

this notice will know from their own experience. In the international sphere he was, from 1930, intimately connected with the Health Organization of the League of Nations. He was Chairman of the International Conferences for the Standardization of Vitamins in 1931 and 1934 and of the International Technical Commission sponsored by the League. With Professor E. V. McCollum, Mellanby represented nutritional experts on the Medical Committee of the League of Nations which was responsible for the report that led to 'the marriage of nutrition with agriculture'. He was for many years Chairman of the Accessory Food Factors Committee of the Medical Research Council, and he ensured that the importance of nutrition was recognized and that its principles were put into practice in the feeding of civilians and of service personnel, especially during the second world war. He was also effective in extending work on applied nutrition to British colonial territories and to other overseas countries. But for his death he would have presided over an international conference on protein malnutrition recently held in Princeton. As will be seen from Volume 1, page 1 (1944), of the *Proceedings of The Nutrition Society*, he was one of eleven signatories to the document which led to the founding of The Nutrition Society. B. S. PLATT

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The nutrition of Nigerian children, with particular reference to their energy requirements

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The physical condition of Nigerian children, and their capacity to learn, which educationists believe is closely related to the adequacy of their diets, are of great importance to a country like Nigeria in which the present speed of development is frighteningly fast. In the rural areas the rate of progress is still slow, but it is the peasant farmer, cattleman and fisherman who must supply the energy foods and nutrients for the increasing numbers of semi-literate, literate and educated people living in urban communities.

The present paper reports the results of an investigation designed to compare the state of health and of nutrition of peasant children from different parts of the Nigerian bush with those of the offspring of educated families living in towns.

EXPERIMENTAL

The people studied

Three groups of peasant children and one group formed from the sons and daughters of clerks, nurses, railway officials and traders were investigated.

The Kanuri and Shuwa tribes live in small villages on or close to the banks of Lake Chad. The vegetation there is sahel savannah, the mean annual external temperature being 78° F. and the mean relative humidity 40%. They are farmers, cattle herdsman and fishermen. Their staple food is sorghum. They eat fish and meat and drink milk in reasonable quantities, but grow few fresh vegetables and little fruit. They are active people who walk long distances to market and to their farms and while herding cattle. The women and children walk from 15 to 20 miles carrying goods to and from the markets three times a week, and their farms, where they plant large areas of sorghum and cowpeas (*Vigna* spp.), may be 5 miles from the village.

The Camberri farmers live in Niger Province in the guinea savannah zone of vegetation, the mean annual external temperature and relative humidity being 77° F. and 60%, respectively. Their staple foods are millet (*Pennisetum* spp.) and sorghum. Their energy expenditure is not as high as that of the Kanuri and Shuwa, but is considerable. The men wrestle, box and dance in their spare time, and the women pound the grain and walk 5 miles to market two or three times a week.

The Otukwang Clan farmers live in Ogoja Province on the edge of the high forest and the savannah derived from it, growing yams (*Dioscorea* spp.), coco yams (*Colocasia* and *Xanthosoma* Schott), legumes and fruit. They eat many kinds of wild leaves and tree nuts, and catch a few small animals for the pot. Occasionally a baboon or duiker is shot and shared between many families. The mean annual external temperature is 78° F. and the relative humidity 85%. Their energy expenditure is much less than that of the Kanuri, Shuwa and Camberri, since they farm close to their compounds, and the local markets are close at hand. Building yam heaps, planting and weeding take only a few weeks of the year, and much time is spent sitting at home playing games of chance and gossiping. Occasionally dances are held in connexion with some fetish ceremony; they continue far into the night, and large quantities of palm wine are drunk.

The children of the Ibo and Yoruba townspeople live in Kaduna, the administrative capital of Northern Nigeria. They attend the Government school and the Ministry of Education health clinic. The school curriculum resembles that of an English day school, including organized games and physical training. The mean annual temperature in Kaduna is 77° F. and the average relative humidity is 60%. As they are of south Nigerian origin their staple foods are yams and cassava (*Manihot utilissima*), but, thanks to the good education and high salaries of their parents, they eat a much more varied diet than the peasant children. Their food is bought in the Kaduna markets.

Methods

Subjects. All the children aged 4-6 years and 10-12 years from one small village in each of the rural areas just described, and all the children aged 10-12 years of ten Ibo and Yoruba families living in Kaduna, were included in the study. The numbers were:

	Aged 4-6 years	Aged 10-12 years
Kanuri and Shuwa	27	16
Otukwang Clan	26	17
Camberri	23	15
Ibo and Yoruba	0	39

The weights and heights of many other children were measured in addition, in order to compare the rate of growth with the standards of the Middlesex County Council (Bolton, 1954). The total number of heights and weights recorded for this purpose was:

Age (years)	Kanuri and Shuwa		Otukwang Clan		Camberri		Ibo and Yoruba	
	Male	Female	Male	Female	Male	Female	Male	Female
6-7	12	23	12	10	8	7	10	9
7-8	11	10	11	12	14	12	8	12
8-9	12	11	12	11	20	12	18	10
9-10	10	11	10	9	11	11	15	12
10-11	11	11	12	11	13	13	9	10
11-12	11	12	12	20	9	10	14	13
12-13	10	11	14	10	12	10	18	14
13-14	12	14	11	11	15	12	17	16
14-15	12	11	21	10	10	13	10	17
15-16	13	11	11	11	12	12	15	13
Total	114	125	126	115	124	112	134	126

The ages of the Ibo and Yoruba children were obtained from birth certificates, but those of the peasants' children had to be assessed by questioning the parents and neighbours and by clinical examination. The subjects were unselected, the children in villages or compounds near to those in which the dietary studies were made being measured as they presented themselves until the numbers for each age and sex group were 10 or more, though that number was not always secured owing to lack of children or of time. They wore only a cotton cloth or shorts when being weighed.

Clinical examination. Clinical examinations of the children were made midway between the end of the harvest and the beginning of the next planting season. Blood was taken from an antecubital vein into a 10 ml. bottle containing the residue of one drop of 30% (w/v) potassium-oxalate solution. Total plasma proteins were estimated by the method of Van Slyke, Hiller, Phillips, Hamilton, Dole, Archibald & Eder (1950), and haemoglobin with the Medical Research Council grey-wedge photometer (100% being equivalent to 14.8 g/100 ml.). The erythrocyte-sedimentation rate (E.S.R.) was measured in Westergren tubes. The Ide test for yaws and syphilis (Smith, Elmes & Smith, 1945) was carried out. Height was measured in the vertical position, and children were weighed on a spring balance calibrated monthly against government-inspected weights.

Skinfold thickness was measured with the Longworth calipers designed by Ancel Keys (1954, unpublished), the area of the blades being 1.2 cm², and the opening pressure 180 g. Measurements were made halfway between the head of the humerus and the elbow joint, over the biceps anteriorly and the triceps posteriorly; below the angle of the right scapula; below the right costal margin in the mid-clavicular line; and just below and to the right of the umbilicus. For comparative purposes those measurements were summed for each individual. The pelvic intercrystal diameter was measured with a pelvimeter.

Food consumption. The daily food consumption of the children was measured in 1954 for three periods each of 10 days, shortly after the harvest, midway between the harvest and the next planting, and during the planting season. It had been found in previous studies of the present type that the meals eaten on the first day or two and on the last day of measurement tended to be larger and of better quality than was customary; therefore, the first 2 days' and the last day's records were discarded, and the average daily food consumption was calculated for the remaining 7 days of each period. The rates of consumption thus obtained were assumed to be typical of the rate for the given season. The planting season was found to cover 2 months, the season of plenty after the harvest also lasted 2 months, and the season between planting and harvest, when food intake was fairly steady or falling slightly, was 8 months. For the consumption of all food eaten, a weighted daily mean was calculated from the amounts recorded and the duration of each season. For perishable foods with a short season of weeks or months the average consumption on a daily basis was calculated from the quantities consumed and the length of time the food was available.

During the survey all the foods prepared for each meal were weighed before and after cooking, and individual or group helpings were weighed before they were eaten. Plate waste was measured but was found to be negligible except when the consumer was suffering from an illness such as malaria. The children in age groups 4-6 years and 10-12 years commonly shared a calabash into which were placed the staple food and the soup; the individual intake was then calculated by dividing the total quantity consumed by the number of consumers. Girls and boys were not given food separately so it was impossible to differentiate between the food consumption of the sexes in those two age groups. The children were questioned before every meal and in the morning about their food consumption between meals and during the night. The habits of the Kanuri and Shuwa children 10-12 years old were so irregular that it was impossible to measure their food consumption satisfactorily. Records were not obtained for Ibo and Yoruba children 4-6 years of age.

The nutrient composition of the diets was computed from the tables of food composition of the Food and Agriculture Organization of the United Nations (Chatfield, 1949, 1954). When those tables did not provide the necessary information the United States Department of Agriculture (Leung, Pecot & Watt, 1952) and the Medical Research Council (Platt, 1945) tables were consulted. The nutrient composition of several foodstuffs commonly used in Nigeria is not included in any of those tables. Many such foods have been analysed by the Government Chemist in London, and I am indebted to his staff for the results of the analyses. The tables used express the

nutrient composition of foods in terms of the uncooked edible portion. From the weight of individual or group helpings it was possible to calculate the amount of uncooked food from which they were derived. Soups of reasonably uniform consistency were measured by volume after preparation, and the individual consumption in terms of uncooked ingredients was calculated by proportion in the same way.

RESULTS

Diet. Details of the children's diets are shown in Table 1. The leaves used included *Albizzia gummifera*, *Vernonia*, *Phytolacca dodecandra*, *Corchorus olitorius*, *Passiflora foetida*, *Cucurbita*, *Phaseolus lunatus*, *Leptadenia lancifolia*, *Talinum triangulare*, *Hibiscus sabdariffa*, *Amarantus* spp., *Adansonia digitata* and others. Foods eaten in quantities which were found to be less than 1 g daily included *Cocos nucifera*, *Piper guineense*, small birds of various species and dried shrimps. Other foods were found to be used in very small quantities. The Otukwang peasants ate daily, on an average, 3 g of cassava tuber. Bambara nuts (*Voandzeia subterranea*) were eaten by all except the Kanuri and Shuwa in amounts which averaged 1-2 g daily; bitter kola (*Garcinia Kola*) and ukpa (*Tetracarpidium conophorum*) were used by the Ibos and Yorubas in small

Table 1. Food consumption (g/day) of Nigerian children aged 4-6 years and 10-12 years from different tribes and social classes, calculated as a mean weighted to allow for seasonal variations (see text, p. 184)

	Kanuri and Shuwa cattlemen and farmers	Otukwang Clan farmers		Camberri farmers		Ibo and Yoruba clerks
		4-6	10-12	4-6	10-12	
Age group (years) ...	4-6	4-6	10-12	4-6	10-12	10-12
Number in group ...	27	26	17	23	15	39
Guinea corn (<i>Sorghum vulgare</i>)	312	4	7	148	351	0
Millet (<i>Pennisetum typhoideum</i>)	0	1	2	16	21	0
Yam: fresh (<i>Dioscorea</i> spp.)	0	616	1103	60	30	425
dried	0	4	20	0	0	0
Coco yam (<i>Colocasia Schott</i>)	0	46	92	0	0	43
(<i>Xanthosoma Schott</i>)	0	8	18	0	0	0
Cassava, flour (<i>Manihot utilissima</i>)	0	1	2	0	0	312
Rice: milled (<i>Oryza sativa</i>)	0	1	0	0	0	56
home-pounded	0	3	1	4	0	0
Maize: mature (<i>Zea mays</i>)	0	0	1	0	0	21
immature	0	1	1	0	0	2
Sweet potato (<i>Ipomoea batatas</i>)	0	2	1	35	45	5
Groundnut (<i>Arachis hypogaea</i>)	1	3	10	1	1	15
Beniseed (<i>Sesamum indicum</i>)	0	1	1	0	0	0
Karkashi (<i>Ceratotheca sesamoides</i>)	0	<0.5	1	3	5	0
Locust bean (<i>Parkia</i> spp.)	0	1	2	0	0	0
Locust bean, fermented	0	2	3	3	3	2
Pumpkin seed (<i>Cucurbita</i> spp.)	0	1	1	1	1	2
Melon seed (<i>Citrullus vulgaris</i>)	0	0	0	1	1	1
Palm kernel (<i>Elaeis guineensis</i>)	0	1	3	0	0	0
Wild mango kernel (<i>Irvingia gabonensis</i>)	0	1	1	0	0	1
Kola nut (<i>Cola acuminata</i>)	3	0	2	0	1	2
Cowpeas (<i>Vigna sinensis</i>)	1	2	14	108	144	89
Lima beans (<i>Phaseolus lunatus</i>)	0	2	2	0	0	0
Lablab beans (<i>Dolichos lablab</i>)	0	2	2	0	0	0
Banana (<i>Musa sapientum</i>)	0	2	3	0	0	10

Table 1 (continued)

	Kanuri and Shuwa cattlemen and farmers	Otukwang Clan farmers		Camberri farmers		Ibo and Yoruba clerks
	4-6	4-6	10-12	4-6	10-12	10-12
Age group (years) ...	4-6	4-6	10-12	4-6	10-12	10-12
Number in group ...	27	26	17	23	15	39
Plantain (<i>M. sapientum</i> var. <i>paradisiaca</i>)	0	12	26	0	0	4
Red palm oil (<i>Elaeis guineensis</i>)	0	3	8	1	1	18
Groundnut oil (<i>Arachis hypogaea</i>)	0	0	0	0	0	6
Peppers, dry red (<i>Capsicum</i> spp.)	1	1	2	3	3	3
Okra: fresh (<i>Hibiscus esculentus</i>)	2	2	3	2	2	7
dried	20	1	1	2	1	0
Green leaves: fresh	1	15	20	2	3	6
dried	0	<0.5	1	2	4	0
Mango, ripe fruit, fresh (<i>Mangifera indica</i>)	0	16	39	0	0	55
Fruit, various (see text below)	10	9	16	3	7	4
Onion (<i>Allium Cepa</i>)	4	<0.5	<0.5	0	0	2
Tomato (<i>Lycopersicum esculentum</i>)	1	0	0	0	0	8
Fungi (various spp.)	0	1	1	1	1	0
Larvae (termites and other insects)	0	1	2	0	0	0
Beef: fresh	1	0	0	0	0	41
dried	1	0	0	0	0	0
Pork, lean, fresh	0	0	0	0	0	7
Duiker meat (<i>Cephalophus doriae</i>)	0	1	2	12	30	0
Liver	0	<0.5	<0.5	<0.5	<0.5	1
Baboon meat (mandrill and baboon)	0	1	2	0	0	0
Bush rat (<i>Cricetomys gambianus</i>)	0	1	2	0	1	0
Puff adder (<i>Bitis arietans</i>)	0	1	1	0	0	0
Milk: Zebu cattle, fresh	5	0	0	0	0	0
sour	105	0	0	0	0	0
sweetened condensed	0	0	0	0	0	6
Butter, cow's	3	0	0	0	0	1
Fish: fresh (various spp., e.g. <i>Lates</i>)	70	0	0	0	0	2
dried (<i>Clariidae</i> , <i>Tilapia</i>)	14	0	0	0	0	9
Fish oil	7	0	0	0	0	0
Cocoa powder, imported	0	0	0	0	0	4
Sugar, cubes, imported	0	0	0	0	0	8
Salt, imported	11	2	4	5	7	4
Toka (filtered ash salt)	0	1	1	2	2	0

amounts. Fruit, apart from mangoes, included *Landolphia florida*, grapefruit (*Citrus grandis*), pineapple (*Ananas comosus*), pawpaw (*Carica papaya*), custard apple (*Anona* spp.), orange (*Citrus sinensis*), melegueta pepper (*Aframomum* spp.), tuara (*Detarium senegalense*), garden egg (*Solanum Melongena*), jujube-tree fruit (*Ziziphus* spp.), the desert date (*Balanites aegyptiaca*) and fresh red and green peppers.

Height and weight. The mean heights and weights, pelvic intercrystal diameters and skinfold thicknesses of Nigerian children are presented in Table 2, and compared with the heights, weights and intercrystal diameters of American children of the same age (Stuart & Meredith, 1946). The Kanuri and Shuwa children were taller and heavier than the Otukwang and Camberri children, but in the 10 to 12 year-old group they were lighter though taller than the Ibo and Yoruba children. The Nigerian children's measurements were all less than those of the Americans. The skinfold thicknesses of the Otukwang children were greater than in the other tribes (Table 2). A significant correlation between weight and skinfold thickness was not found in any of the groups.

Table 2. Mean height, weight, pelvic intercrystal diameter, skinfold thickness and ratio of total to cristal height of Nigerian children aged 4-6 years and 10-12 years from different tribes and social classes, compared with the height, weight and pelvic intercrystal diameter of American children of the same ages

	American* (at school)		Kanuri and Shuwa farmers and cattlemen		Otukwang Clan farmers		Camberri farmers		Ibo and Yoruba clerks (at school)
	4-6	10-12	4-6	10-12	4-6	10-12	4-6	10-12	10-12
Age group (years) ...									
Number in group ...	—	—	27	16	26	17	23	15	39
Height (in.)	43.8	57.0	41.6	56.4	40.2	52.4	41.4	54.5	55.9
Standard deviation (in.)	—	—	3.1	2.5	3.7	2.8	4.4	2.0	2.7
Weight (lb.)	42	78	39	69	35	66	35	68	72
Standard deviation (lb.)	—	—	6.2	6.8	5.8	5.7	4.5	4.7	5.6
Intercrystal diameter (in.)	7.1	9.1	6.0	8.2	6.2	7.5	6.0	7.8	8.2
Standard deviation (in.)	—	—	0.52	0.60	0.74	0.41	0.41	0.57	0.46
Ratio, total: cristal height	—	—	1.72	1.63	1.71	1.60	1.68	1.62	1.61
Skinfold thickness (mm)	—	—	32	26	40	31	30	28	29
Standard deviation (mm)	—	—	5.8	6.0	9.0	6.4	5.3	4.4	6.5

* Stuart & Meredith (1946), quoted by McLester (1949).

The ratio, total to cristal height, was reasonably constant in all groups, being from 1.68 to 1.72 between 4 and 6 years old, and from 1.60 to 1.63 from 10 to 12 years of age.

Intake of nutrients. In Table 3 the heights and weights of Nigerian children are considered in relation to their intake of calories in comparison with the requirements for calories suggested by the Food and Agriculture Organization of the United Nations: Committee on Calorie Requirements (1950). In the same table the children's intake of nutrients is compared with the recommendations of the (U.S.A.) National Research Council (1953). It is apparent that the Otukwang children were smaller than any other group, and that their intake of calories and protein was considerably less. All the diets except that of the Kanuri and Shuwa provided quantities of calcium which were less than half the allowance recommended by the National Research Council. The calcium content of waters in Lake Chad and its tributaries in the area under discussion was found to average 10 p.p.m. as Ca, in Mbanega 12 p.p.m., in the Camberri area, 10 p.p.m. and in Kaduna 8 p.p.m. The Kanuri, Shuwa and Camberri diets lacked adequate amounts of vitamin A, and all the diets were deficient in riboflavin. The only diets which provided reasonable amounts of ascorbic acid were those of the Otukwang, Ibo and Yoruba children. Experiment in Nigeria has shown that about 80% of ascorbic acid is destroyed when yams and other root vegetables are soaked, pounded and boiled into fofoo. The preparation of flour from cassava destroys 100%, and vegetables, leaves and such fruit as peppers, when boiled in an emulsion of oil and water lose on an average 67% of the ascorbic acid present in the edible portion. Allowance has been made for the losses in calculating the amounts of ascorbic acid in the children's diets.

Comparison with American standards. In Table 4 the Nigerian children's heights and weights and intakes of calories and protein are set out, together with their differences from the American standards and from the allowances recommended by the

Table 3. Mean height and weight of Nigerian children aged 4-6 years and 10-12 years from different tribes and social classes, considered in relation to their daily intake of calories and nutrients compared with the recommended allowances of, for nutrients, the (U.S.A.) National Research Council: Food and Nutrition Board (1953) and, for calories, the Food and Agriculture Organization of the United Nations: Committee on Calorie Requirements (1950)

	Recommended allowance		Kanuri and Shuwa farmers and cattlemen	Otukwang Clan farmers		Camberri farmers		Ibo and Yoruba clerks
	4-6	10-12		4-6	10-12	4-6	10-12	
Age group (years) ...	4-6	10-12	4-6	4-6	10-12	4-6	10-12	10-12
Number in group ...	—	—	27	26	17	23	15	39
Height (in.)	—	—	41·6	40·2	52·7	41·4	54·5	55·9
Weight (lb.)	—	—	39	35	66	35	68	72
Intake of calories (Cal.)	1480*	2300*	1380	910	1770	1110	1970	2730
Intake of nutrients:								
Protein: total (g)	50	70	56	25	46	47	82	65
from animal sources (g)	—	—	22	1	2	2	6	15
Fat (g)	—	—	23	10	22	12	23	49
Carbohydrate (g)	—	—	242	183	355	215	386	516
Calcium (g)	1·0	1·2	1·1	0·3	0·4	0·3	0·4	0·5
Iron (mg)	8	12	26	10	17	17	29	18
Vitamin A (i.u.)	2500	4500	1300	3300	7300	1270	1970	14100
Thiamine (mg)	0·8	1·2	1·6	0·8	1·5	1·8	3·0	1·6
Riboflavin (mg)	1·2	1·8	0·6	0·3	0·5	0·6	1·0	0·6
Nicotinic acid (mg)	8	12	13	6	12	10	20	14
Ascorbic acid (mg)	50	75	10	30	69	6	10	44

* Allowance has been made for a mean annual external temperature of 25°.

F.A.O. and by the (U.S.A.) National Research Council. The calorie values for all the diets, except that of the Ibo and Yoruba group, were less than the suggested requirements. The Otukwang diet, based on yams, did not provide enough protein.

Clinical findings. The parasitic infestation rate, the incidence of enlargement of the liver and spleen, and the biochemical and serological findings are given in Table 5. The total infestation rates were greatest in the Otukwang children, but malaria, although endemic throughout, affected the Kanuri and Shuwa more than any other group. Yaws was prevalent among the Otukwang Clan. A minor form of syphilis was commonly seen in the Kanuri and Shuwa adults, but positive Ide tests were not obtained from any of their children.

The incidence of certain clinical features is recorded in Table 6. The general appearance of the Kanuri and Shuwa children aged 10-12 years was superior to that of any other group. The poorest appearance was presented by the Otukwang children. Staring hair was seen commonly in the Kanuri, Shuwa and Camberri. Angular stomatitis was often seen in all groups but was least in the Kanuri and Shuwa. A general and nodular enlargement of the thyroid gland was not uncommon in the Otukwang children, whose parents often suffer from simple goitre. Dental caries was frequently observed in the Kanuri, Shuwa, Ibo and Yoruba children, and gingivitis was seen in all

except the Kanuri, Shuwa and young Camberri groups. Tropical ulcers and their scars were found least in the Ibo and Yoruba children, and most often in the Otukwang Clan.

Table 4. *Deviation from certain American standards of the mean height and weight of Nigerian children aged 4-6 and 10-12 years from different tribes and social classes, and the difference between their intakes of calories and protein and the recommended allowances of, for calories, the Food and Agriculture Organization of the United Nations: Committee on Calorie Requirements (1950) and, for protein, the (U.S.A.) National Research Council: Food and Nutrition Board (1953)*

Standard or allowance*	Deviation from standard by children of				
	Kanuri and Shuwa farmers and cattlemen	Otukwang Clan farmers	Camberri farmers	Ibo and Yoruba clerks	
Children aged 4-6 years					
Number in group ...	—	27	26	23	—
Height (in.)	43·8	-2·2	-3·6	-2·4	—
Weight (lb.)	42	-3	-7	-7	—
Intake of calories (Cal.)	1480†	-100	-570	-370	—
Intake of total protein (g)	50	+28	-24	-1	—
Children aged 10-12 years					
Number in group ...	—	16	17	15	39
Height (in.)	57·0	-0·6	-4·3	-2·5	-1·1
Weight (lb.)	78	-9	-12	-10	-6
Intake of calories (Cal.)	2310†	‡	-540	-340	+420
Intake of total protein (g)	70	‡	-22	+18	+10

* The standards for height and weight for American children were taken from Stuart & Meredith (1946).

† Adjusted for a mean annual external temperature of 25°.

‡ Records not obtained.

Performance compared with that of English children. Figs. 1 and 2 compare the heights, weights and growth rates of the four groups of Nigerian children with the standard curves printed on the Middlesex County Council school medical record cards, which were prepared as follows. The heights of the schoolchildren were plotted against the weights, and from the graph a table was drawn up showing the height for weight at regularly spaced weight intervals. The height for age was plotted on the cards, and a weight scale was marked on the right of the card, for which the values obtained by plotting height against weight were used. The divisions on the weight scales are not evenly placed, but approximate to a logarithmic progression. Thus, if the ratio of height to weight for groups of children to be compared with the Middlesex schoolchildren is the same as that of the Middlesex schoolchildren, height and weight will coincide and growth will be shown as a single line, even if it is advanced or retarded in comparison with the standard. If the ratio of height to weight is different a double line will result. In children thinner than the standard the weight line will fall below that for height; with fatter children the reverse will occur. In all except the Kanuri

Table 5. *Percentage incidence of parasitic infestations, yaws and enlargement of liver and spleen, mean concentration of haemoglobin and of total plasma proteins, and mean erythrocyte sedimentation rate in Nigerian children aged 4-6 years and 10-12 years from different tribes and social classes*

	Kanuri and Shuwa farmers and cattlemen		Otukwang Clan farmers		Camberri farmers		Ibo and Yoruba clerks	
	4-6	10-12	4-6	10-12	4-6	10-12	4-6	10-12
Age group (years) ...	27	16	26	17	23	15	39	39
Number in group ...	0	0	33	25	0	4	5	5
Percentage with parasitic infestation with: ascaris	0	0	0	0	30	15	4	4
ankylostomes	0	23	0	0	33	24	0	0
<i>Taenia saginata</i>	0	0	0	0	0	0	0	0
<i>Trichuris trichiura</i>	0	0	0	25	0	0	0	8
<i>Schistosoma haematobium</i>	4	4	0	0	3	3	6	6
<i>Schistosoma mansoni</i>	0	0	0	0	0	0	0	0
<i>Entamoeba histolytica</i>	0	0	0	5	0	3	3	3
microfilariae	0	0	13	40	0	0	0	0
subtertian malaria parasites	50	50	38	40	27	33	12	12
Percentage with yaws: secondary	0	0	64	0	0	0	0	0
tertiary	0	0	0	20	0	0	0	4
foot	0	0	0	20	0	0	0	8
Percentage with enlarged: liver*	0	0	18	5	0	0	0	0
spleen†	69	80	27	26	31	50	26	26
spleen and liver	0	8	36	26	15	0	5	5
Percentage with Ide test positive	0	0	58	100	0	0	14	14
Haemoglobin concentration (g/100 ml.)	11.6	11.4	10.6	10.6	10.0	11.8	12.7	12.7
Standard deviation (g/100 ml.)	2.4	3.0	3.1	2.3	2.1	1.8	2.9	2.9
Total plasma-protein concentration (g/100 ml.)	7.7	7.7	7.7	8.1	7.9	8.2	7.5	7.5
Standard deviation (g/100 ml.)	1.4	0.8	0.8	0.4	1.9	0.6	1.2	1.2
Erythrocyte sedimentation rate (mm/h, oxalated, Westergren tubes)	57	59	61	78	52	57	35	35
Standard deviation (mm/h)	18.0	27.3	9.8	28.3	14.5	15.6	18.5	18.5

* The liver was recorded as enlarged if the lower edge was palpable $1\frac{1}{2}$ in. below the costal margin in the mid-clavicular line, the subject being supine.

† The spleen was recorded as enlarged if it was palpable below the costal margin, the subject being supine.

Table 6. Incidence of certain clinical features found at examinations, carried out between the harvest and planting, in Nigerian children aged 4-6 years and 10-12 years from different tribes and social classes

	Kanuri and Shuwa farmers and cattlemen		Otukwang Clan farmers		Camberri farmers		Ibo and Yoruba clerks
	4-6	10-12	4-6	10-12	4-6	10-12	
Age group (years) ...	27	16	26	17	23	15	39
Number in group ...	40	78	36	39	40	44	60
General appearance	60	22	55	61	60	56	38
Percentage with general appearance: good	0	0	9	0	0	0	2
fair	30	20	9	0	20	25	3
poor	69	60	12	10	33	25	10
Skin	23	20	0	0	67	75	0
Percentage with: staring hair	0	0	0	0	0	0	0
generalized xerosis, mild	0	0	18	11	20	25	29
generalized xerosis, very dry	0	0	28	23	13	13	27
follicular hyperkeratosis	8	8	0	0	20	23	13
nasolabial seborrhoea	8	8	0	0	0	0	0
angular stomatitis	8	8	0	0	0	0	0
permanent gooseflesh	16	58	27	18	20	70	49
Tongue	0	0	18	20	10	10	29
Percentage with pebbling of papillae	0	3	9	0	0	0	1
Eyes	0	0	0	0	0	0	0
Percentage with: injected conjunctiva	0	0	0	0	0	0	0
superficial corneal opacities	0	0	0	0	0	0	0
dry cornea	0	0	0	0	0	0	0
xerophthalmia	0	0	0	0	0	0	0
Thyroid	0	0	9	18	0	0	5
Percentage with: slight general enlargement	0	0	0	9	8	0	0
nodular goitre	8	10	0	0	0	0	18
Teeth and gums	0	0	18	10	0	25	29
Percentage with: caries*	0	0	0	0	0	0	4
gingivitis†	8	8	0	0	0	0	0
periodontitis, purulent	0	0	0	0	0	0	0
Ulcers	8	0	0	23	0	20	4
Percentage with: ulcers near ankles	0	40	36	80	20	30	6
ulcer scars near ankles	0	0	0	0	0	0	0

* Includes all subjects who had one or more carious teeth.

† Gums swollen and red or purple, often bleeding on pressure.

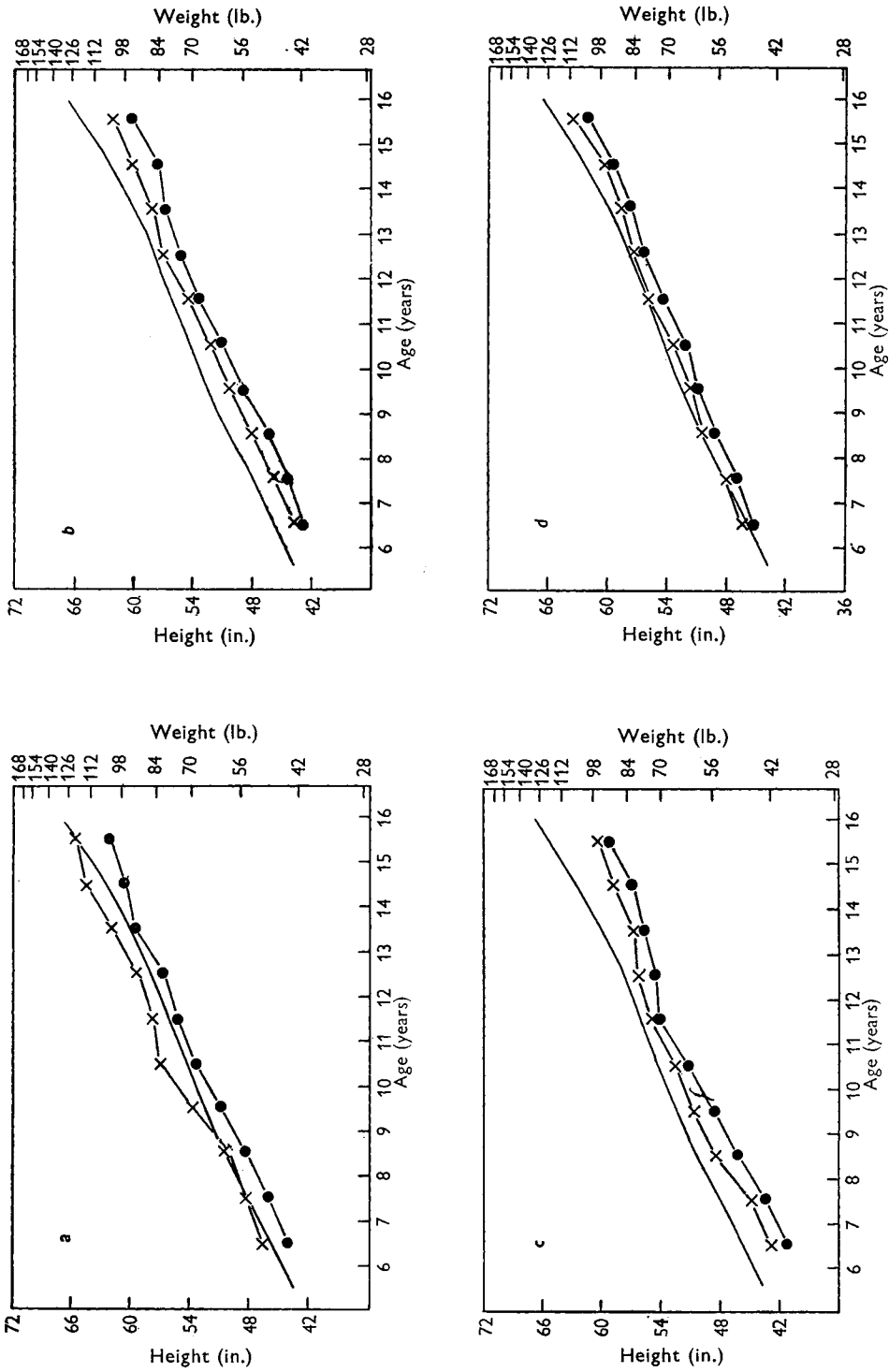


Fig. 1. Mean heights and weights of Nigerian boys from the (a) Kanuri and Shuwa (114 boys), (b) Camberri (124 boys), (c) Otukwang (126 boys) and (d) Ibo and Yoruba (134 boys) tribes, compared with the standard curve for height and weight combined used by the Middlesex County Council (for full explanation see text, p. 189). x ----- x, height; ●-----●, weight; ———, Middlesex County Council standard curve.

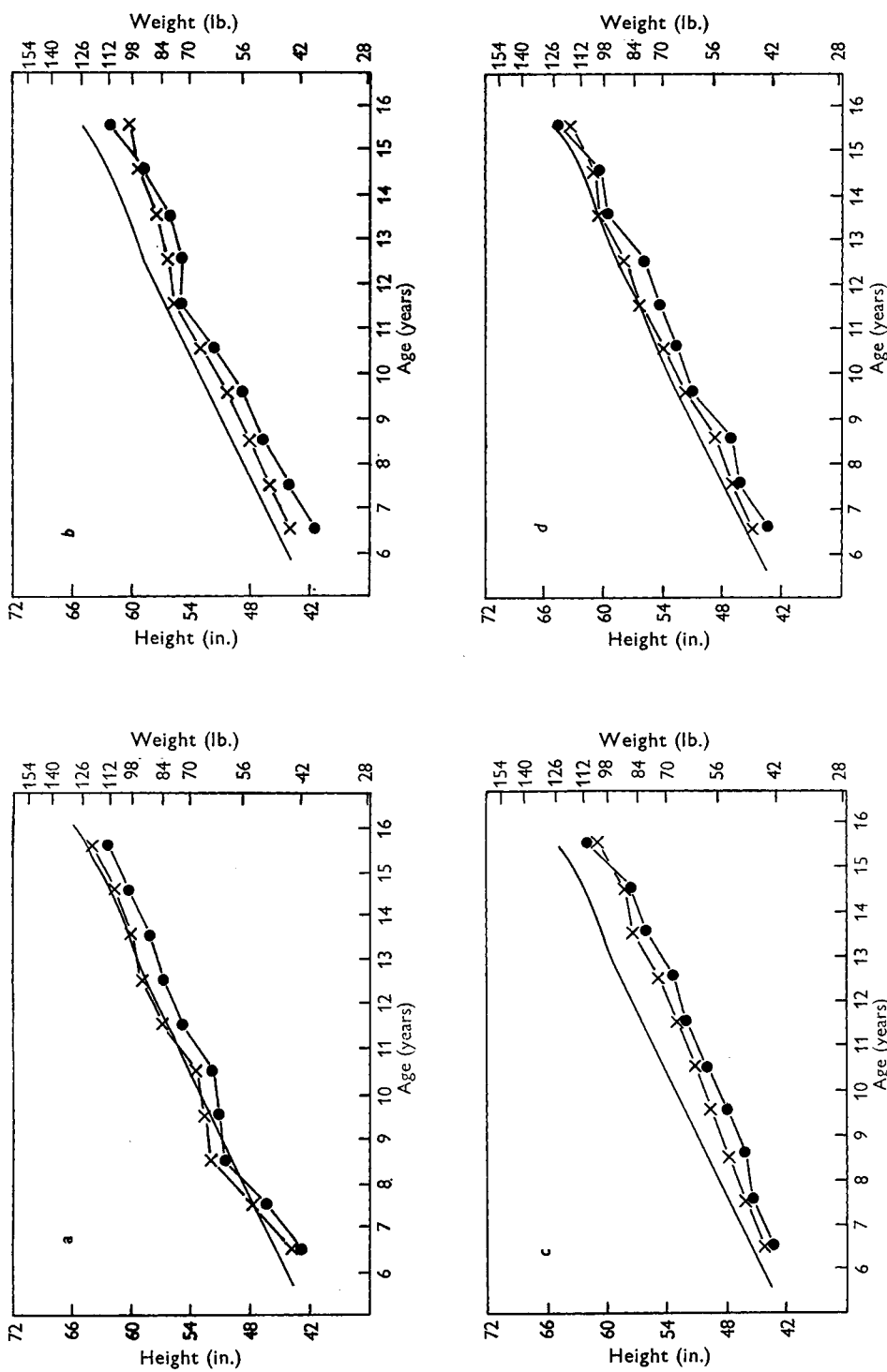


Fig. 2. Mean heights and weights of Nigerian girls from the (a) Kanuri and Shuwa (123 girls), (b) Camberri (112 girls), (c) Otukwang (115 girls) and (d) Ibo and Yoruba (126 girls) tribes, compared with the standard curve for height and weight combined used by the Middlesex County Council (for full explanation see text, p. 189). x—x, height; ●—●, weight; —, Middlesex County Council standard curve.

and Shuwa it is obvious that the Africans were shorter and lighter than the English, the discrepancy being greater for weight than for height. The Kanuri and Shuwa boys were taller than the Middlesex boys, but lighter; the Kanuri and Shuwa girls were of about the same height as the English girls, but their growth curve shows a depression between 8 and 10 years of age. At some period between 12 and 15 years all the charts except that of the Kanuri and Shuwa girls show a period during which growth was slower than that of the English children. Between the ages of $14\frac{1}{2}$ and $15\frac{1}{2}$ years the weights of Otukwang, Camberri, Ibo and Yoruba girls increased relative to their height, but such a change did not occur with the Kanuri and Shuwa girls.

DISCUSSION

The effect of intake of calories and protein on height and weight

Study of Tables 3 and 4 suggests that in determining the height and weight of the children a greater part is played by the intake of calories than by the amount of protein in the diet, provided that the deficiency of protein, quantitative or qualitative, is not severe. The weights and heights of the Ibo and Yoruba children were less than the American and British standards (Table 4 and Figs. 1 and 2), although their diets supplied more calories and protein than the recommended allowances, from which it could be inferred that the allowances are not sufficient for those children's needs. There are, however, certain points which must be considered. The dietary survey may not have been accurate to within 400 or 500 Cal. and 10 g of protein, although it is believed that it was, in fact, accurate to at least twice that degree. The discrepancy might be due to high energy expenditure by the Ibo and Yoruba children. The presence of intestinal parasites and subtertian malaria must increase the requirements for calories and nutrients. Again, it is possible that the Nigerian diets have a low digestibility. It is probable that each of the factors just mentioned is responsible for part of the discrepancy between the intake of energy and protein of the Ibo and Yoruba children on the one hand and the height and weight attained by them on the other. Where the peasant children are concerned the additional factor comes into play, that they were not given a fair share of the family rations. The mean daily calorie intakes of the parents of the children, compared with the requirements suggested by F.A.O. adjusted for sex, age, weight, environmental temperature, pregnancy and lactation, were as follows:

	Computed mean daily intake (Cal.)	F.A.O. suggested requirement (Cal.)	Difference (Cal.)
Kanuri and Shuwa: men	2980	2550	+ 430
women	2650	1910	+ 740
Otukwang Clan: men	2400	2540	- 140
women	1950	2080	- 130
Camberri: men	2780	2710	+ 70
women	2080	2060	+ 20
Ibo and Yoruba: men	3000	2750	+ 250
women	2890	2690	+ 200

Comparison with the values for the children (Tables 3 and 4) makes it clear that only the young Ibos and Yorubas were given a share of the ration which was proportionate to that eaten by their parents.

Quenouille, Boyne, Fisher & Leitch (1951), in their statistical studies of recorded energy expenditure of man, concluded that basal metabolism changes inversely with environmental temperature and directly with atmospheric humidity. According to their tables the basal metabolic rate of the Ibo and Yoruba boys and girls, respectively, living in Kaduna would be 73 and 63 Cal./24 h less than at the standard temperature and humidity of 70°F and 75%. The dietary survey suggests that the Ibo and Yoruba children living in Kaduna consume more calories than are adequate for their needs. They are not overweight judged by American or British standards. It is possible, therefore, that the F.A.O. standards underestimate the total energy requirements of these children, including the calories burnt during fevers and in feeding intestinal parasites.

Clinical features

The list of clinical features in Table 6 and their distribution are in keeping with the hypothesis that vitamin A deficiency results in staring hair and generalized xerosis. The quantities of vitamin A and carotene, and of ascorbic acid consumed, were sufficient to prevent the occurrence of follicular hyperkeratosis. The distribution of gingivitis in the children does not suggest that lack of ascorbic acid is an important aetiological factor in these groups of Nigerian natives.

The occurrence of angular stomatitis, nasolabial seborrhoea and abnormal vascularity of the conjunctiva in the Nigerian children confirmed the observation made earlier that lack of riboflavin is of aetiological importance (Nicol, 1949, 1952). Permanent gooseflesh, however, previously attributed to the same cause, was not seen in the Otukwang children, whose intake of riboflavin was very low. In connexion with abnormal vascularity of the conjunctiva it is important that all the groups except the Kanuri and Shuwa are exposed to infestation by the microfilariae of *Onchocerca volvulus* (Budden, 1955).

The incidence of dental caries was highest in the group of children living in Kaduna. It was not observed in the most poorly fed children, but the Kanuri and Shuwa had a high incidence. Thus there was no straightforward relationship between dental caries and the consumption of cereals and calcium. Vitamin D was presumably not lacking to any group. The standard of dental hygiene is primitive throughout, only a few of the Ibos and Yorubas using toothbrushes and toothpaste in preference to the chewstick. Refined sugar, condensed milk and cocoa are eaten in small amounts by the Ibo and Yoruba children, but not by the Kanuri and Shuwa.

The incidence of ulcers and their scars near the ankle was highest in the Otukwang Clan, whose diet differed from the others in its low protein content, and lowest in the Ibo and Yoruba town dwellers, who ate well and are not exposed to injury as much as the children living in bush.

Malaria is endemic throughout the tribal areas, and many of the children living in Kaduna become infected during the rains. Splenomegaly was most frequent in the Kanuri and Shuwa (Table 5). Enlargement of the liver to 1½ in. below the costal

margin was common among the Otukwang children, fatty infiltration and periportal fibrosis being the pathological picture in the three cases in which biopsies were performed. A deficiency of protein of good quality could be the cause, but not necessarily of animal protein, as the incidence of hepatomegaly was low in the Camberri, who eat very little meat or fish, and do not drink milk.

Haemoglobin concentration was low throughout, and the values for plasma proteins and the E.S.R. were high. In the Ibo and Yoruba children a comparatively low rate of infestation with parasites was associated with a higher haemoglobin value and a lower concentration of plasma protein and E.S.R. than in the other three groups.

Conclusions

There is little to choose between the physical development of the Kanuri and Shuwa peasant children on the one hand and the Ibo and Yoruba schoolchildren on the other. Both groups eat well by Nigerian standards, although the consumption of different foodstuffs by the two groups produces two different nutritional patterns. The results presented suggest that the calorie requirements of certain groups of Nigerian children have been underestimated, when the environmental factors of temperature and humidity, infestation with intestinal parasites, and malaria are taken into account. The calorie value of the Ibo and Yoruba children's diet was found to exceed by 18% the figure suggested for their requirement by the Food and Agriculture Organization.

Among all but the educated Ibos and Yorubas living in Kaduna, the children do not consume enough food to supply the energy and nutrients they require, even when the diet of the adults supplies plenty of calories. It could well be that the tall, slender Kanuri and Shuwa would attain larger adult stature, in spite of the parasites they harbour, if the children were given enough food to satisfy their needs.

SUMMARY

1. The diets of three groups of Nigerian peasant children living in bush and one group of schoolchildren living in a large town were measured in 1954. The methods used to determine their average daily intake of calories and nutrients are described.

2. The general clinical condition of each group was assessed, together with the mean height, weight, pelvic intercrystal diameter, skinfold thickness, haemoglobin concentration, total protein content of the plasma, and erythrocyte sedimentation rate.

3. It is suggested that the calorie requirements of the children in their own environment are greater than those suggested by the Food and Agriculture Organization of the United Nations.

4. Staring hair and generalized xerosis were associated with a low intake of vitamin A, and angular stomatitis, nasolabial seborrhoea and an abnormal degree of injection in the conjunctiva with a low intake of riboflavin.

5. A relationship between gingivitis and dietary ascorbic acid was not observed, nor was any simple association demonstrated between dental caries and the consumption of cereals and calcium.

6. By Caucasian standards the mean haemoglobin concentration of all the groups of children was low, and the total plasma proteins and erythrocyte sedimentation rates were high.

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