The effect of diet on the haemoglobin and haematocrit values of some Nigerian village children

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1. Eighty-eight Nigerian village children aged 1–12 years were involved in this study.
2. A food consumption survey on each child was carried out for 7 consecutive d; iron, folic acid and calorie intakes were calculated from food composition tables.
3. Samples of the children's diets (cooked) were collected and analysed for moisture, total nitrogen and ascorbic acid content.
4. Blood samples were assessed for haemoglobin and haematocrit values.
5. Calorie, protein and folic acid intakes were low for all age groups; iron and ascorbic acid intakes were adequate.
6. There was no incidence of severe anaemia. Only 10% of all the eighty-eight children had a haemoglobin concentration below acceptable levels and only about 8% of all the eighty-eight children had haematocrit values below acceptable level.

Anaemia has always been considered a common health problem among children in developing countries. Previous workers have confirmed the prevalence of nutritional anaemias among Nigerian children (Nicol, 1956, 1959; Macgregor, 1958; Cobban, 1959). Gilles (1965) reported low haemoglobin levels among Nigerian village children and he suggested that a high degree of malarial infestation was a contributory factor. Edozien (1965*a*) also reported low haemoglobin and haematocrit values among Nigerian village children but found that most of them had normal total circulating red cell volume and higher red cell mass per unit body-weight than the subjects in the reference group. Thus, he suggested, low haemoglobin and haematocrit values among the village children did not necessarily indicate the presence of anaemia. The diets of the children in both studies referred to above were reasonably high in iron but low in protein. The average daily iron intake in both studies was 14 mg and the average daily protein intake was 18 g. Edozien (1965*b*) found that 39% of the children examined had serum protein levels below an acceptable value and 53% of the children examined had serum folic acid levels below an acceptable value. This study set out to investigate whether anaemia was a common health problem among the village children and the relationship between the diet of the children and their haemoglobin and haematocrit values. Four nutrients having a direct relationship with haemopoiesis were studied, namely protein, iron, ascorbic acid and folic acid.

EXPERIMENTAL

The study was carried out at the village of Osegere, 15 miles north-east of Ibadan (the capital of Western State) with a population of about 1500. The houses were

numbered 10–199 and the houses chosen for the study were selected by random sampling. A random sampling table was used, a finger (with the eyes closed) was placed on a number and the numbers that followed underneath were chosen. The last two figures of the numbers were the figures that had to correspond with the last two figures in the numbering of houses. Fifty-seven houses were chosen and eighty-eight children were involved. They were all between the age of 1 and 12 years.

Blood samples

Blood samples were taken from the left thumb. The haemoglobin concentration was measured colorimetrically as cyanmethaemoglobin (King & Wootton, 1956). Haematocrit values were measured in heparinized capillary tubes with the aid of a portable haematocrit centrifuge (Dacie & Lewis, 1963) and they were compared with the values shown in Table 1.

Table 1. *Haematological values for Nigerians from 0 to 12 years of age (Interdepartmental Committee on Nutrition for National Defence, 1965)*

Category*	Haemoglobin (g/100 ml)	Packed cell volume (%)
Deficient	10·0	30·0
Low	10·0–10·9	30·0–33·9
Acceptable	11·0–11·9	34·0–36·9
High	12·0	37·0

* 'Deficient' signifies a condition in which signs of anaemia are well marked, 'low' one in which anaemia can be regarded as normally present, 'acceptable' one in which anaemia might occur, and 'high' one in which there is no biochemical evidence of anaemia.

Food consumption survey

Food consumption was assessed for 7 consecutive d by an individual consumption survey method. The food of each child was weighed just before being eaten and the waste (if any) on the plate was weighed after the meal. It was easy to follow up the children's intake as a food consumption survey for the adults was carried out concurrently.

Estimation of food values. The diets consisted mostly of cooked food made from cassava, yam, beans, maize, rice and plantains. While, in the main, the approximate composition of the diets was well known, there were a few unique dishes. The weights of raw foodstuffs used in preparing such dishes were recorded. Samples of all foods eaten (cooked and uncooked) were collected for analysis for moisture, total nitrogen and ascorbic acid content. The calorie, iron and folic acid contents of most dishes were calculated from departmental food analysis records (which are based on both raw and cooked foods). A few items not available in the departmental records were calculated from the FAO (1968) food tables. These calculations were based on the weights of uncooked foodstuffs used for the preparation of the dishes because FAO tables refer to nutrient values of uncooked foodstuffs. Table 2 shows the dietary pattern.

Analytical methods

Moisture. Moisture was measured by drying weighed portions of the food to constant weight in an air oven at 98–100°.

Protein. Total nitrogen was measured by the micro-Kjeldahl technique following the recommendations of Chibnall, Rees & Williams (1943). Protein was taken as $N \times 6{\cdot}25$ for all dishes except cereal dishes when $N \times 5{\cdot}7$ was used.

Ascorbic acid. This was estimated by visual titration with 2:4 di-chlorophenol indophenol according to the method described by the Association of Vitamin Chemists (1966).

Table 2. *Dietary pattern of the village children*

Foodstuff	Dish	Comments
Carbohydrates: Cassava	Lafun	Cassava flour cooked with water
	Gari	Fermented cassava flour
	Eba	Gari cooked with water
Yam	Amala	Yam flour cooked with water
	Boiled yam	
	Pounded yam	Pounded boiled yam
Cocoyam	Boiled	
	Pounded	
Plantains	Roasted	
	Dodo	Fried plantain
Maize	Pap	Fermented maize meal cooked with water
	Agidi	Cold, moulded pap
	Mosa	Fried maize meal
Rice	Boiled	
Proteins: Beans	Akara	Fried milled beans
	Moyinmoyin	Steamed milled beans
	Alapa	Steamed milled beans mixed with milled melon seeds
	Adalu	Boiled beans eaten with pepper sauce
Meat	Meat stew	
Fish	Dried fish stew	
Melon seeds	Egusi stew	Eaten with carbohydrate dishes
Vitamin sources: Vegetables	Ewedu soup Spinach soup	Leafy vegetables
	Okro soup	Eaten with carbohydrate dishes
Fats: Palm oil	Palm oil	For cooking

Requirements

These were calculated as follows: calories from the report of the FAO committee (FAO, 1965); protein from the report of the joint FAO/WHO committee (WHO, 1965); iron and ascorbic acid from the requirements suggested by the British Medical Association (1950). So far, no accurate estimate of the daily requirement for folic acid has been made, but it is generally accepted that an average diet that will maintain good folic acid nutrition should contain 0·5 mg daily.

RESULTS

Table 3 shows an average nutrient intake among the village children. The protein intake of all age groups was generally low as compared with their requirements. This finding agrees with others in this part of the country (Nicol, 1959; Gilles, 1965; Edozien, 1965*b*). The iron intake was high among all age groups, also in agreement

Table 3. *Average daily nutrient intake of the village children*

Age group* (years)	Calories (kcal)	Protein (g)	Iron (mg)	Ascorbic acid (mg)	Folic acid (μg)
1–3 (20)	633	13·4	8	15	63
	49	**61**	**101**	**100**	
3–6 (23)	963	17·0	11	15	71
	57	**62**	**147**	**100**	
6–9 (25)	1023	18·3	13	20	87
	51	**67**	**123**	**100**	
9–12 (20)	1280	19·7	16	25	93
	51	**67**	**118**	**83**	

Values in bold-face type represent percentage of requirements.
* Figures in parentheses are the numbers of children studied.

Table 4. *Average haemoglobin (g/100 ml blood) and haematocrit values (packed cell volume (PCV) %) of the Nigerian children*

Age group* (years)	Haemoglobin		PCV (%)	
	Mean	Range	Mean	Range
1–2 (20)	11·9	10·1–12·7	36·4	30–38
2–5 (23)	11·8	10·4–13·5	36·8	33–42
5–10 (25)	12·4	10·8–13·9	38·7	30–47
10–12 (20)	12·8	11·2–13·9	39·8	36–43

	Percentage distribution							
	Haemoglobin				PCV (%)			
Age group (years)	Deficient	Low	Acceptable	High	Deficient	Low	Acceptable	High
1–2	0	10	20	70	0	10	20	70
2–5	0	20	33	47	0	13	37	50
5–10	0	8	22	70	0	8	14	78
10–12	0	0	12	88	0	0	12	88

* Figures in parentheses are the numbers of children examined.

with reports from other parts of the country as shown in a previous paper ('B. O. A. Osifo, unpublished), and so iron nutrition may not be as large a problem as we have thought. The ascorbic acid intake was also generous and it met the recommended dietary allowances for all age groups. Folic acid intake was low.

Table 4 shows the average haemoglobin and haematocrit values. There was no child with a deficient haemoglobin level. In all groups, over 80% of the children had haemoglobin levels within the range of 'acceptable' and 'high'. Even in the most

vulnerable age group (2–5 years old) only 20% of the children had a low haemoglobin level. This could be a result of faulty weaning. It is also interesting to note that in all age groups the minimum packed cell volume (PCV) was 30%. There was no child with a deficient PCV level. In all groups, over 85% of the children had PCV levels in the range of 'acceptable' and 'high'.

DISCUSSION

Throughout the study, no severe case of anaemia was found. Edozien (1965*b*) found that the red cells of children in Nigerian villages were usually normocytic and normochromic and there was no evidence of a haemolytic process. He suggested that the low haemoglobin levels were due to overhydration, with high plasma volumes resulting from protein and calorie deficiency. The present study has shown that both protein and calorie intakes were low among the children and this could be a contributory factor to the low levels of haemoglobin as reported by Edozien (1965*b*). Edozien (1965*b*) also reported that severe cases of anaemias (i.e. reduction in the red cell mass) caused by protein deficiency occurred only in advanced stages of protein deficiency. The level of protein intake found in this study seemed adequate to avoid protein-deficiency anaemia. This could be a case of physiological adaptation to low protein intake, as these children have never been used to a higher level of protein intake.

The iron and ascorbic acid intakes appeared to be adequate. It must be emphasized that this study took place in a dry season when vegetables and fruits were scarce. Higher figures for ascorbic acid and iron intake have been reported during the wet season in some of our departmental reports (unpublished). It has also been shown ('B. O. A. Osifo, unpublished) that iron intake in this village was adequate for normal, healthy adult women until the physiological stress of pregnancy occurs.

The folic acid intake was found to be low and it is perhaps surprising that such high haematocrit values were found. Edozien (1965*b*) reported high serum levels of vitamin B_{12} among the population in this same village. There is evidence (Stokstad & Koch, 1967) that vitamin B_{12} is essential for the efficient metabolism and utilization of folic acid, and the reported abundance of vitamin B_{12} among the village population may partly account for the low incidence of anaemias caused by folic acid deficiency.

Finally, it must also be mentioned that these children received a high standard of medical care throughout the year as there was a health centre at the village. Moreover, it is possible that their dietary habits have improved because of the *ad hoc* nutrition lectures given to their mothers at the clinic.

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