A study of the age of onset, diet and the importance of infection in the pattern of severe protein-energy malnutrition in Ibadan, Nigeria

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1. Fifty unselected consecutive cases of protein-energy malnutrition (PEM) presenting at the General Out-patient Clinic of the University College Hospital, Ibadan were classified as marasmus (twenty), kwashiorkor (nineteen) marasmic-kwashiorkor (seven) and undernutrition (four) according to the Wellcome Classification of PEM (*Lancet*, 1970; Waterlow, 1972).

2. The mean age of the children with marasmus (22·4 months) and of the children with kwashiorkor (25·4 months) were not significantly different. The children with marasmic-kwashiorkor (27·8 months) were significantly older than the children with marasmus.

3. The deficits in weight- and length-for-age were similar to values previously reported (Waterlow, 1972) even though the children with marasmus tended to be older and the children with kwashiorkor younger than has been reported. Values obtained for the deficit in length-for-age suggested that the children with marasmus had been undernourished from birth whereas the children with kwashiorkor had apparently grown normally until they were 10 months old. It is possible that the history of growth in the first year of life influences the final form of PEM in these two groups of children.

4. Forty-nine of the fifty children had been breast-fed for at least 9 months and nine children had been breast-fed for 2 years. Of the twenty children with marasmus nine were still receiving some breast milk. The diets fed to weaned children with marasmus and to children with kwashiorkor were identical and consisted solely of a maize-starch gruel with no supplementation of protein or vitamins. The similarity in the dietary histories of the two main groups of children suggests some uncertainty concerning a specific role for protein deficiency in the development of kwashiorkor.

5. All the children had had similar infections. The most common of these were measles (morbilli) (40% of all cases) and gastrointestinal infections. However the children with marasmus had a history of chronic diarrhoea whereas the children with kwashiorkor had had more acute diarrhoea.

6. The similar dietary histories but dissimilar histories of infection given by the mothers of the children with marasmus as opposed to those with kwashiorkor suggest that recurrent diarrhoea was at least partially responsible for the chronic undernutrition in the group of children with marasmus. Furthermore although the weaning diets were inadequate the final deterioration in nutritional status was precipitated by gastroenteritis, often following measles.

Protein-energy malnutrition (PEM) manifests itself in two main forms: kwashiorkor and marasmus. There has been much controversy with regards to the aetiology of the two conditions, as well as their age of onset (Waterlow & Alleyne, 1970). Much

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Table 1. *The distribution of fifty malnourished children among the four main groups recognized in the Wellcome Classification of protein–energy malnutrition* (*Lancet*, 1970)

(Weight deficits were assessed against local standards (Janes, 1975))

Group	Criteria of Wellcome Classification of PEM: Oedema	Criteria of Wellcome Classification of PEM: Weight-for-age (% expected weight-for-age)	No. of children
Kwashiorkor	+	60–80	19
Marasmic-kwashiorkor	+	60	7
Marasmus	−	60	20
Undernutrition	−	60–80	4

+ Oedema present; − oedema absent.

of this controversy has been due to confusion over the criteria which should be used to identify marasmus and kwashiorkor. A simple set of criteria based upon the weight deficits of the children and the presence or absence of oedema was suggested by a Wellcome Foundation working party (*Lancet*, 1970). They recognized four main groups of malnourished children (Table 1) and their recommendations have been discussed in detail by Waterlow (1972). Since their report was published several workers (Shakir, Demarchi & El-Milli, 1972; Hijazi, 1974) have used the Wellcome Classification (*Lancet*, 1970) to describe the relative incidence of the four main types of PEM in hospital cases.

It has been proposed that the dietary aetiologies of kwashiorkor and marasmus are different (Dean, 1965; McCance, 1971), kwashiorkor being due to protein deficiency, and marasmus the result of energy deficiency. However in a number of countries the ages of the children with either marasmus or kwashiorkor appear to be different and because of this age difference it is difficult to make valid comparisons of the dietary factors associated with the two conditions. In one of the few published studies of the dietary histories of children of similar ages suffering from either kwashiorkor or marasmus, Gopalan (1968) was unable to find any qualitative difference between their diets.

Many factors, in addition to inadequate diet may be involved in PEM. These include infection (Gopalan, 1968); in this respect gastroenteritis and measles (morbilli) appear to be important (Dean, 1965).

The purpose of the present paper is to report on the current pattern of hospital cases of severe PEM in Ibadan, Nigeria, with particular reference to the age of onset, the dietary history and the patterns of infection in the children.

EXPERIMENTAL

The children were fifty consecutive cases presenting at the University College Hospital, Ibadan referred to us by the General Out-patient Clinic. Six children, whose severe PEM had resulted from either a multiple pregnancy, maternal death

Table 2. *The age and sex distribution of fifty malnourished Nigerian children from Ibadan within the four main groups recognized in the Wellcome Classification of protein-energy malnutrition* (*Lancet*, 1970)

(Values given are the nos. of children in each age-range and group)

	♂				♀			
Group ...	KW	MK	MA	UN	KW	MK	MA	UN
Age-range (years)								
0–1	0	0	1	1	0	0	0	0
1–1·5	0	0	4	1	1	0	2	0
1·5–2	2	0	2	1	3	2	3	0
2–2·5	2	2	2	1	9	2	2	0
2·5–3	1	0	3	0	1	1	1	0
Total	5	2	12	4	14	5	8	0

KW, Kwashiorkor; MK, marasmic-kwashiorkor; MA, marasmus; UN, undernutrition.

or the presence of congenital abnormalities, and who were unrepresentative of the general pattern of severe PEM in the community, were excluded from the study.

On their first visit to the Institute of Child Health, Ibadan, a detailed birth, developmental and dietary history was obtained from the mothers, also information about immunization, previous illnesses and the time of onset of the present symptoms. The children were then physically examined and their 'nude' weight and supine length were measured. The birth dates of the children were obtained from the head of the family group in which the child had been resident. Their deficits in weight- and length-for-age were estimated by comparison with local standards (Janes, 1975).

Differences between mean values were analysed by Student's *t* test.

RESULTS

1. *Ages and anthropometric measurements*

There were twenty-seven females and twenty-three males in the study group. Table 2 gives the distribution of age and sex of the children within the four main groups of PEM of the Wellcome Classification (*Lancet*, 1970). The distribution of children within the four groups were; nineteen with kwashiorkor, twenty with marasmus, seven with marasmic-kwashiorkor, four with undernutrition. Two-thirds of the children with no signs of oedema (undernutrition and marasmus) were male while three-quarters of the children with signs of oedema (kwashiorkor and marasmic-kwashiorkor) were female. The mean age of the children with kwashiorkor (25·4 months) was not significantly different from the age of the children with marasmus (22·4 months). The children with marasmic-kwashiorkor (27·8 months) were significantly older ($P < 0{\cdot}05$) than the children with marasmus (Table 3).

The deficits in weight- and length-for-age are also given in Table 3. The children with kwashiorkor had a smaller deficit in length ($P < 0{\cdot}001$) than those with either

Table 3. *Deficits in body-weight and length (% expected value) of forty-six severely malnourished Nigerian children from Ibadan grouped according to the Wellcome Classification (Lancet, 1970)*

(Mean values and standard deviations; weight and length deficits were assessed against local standards (Janes, 1975))

Group ...	Kwashiorkor (*n* 19)		Marasmic-kwashiorkor (*n* 7)		Marasmus (*n* 20)	
	Mean	SD	Mean	SD	Mean	SD
Age (months)	25·4	4·4	27·8	4·7	22·4	6·6†
Weight-for-age	69·9	7·3	54·8**	4·6	50·0	6·8**
Length-for-age	91·3	3·7	86·5*	3·0	83·8	3·9**
Weight-for-length	81·1	6·0	69·5	7·6	66·1	8·9

Mean value significantly different from that for 'kwashiorkor' group:
* $P < 0.05$, ** $P < 0.001$.
Mean value significantly different from that for 'marasmic-kwashiorkor' group:
† $P < 0.05$.

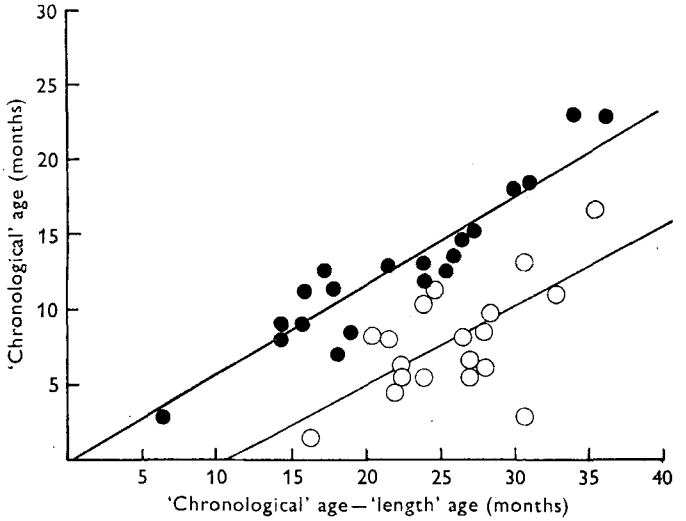

Fig. 1. The relationship between age ('chronological'; months) of presentation at the University College Hospital, Ibadan, and the deficit in length ('chronological' age—'length' age (based on local standards (Janes, 1975); months)) in malnourished Nigerian children with marasmus (●) and kwashiorkor (○), grouped according to the Wellcome Classification of protein-energy malnutrition (*Lancet*, 1970). 'Marasmus' group: *n* 20, slope 0·585, intercept 0·52, *r* 0·886, $P < 0.001$; 'kwashiorkor' group: *n* 19, slope 0·504, intercept 10·35, *r* 0·593, $P < 0.01$. Differences between intercepts: *t* 4·123, $P < 0.001$; Differences between gradients: *t* 0·488, not statistically significant.

marasmus or marasmic-kwashiorkor, suggesting that their malnutrition was of more recent onset. This conclusion was confirmed by the relationship between their deficit in length (expressed as 'chronological' age at presentation minus their 'length' age) and their age (chronological) at presentation at the hospital (Fig. 1). The results suggest that the children with marasmus had been undernourished virtually from

Table 4. *The duration of breast-feeding for forty-four severely malnourished Nigerian children from Ibadan grouped according to the Wellcome Classification of protein-energy malnutrition* (*Lancet*, 1970)

(Values given are the nos. of children in each age-range)

Age-range at complete weaning from breast milk (years)	Group		
	Kwashiorkor	Marasmic-kwashiorkor	Marasmus
0–1	0	1	0
1–1·5	1	2	8
1·5–2	11	4	8
2–2·5	5	1	3
Mean ± SD (months)	19 ± 5	19 ± 5	18 ± 6

birth even though they were presenting at different ages. On the other hand the results indicate that the children with kwashiorkor had not shown any failure to grow until they were 10 months old.

2. *Dietary history*

With the exception of one child with marasmus who had been fed on an artificial milk formula (Lactogen; Nestle Ltd, Ikeja, Nigeria) from birth, all the children had been breast-fed for at least 9 months. Some had not been completely weaned for 30 months (Table 4). Of the children with marasmus 45% were still receiving breast milk, while all the children with kwashiorkor or marasmic-kwashiorkor had been completely weaned. At complete weaning all children received maize starch as their only food with no supplements of protein, vitamins or mineral salts. These results indicate that there were no detectable differences in the dietary histories of children with kwashiorkor, marasmus or marasmic-kwashiorkor.

3. *Immunization and infections*

In general the children in the undernourished group were better immunized than the children in the other groups of PEM (Table 5). No child had been immunized against measles and no child with kwashiorkor or marasmus had received complete immunization against poliomyelitis. In general the children with kwashiorkor had received the least immunization.

Table 6 gives the infections which had affected the children within 3 months of presentation at the hospital. The incidence of measles was high and in 89% of the cases who had had measles the disease had occurred within 2 months of presentation and had apparently precipitated the child's final deterioration. There was no difference in the age of onset or the incidence of measles in the children with either kwashiorkor or marasmus. The incidence of diarrhoea was also very high. Forty-six per cent of all the children had diarrhoea when they were presented at the hospital. All the 'undernourished' group had current diarrhoea. Although 35% of the children with

Table 5. *The immunization status of fifty malnourished Nigerian children from Ibadan, aged 6 months – 3 years, grouped according to the Wellcome Classification of protein-energy malnutrition (Lancet, 1970)*

(Values are given as % immunized of the total no. of children in each group)

Group	BCG vaccination*	Complete triple antigen†	Complete poliomyelitis immuni-zation‡	Smallpox§ (variola)	Measles ‖ (morbilli)
Marasmus	40	25	0	20	0
Kwashiorkor	15	10	0	0	0
Marasmic-kwashiokor	28	0	14	28	0
Undernutrition	75	50	50	50	0

* Bacille Calmette-Guérin immunization against tuberculosis.
† Adsorbed diphtheria – pertussis – tetanus vaccine.
‡ Two oral doses; live poliovirus vaccine.
§ Dried smallpox vaccine.
‖ Live attenuated measles virus vaccine.

Table 6. *Common infections which occurred within the 3 months before presentation at the hospital in fifty malnourished Nigerian children from Ibadan grouped according to the Wellcome Classification of protein-energy malnutrition (Lancet, 1970)*

(Values are given as % total no. of children in each group)

Group	Measles (morbilli)	Acute diarrhoea	Febrile illnesses	Chicken-pox (varicella)
Marasmus	35	35	15	10
Kwashiorkor	30	40	15	0
Marasmic-kwashiorkor	42	56	14	0
Undernutrition	50	100	25	0

marasmus had acute diarrhoea their mothers reported that they had had intermittent diarrhoea for long periods of time. This history was not given by the mothers of the children with kwashiorkor who reported that their children had only recently developed gastroenteritis.

DISCUSSION

Although there are few formal reports of the relative incidence of marasmus and kwashiorkor in different communities, there appears to be a wide variation in the relative proportions of these two main forms of severe PEM in hospital cases throughout the world. In the Middle-East marasmus is more common than kwashiorkor (McClaren, 1966; Shakir *et al.* 1974), in Peru the incidence of the two forms is approximately the same (Baertl, Placko & Graham, 1974) and in Jamaica where marasmic-kwashiorkor once accounted for a high proportion of the hospital cases, marasmus has increased in recent years (Picou, 1974). Kwashiorkor is usually regarded as a particular problem in sub-Saharan Africa (Dean, 1965; McCance, 1971). However the results of the present study suggest that marasmus and kwashiorkor make up equal proportions of the hospital cases of severe PEM in Ibadan. As

Rutishauser & Whitehead (1969) have found that the relative incidence of undernutrition with or without oedema varies from one region of Uganda to another, and a recent survey of clinic cases in Northern Nigeria (Dosseter, 1975) has found that 59% of the cases of severe PEM were without oedema, generalizations as to an African pattern of severe PEM may be unjustified.

It is possible that the present results and information from hospitals in general, underestimate the incidence of marasmus in the community. Mothers tend not to recognize either a low rate of weight gain or even a loss of weight in their child, whereas the presence of oedema alerts them to the child's condition. Consequently children with oedema are usually taken to hospital earlier in the development of severe PEM than those with marasmus, which group may represent those who have survived. Nevertheless the ages of the children in the present study were similar, whether they had marasmus, kwashiorkor or marasmic-kwashiorkor. This was unexpected as previous studies in many parts of the world have indicated that children with marasmus are less than 14 months old, while children with kwashiorkor are older than 18 months (Graham, Cordano & Baertl, 1964; Dean, 1965; McClaren, 1966). There are however exceptions, for example in Jamaica where a large proportion of cases with oedema are about 1 year old (Waterlow & Alleyne, 1970; Picou, 1974) and in India where the children with marasmus tend to be older than has been usual elsewhere (Gopalan, 1968). Our findings are similar to those which have been obtained in India. However, it should be pointed out that reports of the ages of unselected cases are uncommon and where they have been reported they have suggested a smaller difference in the ages of children with marasmus and kwashiorkor drawn from the same environment (Shakir *et al.* 1972; Picou, 1974; Waterlow & Rutishauser, 1974).

The mean deficits in weight and length of the severely malnourished children were similar to those that have been previously found in malnourished children of ages different to ours (Shakir *et al.* 1972; Waterlow, 1972; Hijazi, 1974). In particular the children with kwashiorkor had a lower deficit in length-for-age than those with marasmus or marasmic-kwashiorkor. This suggests that the children with kwashiorkor had been undernourished for a shorter period than those with marasmus. This conclusion is supported by the relationship between the deficits in length-for-age and the ages of the children when they were presented at the hospital. The results suggest that the children with marasmus had been chronically undernourished from birth whereas the children with kwashiorkor were not significantly undernourished until they were 10 months old. The differences in the patterns of growth of the children with marasmus and kwashiorkor were found even though their dietary histories, as reported by their mothers, were similar. Thus of the forty-four mothers from whom we were able to obtain information, forty-three had given their child breast milk for at least 1 year. Unfortunately we were unable to obtain any information upon the amounts of breast milk that were either offered to the children or that they ingested. These must have been inadequate as 45% of the children with marasmus were still receiving some breast milk. Furthermore the six children with marasmus who had been completely weaned for at least 2 months before coming to

hospital had been fed the same diet that had been fed to the weaned children with kwashiorkor. The information on the diets of the children who had been completely weaned tend to exclude a specific protein deficiency in the aetiology of kwashiorkor, in agreement with the results obtained in India (Gopalan, 1968).

The patterns of growth of the children with marasmus or kwashiorkor suggest that it is the events of the first year *post partum* which are important in determining the final features of the terminal stages of severe undernutrition in the second year of life. As there were no differences in the reported dietary histories it is possible that factors other than the feeding practices of the mothers were responsible for the differences in the histories of growth of the two main groups of severely malnourished children. One such factor is infection, particularly of the gastrointestinal tract. Although a high proportion of children presented with diarrhoea, the mothers of the children with marasmus reported that this had continued for a long but uncertain time. In contrast the children with kwashiorkor had only recently developed severe diarrhoea, which had apparently been precipitated by measles in 30% of the cases with kwashiorkor. Furthermore the children in the undernourished group who had been well nourished, on the basis of their deficits in length-for-age, until shortly before presenting at hospital were reported by their mothers to have deteriorated after the onset of diarrhoea, precipitated by measles in 50% of the cases. Thus it is possible that the chronic undernutrition of the children with marasmus was not due to a lack of food being offered to them but to their inability to ingest or absorb the food due to chronic gastrointestinal infections.

The present results do not separate the various factors involved in the aetiology of marasmus as opposed to kwashiorkor but do cast doubt on a qualitative difference in their dietary histories. The results suggest that immunization against measles, the disease which precipitated the final deterioration in the nutritional status of approximately 40% of the present cases, would materially affect the incidence of severe PEM in Ibadan. Collaborative studies of the variations in feeding practices, staple foods and patterns of infection, all of which presumably contribute to the variations in marasmus and kwashiorkor throughout the world, are required to answer these questions in any detail.

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