always occupies a prominent place.

Throughout most of Africa, cow's milk is available only in insignificant amounts either because of trypanosomiasis among the cattle or because of poor milk-yields. In one or two areas it is reported that weaning infants are given a prior claim on whatever milk is available, but in most areas there seems to be no tendency to reserve scanty milk supplies for this purpose. For example, Pales<sup>50</sup> has reported that on the coast of French Guinea, below Fouta Djalon, there are numerous migratory herds which belong to the "Bowe Foulahs". The milk of these herds, which is produced in small amounts, is consumed by the Foulah herdsmen and by the indigenous people of this territory, the Landouma, to the extent that they can afford to buy it. It is consumed by adults and old people and not by children.

However, in some of the pastoral areas where cows thrive reasonably well, milk is used for the feeding of infants. This has reached its highest development in Ruanda-Urundi among the Batussi, a pastoral people originating in the Nile region. Here cow's milk is so highly prized that among certain clans the children of chiefs are said to receive practically no food other than cow's milk, except perhaps cheese and bananas, up to the age of 7-10 years, and sometimes 15 years. Among most of the Batussi, cow's milk is regarded as "royal food" for infants. In one clan, the Abezi of Urundi, this attitude reaches its extreme, the child never being put to the breast but being fed on cow's milk from the beginning of life. The Batussi are, however, the aristocrats of Ruandi-Urundi, constituting only

7% of the population. The remainder of the people in this over-populated area seldom, if ever, have the opportunity to consume cow's milk.

Among the Masai in Kenya it is reported (Wright—personal communication) that

“the child is weaned as soon as the mother has reached the third month of her next pregnancy ; this is usually about three years after the birth of the child. She will start giving the baby cow's milk mixed with some roots of a certain tree called Olpande, which prevents the milk from curdling”.

The child is given this mixture up to the age of 4 or 5 years. “In addition to the milk mixture fat is given, about a mouthful daily, to act as a purgative and produce a soft motion. Other foodstuffs (e.g., gruel, bananas, etc.) are not given to children.” It is reported that kwashiorkor never occurs in this tribal group.

In many areas covered by the survey, particularly areas of high altitude and those in the more northerly latitudes, cattle are kept and infants are undoubtedly given cow's milk as a supplementary food in the post-weaning period. Milk yields are, however, often very low because of poor pasture and the widespread habit of valuing cattle for their number rather than for their quality. Even in these areas, therefore, the amount of cow's milk obtained by infants must be small according to European standards.

Goat's milk is scarcely ever consumed. Although questions were repeatedly asked in the areas surveyed, very little evidence was obtained that goat's milk is used to any important degree in infant feeding. It is often neglected as a source of food or regarded as unfit for human consumption. In general, goats have only enough milk for their kids. It must also be remembered that herds of goats are often, like cattle, regarded as symbols of wealth to be multiplied and accumulated like other material treasure, and not as sources of meat and milk.

Both the time at which supplementary feeding begins and the nature of such feeding vary from area to area. In the Gold Coast supplements are usually given from the age of about six months. Platt informs the authors that in the Gambia supplementary feeding seldom starts before the age of six months although, as already stated, some starchy gruel may be given as early as the third or fourth month. He holds the view, based on experience in different parts of Africa, that in the eastern half of the continent there is a tendency to introduce supplementary feeding much earlier. This is confirmed by Wright in Kenya and by many witnesses interviewed. The most striking example of early supplementary feeding comes from the Kipsigis people in Western Kenya. It was reported by a hospital-assistant trainee belonging to this tribe that after ten days the child is given gruel which he is forced to take by pressing his nose so that he cannot breathe and must swallow. Reports of this remarkable method of supplementary feeding were gathered in interviews with various witnesses during the survey, particularly in the eastern half of the continent. Wright

(personal communication) quotes the following statement about the Luo people of Western Kenya : " after three months the mother could start giving the child any soft kind of food which had been cooked as an adult's food. The mother does not mind much whether the child swallows the food given or not, but the child sucks it and when unable to swallow it spits the hard part out ". He reports that among the Kikuyu people (a group in which kwashiorkor is prevalent) " for a period after the child is born till it develops the first four milk teeth, the child is fed on breast milk and a soft kind of banana which is considered special for feeding small babies ". Another habit of the Kikuyu people is to give the child yams and bananas which have been masticated by the mother. A Kikuyu hospital assistant reported that at the age of about four to six months the mothers start feeding their babies with maize gruel and bananas in addition to breast feeding. The general impression formed is that on the eastern side of the continent it is usual to supplement breast feeding during the first six months of life, and occasionally as early as ten days, by methods which vary from tribe to tribe and from area to area.

Throughout the central and western part of the continent, on the other hand, the impression gained from numerous interviews was that the child is usually fed exclusively at the breast up to the age of about six months. After this, supplementary feeding is usually started, although the child is kept at the breast for a period of a year or more and receives some additional nourishment in this way. The nature of the supplementary foods and the method of preparing and giving them to the child vary considerably but in general there is little serious attempt to prepare special food for the weaning child.

Cereal preparations given to children are usually not malted. However, certain tribes follow the custom of allowing certain cereals (millet, sorghum) to germinate, and sometimes cereal mixtures are fermented. Among fermented preparations are the "rouye" of the Ouoloff people in Senegal which is made from millet ; a paste of germinated sorghum made by the Bahutu in Urundi ; and "luku", a fermented preparation of manioc flour which is used in Kwango in the Belgian Congo.

Some families among the Bahutu in Ruanda, who do not possess cattle, give banana juice or the water in which unfermented sorghum has been cooked to infants at an early stage of life. Towards the age of seven months infants may be given baked bananas to which are added a little later baked potatoes, cooked pumpkin, and paste of a very fluid nature made of sorghum. Still later a little boiled maize is added to the diet, with some green and leafy vegetables, taro, and the leaves and flowers of pumpkin. At about two years of age the infant is completely weaned and begins to take banana beer and beans. From this period of life onward, the child receives the ordinary diet of adults. It may be added

that while kwashiorkor exists among the Bahutu, it does not appear to be very common in this group.

Aside from such exceptions, the general habit of most parts of tropical Africa is to give young children the portions of the foods prepared for adults which seem to be most digestible and which require least mastication.

Kwashiorkor is highly prevalent in the Kwango and Kasai provinces in the south-west part of the Belgian Congo. In these areas manioc is the staple and indeed often almost the only food. The authors were informed by Pieraerts that, in Kasai, infants of three months of age are literally stuffed with manioc flour, in the form of fermented paste of "luku". In addition, the infant may receive breast milk up to 18 months or two years, if the mother does not become pregnant; if she does become pregnant before the infant reaches one year, this means the cessation of all breast feeding and usually the death of the infant.

A little to the west of Kasai, in the Kwango province, and particularly in the regions of Masi Manimba, Kikwit, and Feshi, infants under one year are given "luku" or more rarely "chicouangue", a preparation of fermented and cooked manioc. When, before reaching the age of two years, infants begin to subsist on the ordinary daily food of adults, they receive manioc and baked or boiled plantains, supplemented occasionally by small quantities of beans, fish, or mangos when in season, but never by milk or meat. These facts about infant feeding in Kwango were supplied by doctors working for the Fonds Reine Elisabeth pour l'Assistance médicale aux Indigènes (FOREAMI).

Essentially similar accounts of methods of infant feeding were obtained in Leopoldville, in Nigeria, and in the Gold Coast. The infant during the period of weaning receives gruels of various kinds made from manioc, maize, plantains, or yams. These gruels are usually boiled for long periods. Children of two years of age, showing typical kwashiorkor, seen at Accra in the Gold Coast, had been fed on maize gruels which are called locally "arkassa" and "kenki". Arkassa is a watery maize gruel while kenki is a thicker maize paste which is cooked several times. These children developed kwashiorkor a short time after breast feeding had ceased. At Kumasi in Nigeria infants receive more or less the same foods, i.e., arkassa, kenki, fufu (a local term for gruel made from manioc, yams, and other starchy foods), and ampese (boiled bananas). Typical cases of kwashiorkor aged three years have usually subsisted for some months on these foods with the addition of some papaya from time to time. The authors also observed kwashiorkor in children aged two years who had been subsisting for several months on yams, coco yams, white bread (made of imported flour), and white rice, with an occasional meal of soup. In other characteristic cases occurring in younger children aged about one year, the diet had been composed of some breast milk supplemented by arkassa and fufu and now and then by a few spoonfuls of soup based

on red palm-oil and containing egg-plant, okra, a few small crabs, and chillies.

These examples of feeding practices during weaning suggest that the infant is given the kinds of foods which its parents think are the easiest to digest. The latter tend to confuse the actual entrance of food into the stomach with digestion and imagine that as long as food can pass down the infant's gullet it will be digested. The infant is therefore given soft foods which are easy to masticate. The treatment which such foods receive both before and during the process of cooking, in order to make them more "digestible" in the sense referred to above, may often reduce their content of nutrients, which is not very high even before they are prepared for consumption.

In French West Africa, complete weaning usually takes place between 18 months and two years, if another pregnancy does not intervene to stop lactation. But from the age of six months the infant receives gruels of boiled and fermented millet (*rouye*). It is the habit to respond to all the infant's desires and needs; thus, not only is it put to the breast when it cries but it is also given snacks from the family food. After about eighteen months it is fed entirely on adult food. This consists of a basic dish composed, according to area, of cereals, millet, sorghum, or rice, or of roots and tubers, including manioc, sweet potatoes, taros, and yams, supplemented by a stew whose composition varies from place to place and from tribe to tribe and also varies in accordance with the economic condition of the family. In general, it is composed of vegetable fats, abundant condiments, and mucilaginous products, with the addition of small amounts of vegetables. Sometimes, though rarely, a little meat or fresh or dried fish is added. In some areas this strongly spiced stew is given to all young children. In Dakar, many doctors consider it responsible for the severe gastrointestinal upsets and diarrhoea from which many children who are brought to dispensaries suffer; indeed, they regard it as the cause of practically all the cases of kwashiorkor which occur in this part of Africa.

Among other causes of intestinal irritation is the common African practice of giving children frequent enemas. The authors were informed in the Gold Coast and in Senegal that three to five bowel motions per day are regarded as the normal number by mothers. If young children aged one to three years pass a smaller number they are considered to be constipated and are given an enema, which is administered in a picturesque way by means of a long pear-shaped gourd with a hole at each end. The most pointed end of the gourd is introduced into the anus, the child being held by its feet, head down with the legs apart, while the operator blows into the other end of the gourd. The enema fluid may sometimes be relatively innocuous, e.g., warm water containing red palm-oil, but more often it is rendered strongly irritating by the inclusion of red pepper. It is reason-



able to conclude that the practice of giving such enemas, which always achieve "results", leads to irritation of the mucosa of the large intestine.

"Digestive troubles" appear to be a frequent cause of mortality among infants and young children. This is illustrated by some figures relating to St. Louis in Senegal presented to the Inter-African Conference on Food and Nutrition by Aubry.<sup>5</sup> She reported that from 30% to 60% of all deaths in infants between the ages of one month to three years were due to acute or chronic lesions of the digestive tract. The peak in mortality from this cause occurred between the ages of 6 to 30 months.

The above account of the feeding of infants during the period of weaning shows that the infant begins fairly quickly to consume the ordinary food of the family. But for a long time after this stage is reached it does not succeed in sharing fully in that food. When it begins to compete for its foods with other members of the family around the family dish, it does not secure the best portions. It is the privilege of adult men to help themselves first and to take the pieces of meat or fish which the dish contains. This is not evidence of negligence on the part of the parents. African parents love their children, but it is the general custom among all poor people—and not only in Africa—to allow the breadwinner to obtain the best of whatever food is available. Since the family has often insufficient food to cover its needs completely, the young child is likely to secure only starchy parts of the dish of which it often wastes a large portion. The growth curve of children up to the age of seven or eight years reflects the defects of its diet both in quantity and in quality. The diet of boys tends to be more deficient than that of girls since the latter, remaining in closer contact with the mother, are often able to secure additional morsels during the preparation of meals. Later, children are able to get more and better food, both by obtaining a more adequate share of family meals and by seeking foods to supplement their diet in the fields and the forests.

This section would be incomplete without reference to the diet of pregnant and nursing women. Throughout most of tropical Africa these women do not receive any special kind of diet. They continue to work in the home and in the fields until delivery. When the child is born the mother resumes her ordinary heavy activities after an interval of not more than one or two days. Her diet during lactation remains the ordinary diet of the family. In rare circumstances mothers are the object of special care during the three months after childbirth and are given what are considered to be the best portions of the family food, resuming work in the fields only when the baby has reached six months of age. The authors were informed by Dr. Ofori Atta, an African lady doctor in charge of a children's ward in the Kumasi Hospital, that this happens in the Gold Coast. In other regions, there is a tendency for the amount of food consumed by pregnant and lactating women to be increased in quantity; this means in practice

an increase in intake of starchy foods which in tropical Africa ordinarily supply about 80% of the total calorie value of the diet.

In general, then, no attempt is made to improve the diet of pregnant women, so that the infant is likely to be handicapped by the defects of its mother's diet when it first arrives in the world. Similarly, the diet of lactating women is not supplemented and this must sooner or later affect the quality of breast milk and the state of nutrition of the nursing infant.

Records of the weight of infants in child-welfare clinics at Bathurst and in various rural areas in the Gambia show that birth-weights are lower in the rural areas, particularly in autumn and winter.<sup>56</sup> This reflects the dietary privations of mothers during the "hungry" months preceding the harvest. The birth-weight of children in clinics in Bathurst did not show this seasonal fluctuation since urban wage-earners do not pass through the "hungry" periods which occur in rural areas. An investigation made in Haut Nyong in the French Cameroons in 1946 showed that a period of rest on the part of the mother before delivery had a favourable effect on the condition of the newborn infant and that birth-weight increased in accordance with the length of this period.<sup>30</sup>

The following is a summarized account of the nutrition of young African children and the various factors which influence it :

African mothers do not receive a special supplement to the diet during pregnancy and lactation. The birth-weight of African infants is, in general, below that of European infants. Breast feeding allows the infant to grow fairly normally during the first few months of life. When breast feeding becomes insufficient, which often happens before the fourth and sixth months, the infant's diet is supplemented by gruels of cassava, bananas, maize, sweet potatoes, millet, or rice, all essentially foods rich in carbohydrate and poor in proteins, vitamins, and mineral salts. This practice is continued and extended during the period of weaning. The infant is hardly ever given animal milk at this period. On exceptional occasions it may receive a little meat or small amounts of fish. Fruits (mango, papaya, oranges, etc.) may be included in the diet from time to time when in season and the same may be said of green vegetables, which are usually given in soup. The infant partakes of stews containing different ingredients, including chillies, which are likely to do it more harm than good. Towards the age of two or three years, the young child receives the ordinary adult diet which is in general better than the gruels which before this were its chief food. While its diet remains unsatisfactory in quality and sometimes in quantity, the soup and the inevitable stew which it consumes contain, in small quantities, vegetables and a variety of other foods, such as beans and peanuts, fish fairly frequently, and sometimes meat. But for a long time the child may be unable to compete with its elders in securing an adequate share of food from the family dish, and in obtaining the quantities of protein needed for growth. It is only when it reaches the age of seven

or eight years that its increasing status in the family and its activities outside the home (which enable it to obtain additional foods, such as grubs, etc.) make it possible for its nutritional needs to be more adequately covered.

## 2.2 Relation between Kwashiorkor and Diet

The aim of the survey was not to solve the problem of kwashiorkor ; such an aim would have been pretentious in the circumstances. It was rather to collect facts and present them for consideration and discussion. There is at present insufficient knowledge of the physiological and pathological changes which underlie the syndrome, and this aspect of the problem can be elucidated only by detailed clinical and laboratory research. Further, the information available on food consumption in Africa is at present inadequate. Some dietary surveys have been made during recent years but it is difficult, if not impossible, to estimate food consumption in quantitative terms. The foods eaten at home represent only a part of daily consumption and an account cannot easily be taken of foods obtained and eaten away from home, e.g., leaves, small rodents, and insects. Moreover, the mode of life and social customs of African cultivators make any exact appraisal of food consumption difficult.

Knowledge of the nutritive value of African foods is steadily increasing but still remains insufficient. In particular, little is as yet known of the amino-acid content of the proteins in the vegetable and even animal foods which are included in African diets.

It should be possible to make some satisfactory dietary surveys in areas in which kwashiorkor exists and in which the supply and variety of foods are limited. In particular the food consumption of young children, at least during the period of weaning, could be investigated without serious difficulty.

In the existing state of knowledge, it is hard to establish a precise relation, in scientific terms, between kwashiorkor and nutritional factors. But it is nevertheless possible to reach certain tentative conclusions. The general experience of the doctors, missionaries, nursing sisters, etc., whom the authors met during the survey definitely indicates a relation between kwashiorkor and food-supply and dietary habits. A certain number of facts are available, some of which appear to be fully established while others are reasonably probable.

Kwashiorkor is not found among the Masai, a pastoral people in Kenya who consume milk, and meat occasionally. It is found among their neighbours the Kikuyu, a non-pastoral agricultural group living on the products of the soil. In the same part of Africa, the syndrome exists among the Wakamba who were once a pastoral people but are now cultivators. It does not exist among the Batussi of Ruanda-Urundi who are livestock raisers and consume much curdled milk. It is found among the Bahutu,

an agricultural people living among the Batussi, whose children consume, as their staple food, plantains, sweet potatoes, manioc, and maize. There is, however, little kwashiorkor among the Bahutu people who live on the plateaux where beans are an important part of the diet. The plateau areas of Ruanda-Urundi abound in beans. The authors saw there numerous varieties both of local origin and imported from Europe or from South America. According to Vincent (personal communication), kwashiorkor is not observed among the people living on the borders of Lake Tanganyika, but it is found at a distance of 10 km (about 6 miles) from the shore of the lake. The lakeside dwellers eat plenty of fresh and dried fish which is not available to people living a few kilometres inland. Similarly it has been reported by Pieraerts<sup>52</sup> that in the Kasai region the people living on the banks of rivers, which yield much fish, are free from the syndrome which is, however, found away from the riverside settlements.

In the western region in the Belgian Congo administered by the institution FOREAMI, of which mention has already been made (see section 2.1, page 35), there is no kwashiorkor in the forested valleys. G. Doucet & G. Drummel (personal communication) attribute its absence to the consumption of fish and particularly of beans, this being the only difference between the diet in these areas and in neighbouring areas in which kwashiorkor abounds. Parts of the plateaux above the forested areas may reach an altitude of 800 m to 900 m (2,625-2,950 feet); here there are no fish, no livestock, and not even beans. The staple food is manioc with some cultivated green leaves (usually manioc leaves), together with wild leaves and fruits.

The authors were informed by nursing sisters in the hospital at Leopoldville that around the mission stations there is relatively little kwashiorkor. The missions develop fruit-and-vegetable gardens and raise small livestock, and this example is followed to a varying extent by African families living in the vicinity.

Kwashiorkor is relatively rare in the north-east part of the Belgian Congo, where there is some livestock and where more millet is grown than in other parts of the Congo. It is also rare in Northern Nigeria, where there are herds of cattle and the staple foods are sorghum and millet, manioc and maize being of secondary importance. A few cases were seen in this region; the existence of these could perhaps be ascribed to a small localized famine in the area north of Kano resulting from a poor millet crop.

Pieraerts holds the view that in the Kasai area the incidence of kwashiorkor is in inverse relation to the amount of millet in the diet, the basic food in this area being manioc. This point, however, requires confirmation. The same worker states that malignant cases of kwashiorkor, such as those seen in the hospital at Luluabourg, do not occur among groups whose diet contains millet to the extent of one-fifth of the basic foods. This would not necessarily be in contradiction with the fact that kwashiorkor is found in Senegal among millet eaters. Account must be taken of absorption as well

as of food intake. Reference has already been made to the frequency of intestinal irritation in Senegal and its probable causes. The authors were struck by the very large number of cases of digestive and intestinal diseases among children of weaning age in Dakar and particularly among children attending the Roume polyclinic there. It may be added that severe kwashiorkor is not common in Dakar. In the principal hospital in Dakar, Bergeret has seen only 37 such cases in three years.

Kwashiorkor is frequently observed in Southern Nigeria. It is very common at Ibadan (Jelliffe) and Lagos (Cannon). Here the staple food of young children is manioc taken in the form of gari (a dry starchy preparation) and fofou (a dough-like preparation). The distribution of the syndrome within individual countries and territories is irregular, conforming with differences in diet. Thus Fitzgerald,<sup>24</sup> describing in 1938 a syndrome occurring in Southern Nigeria which strongly resembles kwashiorkor, made the following comment : " There is a shortage of animal proteins and fish proteins in Southern Nigeria. It is in those areas, or under conditions which permit this shortage, that this syndrome is found. By contrast in the fresh-fish-eating countries there is little evidence." He added that " 'gari' can be shown to have an almost constant relationship to the incidence of the syndrome where it is eaten to excess in the absence of protective foods. To a lesser extent this holds also of 'cassava fofou' ". In the Gold Coast, the foods which appear to be closely associated with a high incidence of kwashiorkor are a maize gruel which contains 90% water, arkassa, and kenke. Here manioc is also consumed in the form of gari, but apparently less frequently than other staple foods. Some authorities think that the consumption of manioc is the principal cause of kwashiorkor. Thus Clark <sup>12</sup> has written that " fibroid degeneration and fatty degeneration of the liver and kidney is common when they are both [coco-yam and cassava] eaten ", but that " fatty degeneration is less commonly met with in the British Cameroons where coco-yam but no cassava is eaten ".

In Liberia, according to Kittrell (personal communication), there is a deficiency of proteins as in most other parts of Africa. Kwashiorkor, however, appears to be rare. The staple food is home-pounded rice and no highly-milled rice is imported. It should, however, be said that the local doctors are not very familiar with the appearance of kwashiorkor and that the syndrome has therefore not been looked for to any extent. The authors saw in the hospital and a child's clinic in Monrovia only two cases resembling kwashiorkor in its early stages.

Finally, reference should be made to the influence of season on kwashiorkor. In many parts of the world there are seasonal fluctuations in diet, periods of abundance alternating with periods of privation. Such fluctuations are, however, particularly marked in Africa. The influence of the " hungry months " on the nutrition of mothers and the birth-weight of infants has already been mentioned. Raoult <sup>58</sup> has described the seasonal

incidence of vitamin-deficiency states in African children and Pieraerts,<sup>52</sup> in his investigations of seasonal changes in diet among the Bakwa-Meta—a people of the Lulua tribe living south of Luluabourg in the Kasai Province of the Belgian Congo—has recorded a high incidence of kwashiorkor during the hungry months. He has made the following comments on this point :

“ In Kasai the staple food is manioc. Manioc roots are taken from the ground as they are needed and, since the people plant at two different seasons of the year varieties which mature at different rates, manioc is harvested throughout almost the whole year. In order to make satisfactory ‘bread’, maize and millet are added to the manioc in the proportion of about one-third. But maize and millet are seasonal foods, the first harvest being in December, the second in April and May. During recent years the second harvest has failed in many villages. By July there are often no cereals in the village granaries, ground-nuts and beans have long since been consumed, and the ‘bread’ eaten until December is perforce composed solely of manioc. During the dry season, which lasts from the end of May to the end of September, supplementary vegetable foods—green leaves of various kinds and fruits—become progressively more scanty. On the other hand, a little—a very little—small game and sometimes fish remain available.

“ In September and October, a period of heavy rainfall, the grass grows quickly and the streams swell. There is no more hunting and fishing at this time, no berries, fruits, or insects. On the other hand mushrooms are consumed to some extent until the arrival of flying ants saves the situation in the last days of November. From September to December the diet consists of manioc bread (of which there is plenty) without cereals or supplementary foods except for a handful of manioc leaves or mushrooms which are cooked with palm-oil and red pepper. At this time ‘diboba’ [kwashiorkor] abounds.”

After these examples of poor nutrition, two examples of good nutrition may be given. Others could be added, but there would be no point in multiplication. Basse-Casamance in Senegal, lying between the Gambia and Portuguese Guinea, is an area in which there are plenty of fish, crabs, and oysters. Bergouniou reports that here there are no serious food-deficiency states, and in particular no kwashiorkor among young children. Oysters and fish form the basis of the diet. Pales<sup>50</sup> comments as follows on the diet and state of nutrition of the Boyas of French Guinea who inhabit the coast between Victoria and Conakry :

Molluscs and crustaceans, which are consumed in small daily amounts but regularly every day, make an important contribution to the diet. There is no doubt that the good health of children and adults is partly due to the composition of these foods.

In this part of Africa the staple food is rice. Pales has expressed the view that the local diet consisting of rice, red palm-oil, fish, and crustaceans makes it possible for the people, living in a marshy country, to resist malaria and to maintain, in spite of malaria, a good state of health.

After having made a rough classification of the foods which are and which are not kwashiorkor-producing—a classification based on the impressions of doctors and on clinical observations—it will be of interest to discuss this in terms of the nutrient composition of these foods. As has been said, it is difficult to estimate the nutrient content of actual African

**TABLE II. PROTEIN CONTENT OF GROSS AND NET QUANTITIES OF FOODS YIELDING 100 CALORIES**

Food	Gross weight yielding 100 Calories (in grams)	Net weight yielding 100 Calories (in grams)	Proteins per 100 Calories (in grams)
Beef (thin) . . . . .	61.7	50.5	9.6
Pork . . . . .	26.0	22.0	2.6
Fish, fresh, fat-rich . . . . .	112.0	56.7	11.4
Fish, dried . . . . .	55.5	38.3	15.3
Milk, whole, fluid, 3.5 % fat . . . . .	153.8	153.8	5.4
Milk, skim, dried . . . . .	27.7	27.7	10.0
Wheat flour (medium extraction) . . . . .	28.6	28.6	3.34
Millet ( <i>Eleusine coracana</i> ) . . . . .	30.1	30.1	2.0
Millet ( <i>Setaria italica</i> ) . . . . .	29.1	29.1	2.9
Millet ( <i>Pennisetum glaucum</i> ) . . . . .	27.8	27.8	3.4
Millet (unspecified) . . . . .	29.4	29.4	2.9
Sorghum ( <i>Sorghum vulgare</i> ) . . . . .	29.1	29.1	2.9
Maize (whole meal) . . . . .	27.7	27.7	2.6
Rice (home-pounded) . . . . .	27.8	27.8	2.0
Rice (milled, white) . . . . .	27.8	27.8	1.7
Cassava (fresh) . . . . .	91.2	68.4	0.83
Cassava (meal and flour) . . . . .	29.5	29.5	0.44
Yams . . . . .	113.0	95.0	2.3
Taros . . . . .	115.0	98.0	1.7
Sweet potatoes . . . . .	103.0	85.0	1.1
Plantains, fresh . . . . .	133.0	89.0	1.0
Beans and peas (different species) . . . . .	28.9	28.9	6.4
Soya (whole seeds, dry) . . . . .	29.8	29.8	11.3
Voandzou ( <i>Voandzeia subterranea</i> ) . . . . .	32.0	28.8	5.7
Ground-nuts . . . . .	25.7	18.3	4.7

diets because quantitative data, such as those obtained by dietary surveys, are not available. Accordingly, a unit of "100 calories" has been adopted for comparing different foods. The protein content of a number of important African foods per 100 calories is shown in table II, calorie values being calculated by the method recommended by FAO.<sup>25</sup>

The supplementary foods obtained by young African children during the weaning period are composed largely of carbohydrates. During this period needs for proteins are relatively high and it can be shown that these are not adequately met. The tabulated data which follow show that child-

ren's diets composed of starchy gruels and containing no milk or fish are deficient in protein. The protein-requirement figure recommended by the League of Nations is taken as the basis of comparison.

Daily requirements <sup>e</sup> of the African child at the age of :	<i>12 months</i>	<i>18 months</i>	<i>2 years</i>
calories	730	860	1,000
protein	20 g	25 g	30 g
Daily production of mother's milk :	1,000 g	500 g	0 g
supplying :			
calories	630	315	0
protein	14 g	7 g	0 g
Additional foods in the diet must supply :			
calories	100	545	1,000
protein	6 g	18 g	30 g
Calories required from additional foods can be supplied by one of the following :			
millet	29.1 g	158.6 g	291.0 g
maize	27.7 g	151.0 g	277.0 g
plantain (fresh)	89.0 g	485.0 g	890.0 g
cassava flour	29.5 g	160.0 g	295.0 g
These amounts will provide vegetable protein in the following daily amounts :			
millet	2.90 g	15.8 g	29.0 g
maize	2.60 g	14.1 g	26.0 g
plantain (fresh)	1.00 g	5.4 g	10.0 g
cassava flour	0.44 g	2.4 g	4.4 g

It is clear that the diet of African children becomes deficient in protein at an early stage of life. This deficiency cannot be made good by occasional soups containing small quantities of fish and beans.

The above figures indicate that there is a deficiency of protein in the child's diet at an age when kwashiorkor appears. Can this deficiency be expressed in terms of amino-acids? The lack of information on the actual food consumption in Africa, and on the composition of foods and the amino-acid content of their proteins makes any assessment of the amino-acid content of diets very approximate. However, it is possible to make some rough calculations from the data contained in the *Food balance sheets* published by FAO.<sup>27</sup> These *Food balance sheets*, based on statistical information provided by governments, indicate the available foods per person per day in a given country. It must be remembered that the figures presented in the sheets are only averages for the population as a whole and therefore do not take into account the wide differences between the

<sup>e</sup> These estimates of requirements are based on the recommendations of the League of Nations<sup>44</sup> and the US National Research Council.<sup>47</sup>



TABLE III. DAILY PER CAPUT CONSUMPTION (IN GRAMS) OF 10 ESSENTIAL AMINO-ACIDS IN DIFFERENT COUNTRIES

Country :	Daily intake															
	Essential amino-acids					Proteins										
	Source															
	Arginine	Histidine	Iso-leucine	Leucine	Lysine	Methionine	Phenylalanine	Treonine	Tyrophane	Valine	Animal	Veget- able	Total	Animal	Veget- able	Total
Algeria . . . . .	2376	1.135	2.343	4.038	2.045	0.840	2.510	1.714	0.642	2.627	5.011	15.259	20.270	9.9	40.8	50.7
Tunisia . . . . .	2.067	0.963	1.997	3.202	1.802	0.705	2.141	1.464	0.592	2.205	4.241	12.887	17.128	8.4	35.2	43.6
Morocco . . . . .	3.436	1.639	3.436	6.158	3.247	1.263	3.465	2.527	0.873	3.562	10.823	19.083	29.906	21.4	48.4	69.8
Libya . . . . .	3.403	1.426	3.190	4.951	3.213	1.188	3.148	2.391	0.951	3.490	11.875	15.476	27.351	23.6	40.4	64.0
Madagascar . . . . .	3.817	1.451	3.221	5.372	3.456	1.372	3.029	2.560	0.830	3.814	12.871	16.051	28.922	25.6	35.7	61.3
Mauritius . . . . .	2.557	1.084	2.160	3.726	2.028	0.837	2.282	1.664	0.587	2.516	4.733	14.708	19.441	9.6	37.2	46.8
Southern Rhodesia . . . . .	3.297	1.695	3.059	8.014	2.794	1.362	3.226	2.626	0.623	3.738	8.178	22.156	30.434	16.3	51.7	68.0
Kenya-Uganda . . . . .	3.297	1.333	2.678	4.866	2.884	1.055	2.581	2.222	0.728	3.081	6.911	17.814	24.725	13.8	42.9	56.7
Tanganyika . . . . .	3.640	1.349	2.770	4.678	2.959	1.056	2.807	2.256	0.790	3.240	6.156	19.389	25.545	12.3	46.3	58.6
Egypt . . . . .	3.95	1.75	3.28	7.25	2.84	1.25	3.64	2.65	0.79	3.95	4.7	26.6	31.3	9.3	64.2	73.5
Chile . . . . .	3.61	1.61	3.21	5.18	3.12	1.28	3.31	2.46	0.86	3.51	10.5	17.6	28.1	21.1	47.8	68.9
Indochina . . . . .	3.39	1.11	2.37	4.16	2.35	1.04	2.37	1.98	0.68	3.04	6.0	16.5	22.5	12.1	36.3	48.4
Java and Madura . . . . .	3.00	1.07	2.12	4.43	1.97	0.89	2.30	1.83	0.56	2.74	2.2	18.7	20.9	4.4	41.9	46.3
India and Pakistan . . . . .	3.52	1.28	2.69	4.76	2.49	0.97	2.82	2.11	0.75	3.29	4.2	20.5	24.7	8.3	47.8	56.1
<b>Normal requirements :</b>																
According to Rose <sup>66</sup> . . . . .			1.4	2.2	1.6	2.2	2.2	1.0	0.5	1.6						
According to Stare et al. <sup>68</sup> . . . . .	1.8	0.5	1.3	3.6	1.4	1.4	1.4	1.2	0.4	1.3						
<b>3 villages in Northern Nigeria :</b>																
Bida . . . . .	3.601	1.687	3.223	7.046	2.274	1.278	3.038	2.810	0.843	3.869	2.547	27.122	29.669	5.33	66.36	73.69
Kontagora . . . . .	4.105	1.956	3.756	8.802	2.297	1.437	3.604	3.291	0.963	4.563	0.570	34.204	34.774	1.20	85.69	86.89
Zuru . . . . .	4.294	2.050	3.999	9.117	2.443	1.551	3.757	3.488	1.053	4.824	1.260	35.316	36.576	2.55	89.13	91.68

food supplies of the poor classes who suffer from kwashiorkor and those of the well-to-do class. Nor do they indicate the supplies available to the groups in the population with the greatest protein needs such as lactating women, children, and adolescents.

Some information is available on the amino-acid requirements of the normal adult, but the needs of the child during the vulnerable period of growth and of the pregnant and lactating woman have not been defined.

In spite of these drawbacks, an attempt has been made to calculate the amounts of the indispensable amino-acids in the daily food supplies in a certain number of countries of Africa for which food balance-sheets have been prepared. Table III shows the results. For comparison, figures have been given for certain other countries where the consumption of proteins is low. Kwashiorkor or a similar syndrome has been observed in some of these countries, namely : Egypt,<sup>36</sup> Morocco,<sup>17</sup> Chile,<sup>61</sup> India,<sup>1, 61</sup> and Indochina.<sup>7, 47, 48, 49</sup> The estimates of adult amino-acid requirements shown in table III are those of Rose<sup>59</sup> and Stare et al.<sup>63</sup>

As has been said, there are few published results of dietary surveys in Africa. One survey, which was done by Nicol,<sup>46</sup> made it possible to calculate the approximate amino-acid content of the daily diet for three villages in Northern Nigeria. These figures are also shown in table III.

The following comments on the data given in table III may be made :

(1) In the African countries listed, despite the fact that in some of them cattle are raised (Madagascar and Kenya), the average daily content of methionine in the diet is very low and definitely below even the most modest estimate of needs. Apart from methionine, which is here the limiting factor for the utilization of the proteins, the amounts of tryptophane and lysine are on the low side in relation to estimated requirements.

(2) In the three villages in Northern Nigeria, a region where conditions are relatively favourable, where the diet is based on sorghum and millet and where there is no kwashiorkor, the amounts of methionine are greater than the average amounts for other African countries, and are close to the value given by Stare for adult requirements. For the other amino-acids, including tryptophane, the values are satisfactory.

It is unjustifiable to draw definite conclusions about the etiology of kwashiorkor from these observations. They may, however, stimulate discussion. It is hoped that workers in Africa and elsewhere will collect further data which will enable the possible relation between kwashiorkor and amino-acid deficiency to be more fully studied.

### 3. ETIOLOGY OF KWASHIORKOR

There seems little doubt that the syndrome is due to deficiency in the diet of some factor or factors which are ordinarily supplied by foods containing animal protein or certain of the vegetable proteins of higher biological value. The most obvious protein factors to be considered are certain of the amino-acids, particularly methionine. But the diets of Africans, and especially of African children, are never deficient in only one nutrient. In addition to the very marked deficiency in animal protein, there is a deficiency in vegetable proteins, in minerals, and in vitamins (mainly in riboflavine and niacin and sometimes in vitamin A in areas where there is no palm-oil available). It should be added that these are the only vitamin deficiencies which have been looked for and that an interrelationship exists between certain vitamins and amino-acids. It would, therefore, be a mistake to conclude at this stage that the syndrome is due only to deficiency of one or more amino-acids. Factors such as vitamin B<sub>12</sub>, vitamin E, and pantothenic acid need to be taken into account, as at least contributory factors concerned with one or more of the special features of the syndrome. For example, pantothenic-acid deficiencies might well be considered in relation to the dyspigmentation of the hair, at least in one of its varieties.

Waterlow<sup>72</sup> has shown that the "fatty liver disease" of the West Indies is not curable by treatment with choline nor inositol, at least in the therapeutic doses given by him. Many workers have shown that kwashiorkor cannot be cured by any combination of vitamins and therapeutically it is doubtful whether any vitamins are really required in addition to milk protein followed by a good all-round diet. The claim by Gillman & Gillman<sup>34</sup> that kwashiorkor is curable with a gastric factor, ventriculin, is contrary to the findings of other workers.

Conjecture can be very considerably narrowed by recognizing the remarkable therapeutic effect of milk protein. The missing factor or factors, whatever they may be, are presumably contained in dried skim milk (see section 1.5). But it must be said also that in the stage of "malignant malnutrition", the good results obtained by feeding patients with skim milk may be due partly to the fact that the milk does not require the intervention of pancreatic enzymes to be digested.

An interesting aspect of the problem is the qualitative change which may occur in the breast milk of malnourished mothers. It seems clear from the work of Platt's unit, and particularly from the studies of Waterlow (personal communication), that dyspigmentation of the hair and fibrosis of the liver can develop in infants at the age of six months and possibly even earlier while the infants are still getting the whole of their food intake from the maternal breast. This would indicate that the factor or factors,

deficiency of which is responsible at least for dyspigmentation of the hair and fibrosis of the liver, may be missing from, or deficient in, the maternal milk during the first six months of lactation. Auffret & Tanguy<sup>6</sup> have reported a low methionine content in the maternal milk of Africans at Dakar (average, 0.164 g per litre) as compared with average figures (0.290 g per litre) reported from studies of the milk of European mothers carried out elsewhere. Confirmation of this finding is badly needed. Auffret & Tanguy did not test the milk of European mothers as a control of their method.

The authors support the opinion expressed by the Joint FAO/WHO Expert Committee on Nutrition that the syndrome is not pellagra and should not be referred to as infantile pellagra. The principal reason for this conclusion is that it is not curable by treatment with niacin without milk protein. While most workers hold the view that the dermatosis is closely related to that of pellagra, the syndrome can occur without pellagrous dermatosis. The same can be said for dermatosis of riboflavine deficiency.

Further discussion of the factor or factors in milk which are capable of curing the syndrome would at present be fruitless. The problem urgently needs solution, however, because of the need to find adequate milk substitutes.

In the recommendations made at the first session of the joint committee, one of the objectives laid down for the survey was to "define the part played by other factors, such as tropical parasitism, in determining the variations in clinical manifestations".<sup>75</sup> The authors feel that very little can be said on this point. On the one hand, the syndrome unquestionably occurs in Johannesburg among Africans, the great majority of whom have never been exposed to malaria, bilharziasis, filariasis, ankylostomiasis, nor leishmaniasis. Among these people there may be a small incidence of amoebiasis and ascariasis, but it is clear that tropical parasitism contributes little, if at all, to the production of the syndrome in that area.

On the other hand, the opposite view is widely prevalent and firmly held. It is based on the fact that evidence of the presence of one or more tropical parasitic diseases can be found at autopsy in practically every case of kwashiorkor in the area surveyed. The amount of weight attached to the parasitic factor in etiology varies from person to person. It was in the Gambia that the authors found the greatest emphasis placed on this factor. Platt & MacGregor (personal communication) both stress the probable role of parasitism, particularly malaria. In the children under the age of four years observed by these workers it is likely that malaria is universal, but is probably the only important parasitic disease. They point out that the age of maximum incidence of the syndrome is the age of relative absence of immunity to malaria. An interesting observation about the role of tropical parasites, which does not bear directly on the problem of kwashiorkor but may nevertheless be indirectly relevant, is one maintained in a report by G. Doucet (personal communication) of a field trial, extending

over four years and covering 2,000 children, in which the following three groups were compared :

- (1) a control group without any treatment ;
- (2) a group treated with paludrine or chloroquin daily ;
- (3) a group treated with the same daily antimalarial drug as that given to group (2) but also given a supplement of milk fortified with skim-milk powder and malt extract.

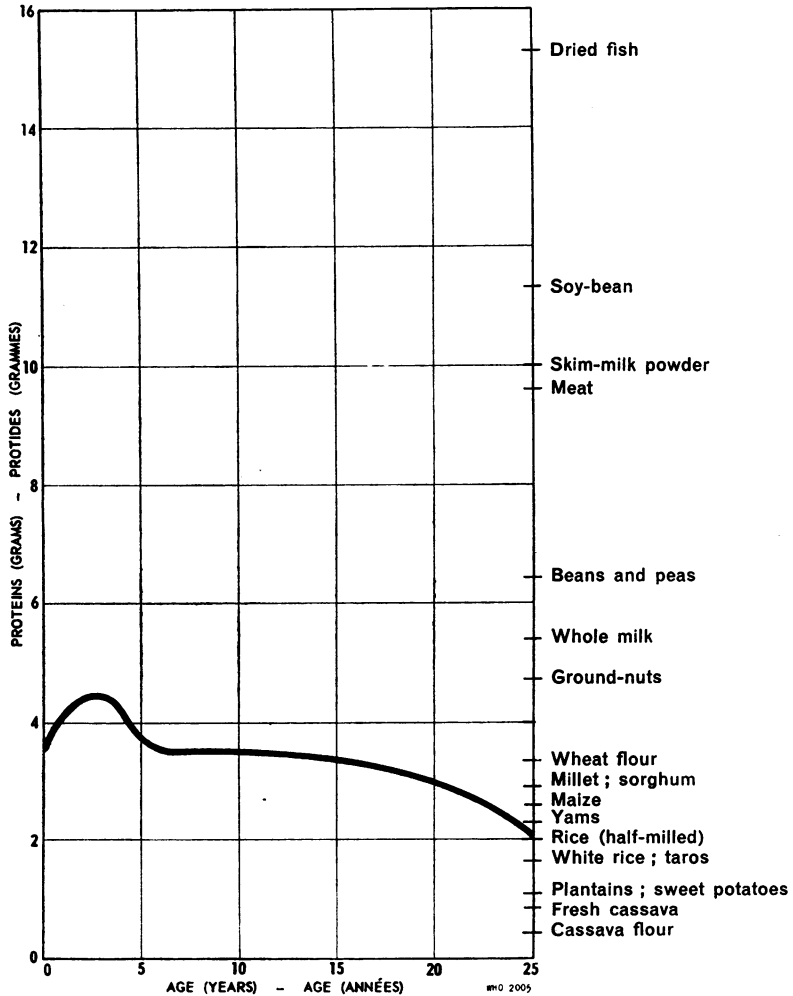
The weight gain in group (3) was 8.7% more than that in the control group, compared with 2.4% and 4.57% more for the children in group (2) receiving paludrine and chloroquin respectively. It was found that both the paludrine and the chloroquin had an important action against intestinal parasites as well as being antimalarial. While the respective values of anti-parasitic drugs and of feeding on weight gain cannot of course be directly applied to the problem of kwashiorkor, these observations are suggestive.

The conclusion of the authors is that whereas tropical parasites are probably always contributory to the etiology of kwashiorkor in the area surveyed and may sometimes play an important part, it is likely that the dietary factor is always dominant.

Finally, mention should be made of the severe diarrhoeas of bacterial or parasitic origin which are highly prevalent among children in some parts of Africa. These accelerate the passage of food through the intestine and reduce the absorption of nutrients. They may also change the intestinal flora and diminish the synthesis within the bowel of certain factors, for example of the following : betaine, of which choline is a precursor ; homocystine, which is a possible substitute for methionine in protein synthesis ; other still unknown factors which are synthesized by the intestinal flora and influence the utilization of homocystine.<sup>57</sup> But such speculations involve the still unproven assumption that deficiency of certain amino-acids, for example, methionine, or other lipotropic factors, such as choline, play a predominant part in the causation of kwashiorkor.

The relationship between protein deficiency, and hence of kwashiorkor, and customary African diets is illustrated in fig. 11. This is drawn up on lines adopted by Trowell but is based on the recommendations of the League of Nations for calorie and protein requirements, while FAO's *Food composition tables for international use* <sup>26</sup> were used in calculating the protein content of foods. Where foodstuffs containing more than 4 g of protein per 100 calories form a considerable part of the diet, there is unlikely to be deficiency of protein. When foodstuffs containing less than 2 g of protein per 100 calories constitute the staple diet, protein deficiency is almost inevitable unless the staple is supplemented by reasonable quantities of foods rich in protein. The areas, therefore, in which protein deficiency and kwashiorkor are likely to occur are those in which cassava, plantains, bananas, and sweet potatoes constitute the staple foods. Obviously the relationship between grams of protein per 100 calories and the incidence of kwashiorkor is not likely to be

FIG. 11. PROTEIN REQUIREMENTS PER 100 CALORIES, ACCORDING TO AGE



The yield of protein per 100 calories from some common foodstuffs is indicated on the right-hand side of the figure.

simple and direct, since one protein may contain a different pattern of amino-acids from another, and the biological value of the proteins will differ. The same may be said of the factor of digestibility which is not taken into account in the diagram. Thus, milk is more protective than beans, although it has a lower ratio of protein to calories than beans. The epidemiological evidence also suggests that maize is less protective than rice, or at least than home-pounded rice, although its content of protein per 100 calories is greater than rice.

Fig. 11 also shows that protein requirement per calorie is higher in infants than in children and adolescents and higher in children and adolescents than in adults. The shape of this curve may explain in part the preponderance of kwashiorkor in the first five years of life. An additional reason for this age incidence, however, is that cow's milk, normally the most convenient source of protein for the child during the post-weaning period, is not available in the tropics of Africa. Its absence is probably among the important causes of the prevalence of the syndrome.

The impression gained during this survey, and also that of many observers, is that deficiency of protein is common in the diet even of adults in Central Africa. This is confirmed to some extent by unpublished nitrogen-balance studies of Holmes. He finds that adult Africans may continue for three months on a high protein diet before attaining nitrogen equilibrium. It is possible, however, that their nitrogen deficiency may not be so severe as is indicated by these findings. It has been suggested by Platt that the apparent deficit may be caused in part by inability to utilize protein in the absence of other nutritional factors, possibly trace elements.

#### 4. PREVENTION OF KWASHIORKOR

The account given in previous sections of food consumption and dietary habits indicates the measures needed for prevention. The main points may be recapitulated here :

(a) There is an almost complete lack of animal protein in the diet of young children as soon as the supply of breast milk gives out. This is combined with insufficiency of vegetable protein.

(b) Foods containing animal proteins—milk, meat, and fish—are protective against kwashiorkor.

(c) Certain vegetable foods rich in protein—beans and ground-nuts—appear to have some protective effect.

(d) The role played by the consumption of starchy foods is apparent. In a rough way these may be classified as follows, according to their "kwashiorkor-producing" effect : manioc ; bananas, plantains, maize, and sweet potatoes ; taro ; yams ; white rice ; home-pounded rice, millet, and sorghum.

(e) Dietary errors due to poverty and ignorance are a causative factor.

##### 4.1 Increasing the Supply of Proteins

###### 4.1.1 *Animal proteins*

(a) In general, and with few exceptions, the territories of Central and tropical Africa are deficient in livestock. Intake of animal protein is low everywhere, rarely reaching, according to the most liberal estimates, more than a few grams per head daily. The consumption of milk is negligible.

The following tabulation shows the consumption of meat, not including game, (in kg and lbs per head per year) in certain African territories, figures for some other countries being given for purposes of comparison :

<i>Tropical Africa</i>	<i>kg</i>	<i>lbs</i>
French West Africa <sup>23</sup>	5.5	12.1
French Equatorial Africa	5.5	12.1
Cameroons	5.0	11.0
Gold Coast <sup>35</sup>	2.5	5.5
Belgian Congo <sup>11</sup>	0.9	2.0
<i>Other countries (1947) <sup>27</sup></i>		
New Zealand	96.4	212.5
USA	74.3	163.8
France	54.2	119.5
Belgium	45.6	100.5
England	41.6	91.7
Egypt	9.2	20.3

The improvement of livestock has been the subject of numerous studies. Programmes for improvement have been established and the governments concerned have attempted to give these practical effect. They include the selection of breeds adapted to climatic conditions in the tropics, measures to prevent animal diseases, the development and improvement of pasturage, the provision of water for livestock at suitable points, and the education of the African in better methods of caring for livestock.

It must, however, be emphasized that the improvement of milk-producing livestock—cattle, goats, and sheep—remains a complex and difficult problem. The same may be said of pigs and small livestock generally. It would not be justifiable to expect a marked improvement in the situation in the immediate future.

(b) The development of fisheries seems to offer much greater promise. Fish is liked almost everywhere in Africa, its sources being coastal waters, rivers, and lakes. The degree to which fisheries can be expanded is a question which must be left to experts in this sphere. Unquestionably such expansion involves numerous difficulties. The example of the Gold Coast is, however, encouraging. In this territory, in which the government has only recently given attention to fisheries, the increase in the catch of fish has been rapid. There are good prospects of a further large increase through the improvement of fishing equipment and the introduction of a type of motor-boat which has already been designed and which will replace the existing flimsy fishing craft. An effort is also being made to develop river fisheries, but here the problem is by no means simple. In areas from which the tsetse fly has been eradicated, it is necessary to re-educate the people who have fled from the tsetse-infested river-banks. They must be taught once more how to make fishing craft and nets and how to repair these. In areas in which there is barter economy, the women must be taught to sell fish



products. A point of importance is that the river fishermen combine fishing and agriculture, which occupy them at different seasons of the year.

In the Gold Coast, with a population of 4.5 million, 20 million kg (about 20,000 tons) of fish were produced in 1949, amounting to 4.5 kg (9.9 lbs) per head per year, which is double the quantity of meat available in this territory.

Increase in the consumption of fish in areas remote from its source can be brought about only by the development of fish farming and by the use of appropriate methods of preservation. The only methods of preserving fish for local consumption now practised are sun-drying, with or without salting, and fire-drying, which sometimes includes smoking. These rough and ready methods are suited to the existing resources of the people and the introduction of modern preservation processes, such as quick-freezing, refrigeration, and canning, would not benefit the average African. Such processes are used to some extent in Africa, but the products are consumed only by Europeans or by a few well-to-do Africans. They are inaccessible to the bulk of the population, with its low purchasing power. Actually the existing type of dried fish is very badly prepared; its universal designation, "stinky-fish", aptly describes it. Only very small fish, such as sardines and herring fry, can be preserved at all satisfactorily by the local primitive methods. Fish with a high oil content and large fish generally, e.g., full-sized herrings, horse mackerel, and barracudas, always retain too much water after drying and do not keep for more than a few weeks under ordinary local conditions of storage and transport.

Measures are needed to improve local methods of preservation and to set up simple and appropriate preservation plants which could be run by village co-operatives or by private enterprise.

Finally, the manufacture of fish powder and paste on an industrial scale presents definite possibilities. It is the custom to include fresh or dried fish in soups, sauces, and stews, and fish powder or paste would be very suitable for this purpose.

#### 4.1.2 *Sources of vegetable protein*

It is possible and necessary to increase supplies of vegetable protein.

(a) In a region in which there is much undernutrition, the main preoccupation has hitherto been to produce enough food to satisfy calorie requirements. But consideration should be given not only to the yield of calories per unit of area, but also to the yield of protein. There are, of course, many complicating factors: lack of skilled labour; the need for crop rotation; difficult climatic conditions; and soil deficiencies. Local customs and preferences are also of great significance. The African desires that his food should, above all, give him the sense of having a full stomach. It is easy to understand why the cultivation of cassava, a crop which demands little labour, gives large yields, and is relatively resistant to the vagaries of

climate, should have been encouraged. But in the attempt to avert famine—in pursuit of what has sometimes been regarded as a foresighted agricultural policy—cassava has been cultivated to such an extent that it is becoming the staple food in many territories. This is a dangerous situation. It is essential to encourage, wherever soil conditions permit, the production of cereals, which are richer in protein than cassava, or of other roots and tubers, also superior to cassava in protein content.

**TABLE IV. CALORIE AND PROTEIN YIELDS PER HECTARE OF SOME AFRICAN CROPS**

Crop	Gross weight* (in 100 kg)	Net weight (in 100 kg)	Calories (in thousands)	Proteins (in kg)
Rice . . . . .	8.5	6	2,151	42.3
Millet . . . . .	5	4.5	1,530	44
Sorghum . . . . .	6	5.4	1,854	33
Maize . . . . .	8.5	7.7	2,845	73
Cassava . . . . .	65	49	7,090	58.5
Cassava flour . . . . .		20	6,750	30
Sweet potatoes . . . . .	40	33	3,105	36.5
Yams . . . . .	40	34	3,554	22.9
Beans (chick peas or cow peas) . . .	4	4	1,380	88.8
Soy-bean . . . . .	3.6	3.6	1,206	129
Ground-nuts . . . . .	6.2	4.5	2,418	113.4

\* Average for the years 1946, 1947, and 1948 for countries visited during the survey.\*\*

Table IV shows the number of calories and the amount of protein yielded per hectare by different crops; it is based on average African figures for yields and food composition. Cassava flour, it may be noted, is among the lowest in protein content of all the foods listed and is also the most “unbalanced” as regards the carbohydrate-protein ratio. Research is needed to develop varieties of cassava which, while giving normal yields, are above the average in protein content.

The protein content of different kinds of millet grown in Africa varies within a wide range, certain kinds having almost twice as much protein as others. The following figures illustrate this point: <sup>26</sup>

Type of millet	Proteins per 100 g
<i>Eleusine coracana</i>	6.5
<i>Setaria italica</i>	9.8
<i>Panicum miliaceum</i>	11.8

When the cultivation of high-protein varieties is possible, account should be taken of differences of this nature. Investigations have already begun

in Africa on the selection of strains of high nutritive value within a particular species, with the ultimate object of increasing daily protein intake. Special attention may be drawn here to the work of the Institut national pour l'Etude agronomique du Congo Belge (INEAC) on this problem.<sup>31</sup>

(b) It is well known that pulse are an excellent source of protein. Among the various types of pulse, the soy-bean stands out in respect of protein content and the degree to which its proteins supplement those of cereals. There is, however, no need to encourage the cultivation of soy-bean throughout Africa ; it would be a mistake to advocate its cultivation wherever this is possible in preference to that of the type of pulse now commonly grown. It is easier to increase the production of foods with which the agriculturalist is already familiar, and which women know how to prepare, than to introduce a new product. With regard to soy-bean, attention may be drawn to a mistaken procedure. For some fifteen years, in various territories in Africa, agricultural experts have striven to introduce this pulse, with reasonably satisfactory results from the agricultural standpoint. But the African has shown no desire to eat soy-bean. The reason is that he has been encouraged to eat it as other pulse are eaten. It has been overlooked that in countries in which soy-bean has long been produced and is a familiar food, the people have learned by experience how to prepare it by empirical methods which modern scientific knowledge has shown to be sensible and appropriate. In these countries it is consumed mainly in the form of " milk ", cheese, fermented sauces, or after sprouting when it does not need cooking and is easily digestible. The spread of soy-bean cultivation in Africa must be combined with efforts to teach the women how to prepare it. Since such efforts have not been made, it would be premature to call the attempt to introduce it a failure.

Another mistake often made by those who are trying to introduce a new food into the diet of a people is to expect results within a few years. This is possible in countries in which the level of intellectual and technical development allows the use of modern publicity methods. But in Africa things are quite different. Demonstrations are needed ; people must be taught and convinced almost on an individual scale. Time is necessary. It will be recalled that cassava, now so widely grown, is not a native African crop and that rice, the cultivation of which is rapidly expanding, is also an import. Sustained efforts are required to introduce any new crop and the results may not be evident for a generation.

Numerous species and varieties of pulse are used in Africa. These include green beans (*Phaseolus vulgaris*), lima beans (*Phaseolus lunatus*), field beans (*Dolichos lablab*), peas (*Pisum sativum*), chick peas (*Cicer arietinum*), cow peas (*Vigna catiang*), etc. The authors did not come across green gram (*Phaseolus radiatus* or *aureus*), a common pulse in South-East Asia, which is rich in protein, has an agreeable taste, and is easy to cook ; it may, however, be cultivated in parts of Africa.

While pulse are grown almost everywhere and by almost all African cultivators, the total consumption is relatively small ; it is not, for example, comparable in amount with consumption in many parts of Latin America, except perhaps in Ruanda-Urundi.

Among the pulse must be included the "underground" pea called Bambara (*Voandzeia subterranea*), which, as table II (see page 43) shows, has a good content of protein, and also ground-nuts which are produced in abundance and eaten everywhere, but not in large amounts. There is a tendency to regard them as a luxury.

(c) Efforts should also be made by governments to increase the production of green vegetables, in order to reduce the quantity of starchy foods in the diet. Vegetables are grown in family gardens, usually by the women, and their extended cultivation will inevitably add to the already heavy burden of work which the African woman carries.

The production of fruit should also be encouraged. The African likes fruit but rarely plants fruit-trees ; the results of such labour take too long to appear. In Northern Nigeria the agricultural department, following the suggestion of the service concerned with the prevention of trypanosomiasis, has promoted the cultivation of fruit-trees (orange, lemon, papaya) on cleared areas of land surrounding villages.

(d) *Cash crops.* In general the importance of increasing the production of food crops for local consumption must be emphasized. Some governments hold the view that it is easier to teach the people, by suitable educational methods, to produce cash crops for export in greater quantities and that the profits obtained from the sale of these will enable the producer to buy an adequate diet. In other territories it is felt that the first need is to produce, within the territory itself, the foods needed for local consumption. In some agricultural research stations, the original aim of which was the improvement of the standard of living of Africans through increasing the production of cash crops (in particular ground-nuts), there has been a change of attitude ; the authorities concerned now seem to feel that the cultivation within the village itself of the foods required must first be assured, cash crops taking second place. Discussion of this problem is likely to continue for some time to come. The policy adopted should take account of the real needs and interests of the African in each individual territory.

#### 4.2 The Hungry Months

Reference has already been made to the effect of seasonal food shortages on the health of mothers and the nutrition of young children. Pieraerts<sup>52</sup> has, among others, demonstrated the seasonal incidence of kwashiorkor. In describing investigations among the Bakwa-Meta during the hungry period from September to December when kwashiorkor is rife in the Kasai province, he refers to two villages, Lulua and Baluba, which are

situated to the west of the same hill. In the first he found much diboba (kwashiorkor), in the second little. The soil in both villages is the same, the inhabitants have the same diseases and parasites, and in both there are similar opportunities for obtaining food from the forest and by hunting and fishing ; the Lulua people are in a somewhat better position than the Baluba people to make use of these opportunities. Both groups have plenty of cassava, but among the Baluba, who are good cultivators, the stocks of cereals harvested in April are sufficient to last until October, while those of the Lulua are exhausted at the end of June.

The Inter-African Conference on Food and Nutrition (1949)<sup>14</sup> recommended the creation of granaries to be stocked with food as a reserve against shortage. It may be added that the African's lack of foresight is partly responsible for the severity of these periodic shortages. Better education of the African peasant is, therefore, among the methods of attacking the problem.

There can be no question that the problem of the "hungry months" is among the most important problems of nutrition in Africa.

### 4.3 Supplementary Feeding of Infants and Young Children

The measures discussed above are concerned with the general improvement of nutrition. Should such improvement take place, the infant at the breast will benefit because it will obtain more milk of better quality. The child will also benefit on reaching the age at which it can share fully in family meals. But there remains the critical period of weaning. Animal milk cannot be produced in most parts of Africa in substantial amounts. Imported processed milk—even skim milk—will remain for a long time beyond the means of the bulk of the population.

It is, therefore, most desirable that some substitute for milk should be found which can help to cover the needs of the child during weaning. The problem, it should be emphasized, is not to find an ideal substitute, but a food or foods which can supplement, as far as possible, the starchy gruels of cassava, plantains, and maize which are at present often the only food of the young child. Research and feeding trials should be undertaken with this end in view.

Among traditional African food preparations, some are better than others. The rouye of the Ouoloff people has often been praised as a superior preparation. This is composed of millet which is made into gruel and fermented for a short time. As a result, some lactic acid is formed and the starch can be more easily attacked by the digestive juices.<sup>2</sup> It is relatively rich in protein (9.5%) and is certainly superior in nutritive value to maize gruels (e.g., arkassa and kenki) and especially to cassava gruels (e.g., the luku of the Belgian Congo and the gari of the Gold Coast).

The practice of allowing maize and sorghum to germinate, followed in some territories, deserves further and more careful study.

So-called "milks" of vegetable origin may be given a trial, whether they are prepared on a factory or domestic scale. Further mention need not be made of soy-bean in this connexion, since its production and consumption are still too limited. Ground-nut "milk" has been tried. At Usumbura, Vincent has attempted to promote its consumption by children whose growth is retarded. It is made as follows by the mothers themselves under the supervision of nurses attached to welfare centres :

One hundred and fifty grams of lightly roasted ground-nuts are pounded with a litre of water. The mixture is filtered through cloth and boiled for ten minutes. The resulting "milk" can be taken by infants as a supplement to breast milk from the age of four to five months.

It is of interest to compare the amino-acid composition of cow's milk with that of soy-bean and ground-nut "milk" (see table V).

**TABLE V. AMINO-ACID COMPOSITION OF COW'S MILK, SOY-BEAN MILK, AND GROUND-NUT MILK**

Composition	Cow's milk	Soy-bean milk	Ground-nut milk
	g per litre	g per litre	g per litre
Proteins . . . . .	35.00	35.00	35.00
Arginine . . . . .	1.26	2.82	4.55
Histidine . . . . .	0.91	1.01	0.95
Lysine . . . . .	2.625	2.40	1.26
Tryptophane . . . . .	0.525	0.56	0.49
Phenylalanine . . . . .	1.785	1.95	2.00
Methionine . . . . .	0.840	0.56	0.39
Threonine . . . . .	1.505	1.57	1.00
Leucine . . . . .	3.434	2.93	2.60
Iso-leucine . . . . .	2.625	2.09	1.68
Valine . . . . .	2.52	2.00	1.90

It will be seen that :

(a) the amino-acid content of soy-bean milk is comparable to that of cow's milk, except in methionine. The methionine content of soy-bean milk is, however, double that of the milk of the European mother<sup>57</sup> and three times that of the milk of the African mother ;<sup>6</sup>

(b) the amino-acid content of ground-nut milk is lower than that of cow's milk in lysine, threonine, and methionine, but its methionine content is superior to that of the European and African mother.

#### 4.4 Education

While much kwashiorkor is due to poverty, much is also due to ignorance. With the best intentions, African mothers commit many grave faults in the feeding of their children. But though young mothers naturally tend to follow traditional routines, they are not unready to learn. Thus, Mrs. du Sautoy writes : " The women themselves do seem to realize that they do not make a good job of feeding their children and are willing to listen indefinitely to anyone who will tell them how they should feed their children."

It is said that there is now less kwashiorkor in the Gold Coast than twenty years ago, that this is due to a rise in living standards, and that many existing cases are due to ignorance rather than poverty. Unquestionably an improvement in the nutrition of children is possible even in less favourable economic conditions than those found in this territory. Prenatal and postnatal consultations, attendance at child-welfare centres concerned with the care of infants and children, and periods spent in maternity hospitals all provide opportunities for educating the mothers. The statistics of attendance at maternity and child-welfare centres throughout Africa, and the large groups of women and infants who throng these centres (which the authors observed throughout their tour), indicate that a considerable proportion of mothers can be reached by such means. Family dietary habits can also be influenced through the education of children in schools, though girls are at present in the minority as regards school attendance. In such ways a beginning can be made and education can be extended when the governments concerned are able to make more trained personnel available. The existing number of trained personnel is insufficient.

The teaching of mothers should be simple. It can be provided through group lessons and practical demonstrations, the latter being given either directly or by means of films. Mobile health units, or their equivalent in the various territories, can, if further developed, make a substantial contribution.

The authors gained the impression that interest in problems of nutrition is growing in Africa. It is most desirable that all local governments, following the example of certain territories, should give financial support to the establishment of nutrition services, which are needed for the following purposes :

- (a) To help in establishing food production programmes designed to cover nutritional needs.
- (b) To initiate simple educational activities adapted to local conditions.
- (c) To train a body of local subordinate personnel which can make direct contact with mothers and schoolchildren.

The problem of kwashiorkor can be attacked immediately through energetic educational measures—concerned with the education of farmers,

mothers, and children in schools—combined with the study of suitable methods of supplementing the diets of young children and the popularization of such methods.

#### 4.5 Immediate Action

The preceding measures must take considerable time to produce satisfactory results. Meanwhile immediate action may be possible to ensure the effective treatment of the syndrome at different stages of evolution :

(a) In most hospitals, outpatient departments, medical centres, etc., skim-milk powder is not at present available to the medical staff for purposes of treatment, although the provision of skim milk is the most valuable form of treatment at present known for established cases of kwashiorkor.

(b) Large numbers of children are seen in hospitals, clinics, and centres attended by expectant and nursing mothers, infants, and young children. These attend for periodic examinations, to be weighed, or for consultations regarding minor ailments. For example, it is reported that, in French territories in Africa South of the Sahara, some 1,450,000 children below the age of five came under medical supervision during the year 1947, each child having been seen on the average 3-4 times. The total population in this age-group in these territories is about 4.5 million. The medical personnel concerned with these services could, if fully aware of the preliminary manifestations of kwashiorkor, detect cases in the earlier stages of the syndrome. There is little doubt that the treatment of incipient cases with skim milk could produce most effective results.

The material difficulties relating to the provision of skim milk could be overcome if skim milk were included among the therapeutic agents generally available to medical and public-health services.

Action along these lines would be the responsibility of the governments concerned. The governments might, however, obtain assistance from international organizations, and particularly from the United Nations International Children's Emergency Fund (UNICEF), in developing measures for treating cases of kwashiorkor with skim milk as suggested above.

### RECOMMENDATIONS

#### Research

(1) There are many fascinating and important problems associated with kwashiorkor which call for clinical and biochemical research and animal experimentation. Many of these have been touched on in the present report. Research has already been undertaken with considerable vigour by individuals and institutions with the support of national governments. FAO and WHO should do whatever possible to stimulate and co-ordinate such research in Africa and other parts of the world in



which kwashiorkor is prevalent. Of special importance is research on (a) the causation of dermatosis associated with kwashiorkor and (b) the effect in treatment of different amino-acids and other factors such as vitamin B<sub>12</sub>.

(2) On the practical side, there are a number of problems calling for study and investigation. These include :

(a) The value of pulse and vegetables in prevention. This calls for a field trial on an experimental basis.

(b) The best methods of cooking and serving pulse and the preparation of suitable foods, with special attention to "milk substitutes" from pulse including ground-nuts.

(c) Customs followed in different areas in the weaning of children and in feeding children between weaning and puberty. These should be studied by competent social anthropologists with some knowledge of nutrition.

(d) Quantitative and qualitative study of breast milk in African mothers at different stages of lactation and under different conditions of maternal diets.

(e) The food intake of children during the weaning and post-weaning periods. Quantitative data are required.

### **Prevention**

#### *1. Emergency action*

The amount and seriousness of kwashiorkor in the area surveyed justify emergency action. First, the attention of governments should be drawn to the need for disseminating knowledge of kwashiorkor among their medical, health, and sanitary staffs and, in particular, the latter should be made aware of the ease with which this syndrome can be successfully treated in hospitals by skim milk if seen at an early stage. Secondly, skim-milk powder should be made available to hospitals and maternity and child-welfare centres in the region in appropriate quantities. Governments should if necessary seek help from UNICEF in obtaining supplies of skim milk.

#### *2. General preventive measures*

(a) Food production should be developed so that the foods which prevent kwashiorkor are made available in greater quantities. Among animal foods, fish is of primary importance, since its production can be rapidly increased, while to increase that of milk and meat will be a lengthy and difficult process. With regard to vegetable foods, attention should be given to the yield of protein per unit area as well as to the yield of calories. Cereals, and particularly millet and sorghum, should be grown wherever possible in preference to manioc. The production of pulse and vegetables should be expanded and steps taken to encourage the local consumption of ground-nuts.

(b) The production on village lands and in village kitchen-gardens of the supplementary foods needed should be an important aspect of preventive policy.

(c) Steps should be taken to relieve shortages of food in the hungry months, e.g., through suitably stored reserve stocks of food, both by families and on a community scale.

(d) Educational campaigns to improve methods of feeding children, especially during the weaning period, should be developed. In particular, sustained efforts to educate mothers are needed.

(e) Attention should be given to the possibility of attacking the problem of kwashiorkor through the "demonstration area" technique. A suitable area in which kwashiorkor is prevalent could be selected and a combination of preventive measures introduced and developed. The information and experience obtained could then be applied in other parts of Africa and also elsewhere in the world. FAO and WHO could assist in the organization of a suitable demonstration project through the technical assistance programme of the United Nations.

## SUMMARY

A survey of kwashiorkor in central and tropical Africa was undertaken in 1950 in accordance with the recommendations of the Joint FAO/WHO Expert Committee on Nutrition in October 1949. The following territories or countries were visited: Kenya, Uganda, Ruanda-Urundi, Belgian Congo, French Equatorial Africa (Middle Congo), Nigeria, Gold Coast, Liberia, Gambia, and French West Africa (Senegal). Information was collected by direct observation and through interviews and discussions in the various areas with the health and agricultural authorities and many other kinds of people in contact with the problem.

If a wide interpretation is put on the term kwashiorkor, then it was encountered in every part of Africa surveyed, i.e., the whole tropical belt between Zanzibar and Dakar; it is also found in the Union of South Africa and in Egypt. There are, however, great differences in its incidence in different areas and in different tribes, which can be correlated with differences in diet. Carnivorous races, such as the Masai in

## RÉSUMÉ

Conformément aux recommandations du Comité mixte FAO/OMS d'experts de l'Alimentation et de la Nutrition qui s'est réuni en octobre 1949, une enquête sur le kwashiorkor a été entreprise en Afrique centrale et tropicale en 1950. Les pays ou territoires suivants ont été visités: Kenya, Ouganda, Ruanda-Urundi, Congo Belge, Afrique-Equatoriale Française (Moyen-Congo), Nigeria, Côte de l'Or, Libéria, Gambie et Afrique-Occidentale Française (Sénégal). Il a été possible de réunir une documentation par des observations directes et au cours d'entrevues et de discussions, dans ces différentes régions, avec les autorités des services de santé et des services agricoles, ainsi qu'avec d'autres personnes ayant à s'occuper du problème du kwashiorkor.

Si l'on donne au terme « kwashiorkor » une acception large, la maladie existe dans toutes les régions africaines visitées, c'est-à-dire dans toute la bande tropicale comprise entre Zanzibar et Dakar; elle est présente aussi dans l'Union Sud-Africaine et en Egypte. Cependant, sa fréquence varie fortement suivant les régions et les tribus. Ces variations peuvent être attribuées à des différences dans le régime ali-

Kenya, and races which produce large quantities of cows' milk, such as the Batussi of Ruanda-Urundi, appear to be wholly exempt. In races which subsist largely upon staple foods which are deficient as regards the quantity or quality of the proteins they contain, such as cassava, plantains, yams, and maize, a variable high incidence is found. The consumption of animal protein, such as meat, fish, and milk, in reasonable quantities is protective. There is some evidence that supplementation with vegetable protein, such as beans, peas, and groundnuts, is also protective.

The syndrome cannot at present be precisely defined but the fundamental group of signs is constituted by (a) retarded growth in the late breast-feeding, weaning, and post-weaning phases with (b) alterations in skin and hair pigmentation, (c) oedema, (d) fatty infiltration, cellular necrosis, or fibrosis of the liver, (e) heavy mortality if better protein is not supplied in the diet, and (f) a variety of dermatoses commonly but not invariably associated. There is a gradual transition of clinical features from kwashiorkor to marasmus and it is impossible at present to define clearly the borderline between these two syndromes.

Kwashiorkor is not obviously different from "Mehlnährschaden" and post-weaning protein-deficiency syndromes in colder climates except in the pigmentary disturbances in skin and hair. Although this report is confined to the features of a syndrome occurring in Africa, it is recognized that the name may justifiably be applied to closely similar syndromes occurring in other parts of the world. It is felt, however, that the use of this term for syndromes in which dyspigmentation is not a feature is etymologically incorrect.

mentaire. Les populations qui se nourrissent de viande, telles que les Massaï du Kenya, et celles qui consomment de grandes quantités de lait de vache, comme les Batussi du Ruanda-Urundi, semblent exemptes de kwashiorkor. Chez les races dont l'aliment de base est pauvre en protides, à la fois du point de vue qualitatif et du point de vue quantitatif, — manioc, bananes, igname et maïs — la fréquence du kwashiorkor est variable, mais toujours élevée. Les aliments riches en protéines animales, tels que la viande, le poisson et le lait, absorbés en quantité raisonnable, ont une action protectrice. On a des raisons de croire que l'adjonction au régime de protéines végétales, sous forme de fèves, de pois et d'arachides, exerce aussi une action protectrice.

Le syndrome ne peut encore être défini de façon précise, mais les symptômes fondamentaux en sont les suivants : a) retard de croissance chez le nourrisson vers la fin de l'allaitement, au moment du sevrage et après le sevrage ; b) anomalies de la pigmentation cutanée et pileaire ; c) œdème ; d) infiltration graisseuse, nécrose cellulaire ou fibrose du foie ; e) forte mortalité lorsque le régime n'est pas amélioré par l'adjonction de protéines de haute valeur ; f) diverses dermatoses, fréquemment mais non constamment associées. Les signes cliniques du kwashiorkor tendent à se rapprocher progressivement de ceux de l'athrepsie, et il est impossible actuellement de différencier nettement ces deux syndromes.

Le kwashiorkor ne diffère pas essentiellement de la dystrophie farineuse (Mehlnährschaden), ni des syndromes de déficience protidique observés au cours de la période qui suit le sevrage dans des pays à climat plus froid, si ce n'est par les anomalies de la pigmentation cutanée et pileaire. Quoique le présent rapport soit limité aux manifestations d'un syndrome que l'on observe en Afrique, le terme « kwashiorkor » pourrait raisonnablement s'appliquer à des syndromes très semblables constatés dans d'autres régions du monde ; cependant, il serait étymologiquement incorrect d'employer ce terme pour désigner des syndromes qui ne sont pas caractérisés par des anomalies de la pigmentation.

The particular age distribution of kwashiorkor is best explained on the basis that the period 1-4 years is a period of high protein requirement whereas under African conditions it is the period of life at which protein intake is likely to be the lowest. The relation between the protein requirements of children and the supply of protein actually available is considered in some detail in the report. Attention is drawn to the possibility that deficiency of certain amino-acids, particularly methionine, may be a basic causative factor.

The syndrome still causes a high mortality in many areas. Mortality can be greatly reduced by treatment with skim-milk powder. This fact is still incompletely appreciated in many parts of Africa with the result that mortality is unnecessarily high.

World maps of the distribution of kwashiorkor, and of the high incidence of adult cirrhosis and primary carcinoma of the liver, overlap to a very large extent but not completely. Parasitic disease may play a part in the production of adult cirrhosis, but the overlap with kwashiorkor and the evidence of the effects of protein deficiency in producing experimental cirrhosis suggest the possibility that all three conditions may be produced in the main by protein-deficient diets. This assumption is for further research. On the other hand, there is evidence that the relationship of adult cirrhosis and primary carcinoma of the liver to kwashiorkor is not one of direct sequence.

The precise frequency and importance of kwashiorkor and its sequelae are difficult to estimate until the relationship of dyspigmentation and adult cirrhosis to the syndrome are more completely understood. A wide and general appraisal of its nature and relationships suggests that it is the most serious and widespread nutritional disorder known to medical and nutritional science.

La meilleure explication de la fréquence du kwashiorkor à certains âges peut s'expliquer ainsi : alors que les besoins en protides sont élevés aux âges de 1 à 4 ans, dans les conditions de vie africaines, cette période est celle où l'apport protidique de l'alimentation est vraisemblablement le plus bas. La relation entre les besoins en protides de l'enfant et l'apport protidique réel est étudiée en détail dans le rapport. Il y a lieu de signaler que l'une des causes fondamentales du kwashiorkor pourrait être la déficience en certains acides aminés, notamment en méthionine.

La haute mortalité que provoque encore cette maladie dans de nombreuses régions peut être considérablement réduite par l'administration de lait écrémé en poudre. Ce fait est encore insuffisamment reconnu dans beaucoup de parties de l'Afrique, et il en résulte une mortalité indûment élevée.

Les régions du monde où la cirrhose et le carcinome primitif du foie sont très fréquents chez l'adulte coïncident dans une certaine mesure, mais non absolument, avec celles où sévit le kwashiorkor. Les maladies parasitaires peuvent jouer un rôle dans l'apparition de la cirrhose chez l'adulte, mais la fréquence de la cirrhose dans les régions à kwashiorkor et la production expérimentale de la cirrhose par un régime pauvre en protides donnent à penser que ces différentes affections peuvent toutes être dues à une carence protidique. Cette hypothèse appelle de nouvelles recherches. D'autre part, les faits semblent indiquer qu'il n'y a pas une relation directe absolue entre le kwashiorkor, d'une part, et la cirrhose et le carcinome primitif du foie chez l'adulte, d'autre part.

La fréquence et l'importance du kwashiorkor et de ses séquelles seront difficiles à apprécier exactement tant que la relation entre les anomalies pigmentaires et la cirrhose chez l'adulte, d'une part, et le kwashiorkor, d'autre part, ne sera pas définitivement établie. A en juger d'après les constatations générales faites sur la nature du kwashiorkor et ses relations avec d'autres manifestations pathologiques, cette maladie constitue probablement la plus grave et la plus répandue des affections de la nutrition actuellement connues.

A number of recommendations are put forward regarding the study and prevention of kwashiorkor. These cover : the co-ordinated investigation of basic scientific and medical problems presented by the syndrome ; study of the value of pulse and vegetables in prevention, with special attention to the best methods of preparing "milk substitutes" ; study of weaning and child-feeding customs ; spread of knowledge of the syndrome among health and medical services ; the distribution of skim milk as an emergency measure ; the increased production of the foods needed for prevention with special emphasis on fish as a source of animal protein ; the replacement or the supplementation of low protein staple foods by pulse or cereals ; the judicious use and storage of foods throughout the year to lessen the effects of the hungry months ; the education of the people, and particularly mothers, in better dietary practices ; and the development of a "demonstration area" into which a combination of preventive measures will be introduced.

Un certain nombre de recommandations ont été présentées en ce qui concerne l'étude et la prophylaxie du kwashiorkor. Elles préconisent des mesures visant à : coordonner les recherches sur les problèmes fondamentaux, scientifiques et médicaux, posés par la maladie ; étudier la valeur des graines de légumineuses et des légumes au point de vue prophylactique, en consacrant une attention toute spéciale aux meilleures méthodes de préparation de « succédanés du lait » ; étudier la question du sevrage et des habitudes alimentaires des enfants ; faire mieux connaître le kwashiorkor aux membres des services sanitaires et médicaux ; distribuer du lait écrémé à titre de mesure d'urgence ; améliorer le ravitaillement en produits alimentaires nécessaires à la prophylaxie de la maladie, en donnant une importance particulière au poisson, source de protéines animales ; remplacer ou compléter les aliments de faible valeur protidique par des graines de légumineuses ou par des céréales ; employer et conserver judicieusement les aliments au cours de l'année, afin d'atténuer les conséquences des mois de famine ; enseigner à la population, et particulièrement aux mères, de meilleurs régimes et habitudes alimentaires ; organiser une « zone de démonstrations » dans laquelle on appliquera un ensemble de mesures prophylactiques.

### Annex 1

#### RECENT AND CURRENT CLINICAL AND BIOCHEMICAL STUDIES IN AFRICA

It was felt that it would be useful to individuals and institutions making a study of the kwashiorkor problem to give a brief survey of work at present going on or recently completed in Africa. It was clear that some individuals and institutions were working without knowledge of parallel or related work proceeding in other parts of Central Africa. A great deal might be gained by bringing together, at some central point, all those individuals who are actively working on aspects of the problem. Failing this, the following statement of work being carried out may be of value in promoting interchange of knowledge by correspondence and exchange of publications. It is hoped that the statement is complete as far as the experience of the authors is

concerned ; if there are omissions, the authors must apologize and crave the indulgence of those people who have not been mentioned or whom they did not meet. This survey is certainly not meant to cover all those people from whom they learned something about kwashiorkor but merely those who are actively engaged in investigating kwashiorkor in its various aspects. <sup>a</sup>

A complete bibliography of work on kwashiorkor in Africa will not be attempted because comprehensive bibliographies are included in a number of recent publications. <sup>4, 33, 65</sup>

The centres are referred to in the order in which they were visited.

At Nairobi, Kenya, many cases of kwashiorkor have been studied in the General Hospital by Dr. F. J. Wright, medical specialist. He is familiar with the general distribution of the syndrome throughout the different tribes of Kenya and made available essays on infant feeding and weaning written by African hospital-assistant trainees. Dr. H. Foy and his co-workers <sup>29</sup> at the Medical Research Institute, Nairobi, are engaged in research on the macrocytic anaemias of Kenya and have studied the haematology of cases of kwashiorkor in the Nairobi hospital. Dr. D. Harvey, also of the Medical Research Institute, has made numerous surveys of food and food composition in Kenya. Dr. M. Clark at Fort Hall, a little north of Nairobi, has extensive experience of kwashiorkor among Kikuyu children.

The pioneer work of Dr. H. C. Trowell at Kampala, Uganda, is well known from numerous publications. He is medical specialist at Mulago Hospital and has made an extensive clinical study of kwashiorkor over a number of years. He is continuing his clinical and biochemical studies in conjunction with the pathological examination of autopsy cases by Dr. J. N. P. Davies. The work of Davies on the pathology of kwashiorkor is well known from his publication in the *Lancet*.<sup>16</sup> He has just been appointed Professor of Pathology at Makerere University, Kampala, and has recently spent some time studying the pathology of the American negro for comparison with material available in Kampala. Other members of the staff of the Department of Pathology have been interested in the subject. Dr. Margaret D. Thompson has recently been sent by the British Medical Research Council to study, in association with Dr. Trowell, the enzymatic activity of the duodenal contents in cases of kwashiorkor and related conditions. She finds that the activity of all three enzymes—pepsin, lipase, and trypsin— is seriously depressed but that this recovers after the successful treatment of kwashiorkor. Dr. E. G. Holmes, Professor of Physiology at Makerere University, heads a unit, supported by the British Colonial Medical Research Committee, which is studying the normal red cells and haemoglobin levels of healthy students and correlating these with the serum proteins. In addition, Holmes is doing nitrogen- and iron-balance studies

<sup>a</sup> The addresses of most of the workers referred to in this survey as being actively engaged in research on kwashiorkor can be obtained on application to the Nutrition Section, World Health Organization, Palais des Nations, Geneva, Switzerland. — Ed.

on malnourished adult Africans with particular reference to hookworm infestation. Holmes has already shown that adult Africans, when given high protein diets, may not reach nitrogen equilibrium even after periods as long as 90 days. Dr. Hebe F. Welbourn has, for some time, been making a study of infant growth and development ; her material was used as a basis for remarks on the growth pattern of African infants.

At Costermansville in the eastern Belgian Congo, Dr. Van den Bergh, who is in general charge of the Institut pour la Recherche scientifique en Afrique centrale (IRSAC), has been interested in nutritional problems. Costermansville was not visited by the authors as Van den Bergh was in America, but a visit was made to one of the IRSAC centres at Astrida in Ruanda-Urundi. Dr. Hiernaux is making a systematic study of the physical anthropology and nutrition of comparative groups of people in Ruanda-Urundi.

At Usumbura, the capital of Ruanda-Urundi, Dr. Vincent is paediatrician to the General Hospital and has studied infant growth, nutrition, and health in and around Usumbura. He reports that ground-nut milk is well tolerated by infants from the age of six months onwards and is then an effective substitute for cow's milk.

At Luluabourg in the Kasai province of the Belgian Congo, Dr. G. Pieraerts has made a careful study of the clinical features and treatment of the syndrome "dépigmentation-œdème" (kwashiorkor) over a number of years and has published several articles.<sup>53</sup>

At Leopoldville, Dr. G. Doucet, who has published an article on m'buaki (kwashiorkor) in the Kwango province,<sup>19</sup> is now engaged in a controlled study of the effects of feeding and chemotherapy on the growth development and health of infants of the employees of the large transport combine, Otraco (Office d'Exploitation des Transports coloniaux). Dr. G. Drummel<sup>20</sup> of the Fonds Reine Elisabeth pour l'Assistance médicale aux Indigènes (FOREAMI) gave the authors valuable information on the work of this organization on health and nutrition in the Kwango province. Dr. C. Dricot, Director of FOREAMI in Africa, Dr. E. Beheydt, physician at the Hôpital des Congolais, and Dr. E. Charles from the Institut de Médecine tropicale Princesse Astrid have studied jointly, in great detail, a small group of cases of kwashiorkor brought to Leopoldville. Their findings will be published in 1951, probably in the *Annales de la Société belge de Médecine tropicale*.

Besides the determination of basal metabolism and routine blood, urine, and gastric-juice analyses, these authors carried out several liver and kidney tests and measured some enzymes (blood phosphatase, and lipase and trypsin of the duodenal juice). Their work has shown :

(1) a constant increase of the basal metabolism rate (30% to 40% above the normal in young children of the same age) ;

(2) a slight albuminuria ;

(3) severe liver deficiency determined by the following tests : Quick test ; Takata-Ara test ; thymol turbidity ; serum bilirubin ; hippuric-acid test ; bromosulfalein test ;

(4) a substantial hydrochloric-acid deficiency in gastric juice (pepsin was not measured) ;

(5) a low level of serum albumin, partly compensated by increase of globulins, mainly gamma globulins ;

(6) a substantial rise in serum lipids (four to five times the normal figure), cholesterol and phospholipids remaining approximately normal ;

(7) a slight decrease of the alkaline phosphatase of the serum ;

(8) a substantial decrease in the enzymatic activity (lipase and trypsin) of the duodenal juice.

In Northern Nigeria kwashiorkor is very rare, but Dr. J. A. B. Nicholson of the medical department at Katsina, who has studied nutrition and infant health in the area over a considerable number of years, showed the authors cases of kwashiorkor in a famine area near Daura. At Kaduna, Dr. J. L. McLetchie heads the Trypanosomiasis and Field Survey Unit which has been gathering information on nutrition throughout Nigeria. Contributions have been made to the information of this unit by Dr. J. P. Sexton, Dr. F. N. MacNamara, and Dr. D. W. Horn.

At Ibadan, Dr. D. B. Jelliffe is Professor of Paediatrics at the University Medical School and has studied cases of kwashiorkor. He observed the occurrence of the syndrome at Duala in the French Cameroons.

At Lagos, cases of kwashiorkor in the African hospital were shown to the authors by Dr. R. Dickie. Dr. D. A. Cannon, at the Research Laboratories, has much material on the pathology of kwashiorkor which was collected in connexion with the publications of Dr. W. Hughes.<sup>38</sup> It would be of great value if an analysis of this material could be published.

At Accra, Gold Coast, cases of kwashiorkor were demonstrated at the General Hospital by Dr. A. J. Hawe, medical specialist, and at the Princess Louise Children's Dispensary, where the original report on kwashiorkor was made by Dr. Cicely Williams, by Dr. W. R. Williams. At Kumasi in the Gold Coast, Dr. B. A. S. Russell has had long experience of kwashiorkor and has published a paper.<sup>60</sup> Dr. Ofori Atta showed the authors a number of cases at the children's hospital at Kumasi. Mrs. du Sautoy, Nutrition Officer in the Gold Coast, gave a valuable report on the infant feeding and weaning habits in this territory.

At Fajara, Gambia, Professor B. S. Platt is in charge of the Nutrition Research Field Unit established by the British Medical Research Council. In this unit, Dr. J. H. Walters and Dr. J. C. Waterlow recently made a study of a large series of liver biopsies from infants and children. Dr. MacGregor is making a careful study of growth and development in infants in a number of isolated villages in the Gambia.



In addition to the points which have been referred to in the clinical section of this report, the following aspects of the work in this territory appear to be of great interest :

- (1) the low serum and liver esterase activity in malnourished infants;<sup>41, 73</sup>
- (2) the effects of deficiency of trace elements (copper, boron, and manganese) in crop production and their possible relationship to the ability of the body to utilize nitrogen (Platt<sup>56</sup>).

At Dakar, French West Africa, Dr. C. Bergeret, chief physician at the African hospital, has published some papers on the clinical features of the local variant of kwashiorkor,<sup>8</sup> which is distinguished from kwashiorkor as seen in most other parts of Africa by the severity and duration of the diarrhoea and by the development of pemphigoid dermatitis. Dr. J. Bergouniou, who is in charge of the anthropological mission established by Dr. L. Pales in French West Africa, has studied clinical malnutrition in infants and has made beautiful colour paintings showing depigmentation of the hair and skin.<sup>10</sup> At the Institut Pasteur, Dakar, working in collaboration with the African hospital and the anthropological mission, Dr. C. Auffret and Dr. F. Tanguy have engaged in biochemical research on the vitamin content of the blood and different viscera, the proteins and lipids of blood-sera, and on liver, the methionine content of the liver and of the plasma, and the methionine content of the milk of African women. Some papers have been published.<sup>6</sup>

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