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MAJOR CAUSES OF ANEMIA IN CHILDHOOD AND PREGNANCY: A REPORT ON SELECTED PROVINCES IN CAMEROON

A Report Prepared By:
A.F. FLEMING, M.D.
S.R. LYNCH

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PREFACE

PREFACE

In conformance with an agreement with the United States Agency for International Development (USAID), AID/DSPE-C-0053, the American Public Health Association (APHA) invited the authors to work with the Ministry of Health of the United Republic of Cameroon and the University of Yaoundé on a three-week field survey to determine the major causes of anemia in Cameroon.

The Authors

The two consultants retained for the project were:

Alan Frederick Fleming, M.A., M.D., F.R.C. Path., F.M.C. Path. (Nigeria); Professor of Haematology and Blood Transfusion, Faculty of Medicine, Ahmadu Bello University, Zaria, Nigeria

Sean Roborg Lynch, M.D., Associate Professor of Medicine, Division of Hematology, University of Kansas Medical Center, Kansas City, Kansas, U.S.A.

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EXECUTIVE SUMMARY

EXECUTIVE SUMMARY

Anemia is known to occur at a high prevalence (38.1 percent) in children in Cameroon. Only a few previous studies of the etiology of anemia in Cameroon have been undertaken. They suggest that iron deficiency is an important factor in both pregnancy and childhood. The present work is of the nature of a pilot study into the etiology of anemia in childhood and pregnancy in the Eastern Province of Cameroon, where the prevalence in childhood is high (57.6 percent), and in the Northern Province, which has a different ecology, but also a relatively high prevalence of anemia in childhood (41.0 percent).

In the Eastern Province, 11 children and 10 women were studied. In the Northern Province, 17 children and 14 women were included. A brief clinical history was taken and a restricted physical examination was performed on all patients. Hematological investigations were confined to hemoglobin (Hb) concentration, blood-cell morphology, malarial parasites on thick films, serum ferritin concentrations, and Hb-electrophoresis on capillary-blood specimens; bone marrow was aspirated from the anterior iliac crests and examined for cell morphology, malarial pigment, and intracellular stainable iron.

Ten of the 11 children in the Eastern Province were anemic. All showed multiple etiology of their anemia, including malaria in nine, other infections in eight, iron deficiency in six, and folate deficiency in six. Seven out of 10 pregnant women in the East were anemic. The most severe anemias were encountered in primigravida. Again, multiple etiology was usual, including malaria in five, iron deficiency in six, folate deficiency in three, and some infection in one. Also, all three non-anemic women were iron-deficient; one was folate-deficient.

Fewer of the patients studied in the North were anemic. Only 10 out of 17 children were anemic. Again, more than one etiological factor was usually present. Included were malaria (four patients), other infections (seven patients), iron deficiency (three patients), folate deficiency (nine patients), and sickle cell anemia (one patient). The seven non-anemic children also showed hematological abnormalities; four had malaria; five, other infections; one, iron deficiency; and three, folate deficiency.

Eight out of the 14 pregnant women in the Northern Province were anemic. Four had malaria; three had iron deficiency; three had folate deficiency; and one had another infection. In six non-anemic women, malaria was diagnosed in two, iron deficiency in two, and folate deficiency in four.

It is not possible to make any accurate generalizations about the etiology or pattern of anemia in the population of Cameroon as a whole on the basis of the results obtained in this pilot study. The restrictions imposed by constraints of time and available facilities required that studies be carried out on a highly selected group of patients. The value of the investigation, therefore, lies first in the demonstration that it is possible to evaluate anemia in the field using relatively inexpensive supplies and equipment which are already available. The second important conclusion is that at least four factors known to be the most important

causes of anemia in underdeveloped countries were immediately identified and that no other unexpected factor was encountered. Based on these findings, the investigators consider it appropriate to recommend treatment for patients drawn from high-risk groups (young children and pregnant women) in whom anemia is identified; further investigation is unnecessary unless the patient fails to respond.

Anemia is a sufficiently significant problem that it is appropriate to consider the implementation of public health measures and nutritional planning specifically designed to alleviate the problem. However, before this is done, the authors urge that a carefully planned field study be conducted to identify the pattern of anemia in other segments of the population (men, non-pregnant women, and older children). Finally, since it is not possible to say with confidence which etiological factor was most important in any one patient or what impact on anemia the correction of one factor or more would have, it would be wise to attempt to define the factors' individual contribution to the overall frequency of anemia by conducting an investigation in which selective correction is undertaken.

RECOMMENDATIONS

RECOMMENDATIONS

Anemia is a cause of serious socioeconomic problems. Work capacity is limited severely; if a farmer is incapacitated, his family suffers from deprivation of either his produce or his earnings, and the area of land which is cultivated effectively is reduced. Severe anemia in women has adverse effects on the home, especially on the younger children. Anemia in pregnancy results in maternal morbidity or mortality and is associated strongly with low birthweight, prematurity, and perinatal mortality. As a consequence, the live infants born to anemic mothers are prone to complications of malnutrition and infection. Anemia from any cause in childhood is associated with retarded growth, delayed development, and poor performance at school.

Financial investment in the diagnosis, prevention, and treatment of anemia in the community commands a high priority for both economic and humanitarian reasons. Specific recommendations are provided below.

Staff Development in Cameroon

Investment should be made in staff development in the discipline of hematology and blood transfusion. This should be considered at several levels.

A. Training of Medical Laboratory Assistants

Candidates entering the course would need to have completed primary education. The training which is visualized is in-service; it would be similar to that leading to the National Certificate for Medical Laboratory Assistants, which is issued by the Institute of Medical Laboratory Technology of Nigeria.

B. Training of Medical Laboratory Technologists

Candidates entering the course would need to have completed secondary education. The instruction would likely be a combination of formal biological science-teaching and in-service training, with the emphasis on practical procedures. This program should be an expansion of existing training courses. One other objective would be to organize and raise the prestige of the profession of medical laboratory technology.

In the training of laboratory assistants and technologists, emphasis should be placed on the development and use of standard hematological techniques which are applicable in the field, where a minimum of laboratory equipment is available.

C. Medical Students

Hematology is part of the curriculum of the course leading to qualification as a medical practitioner in Cameroon. Teaching of the discipline could be strengthened in the short term by recruiting students from overseas until more Cameroonians have specialized in hematology.

D. Postgraduate Students

Encouragement should be given to young Cameroonian physicians to specialize in hematology, combining both the clinical and laboratory disciplines. Two incentives might be the expansion of postgraduate training in Cameroon and the provision of scholarships for selected Cameroonian doctors for training overseas.

Immediate Intervention

On the evidence available and without further research, advice on the prevention and treatment of anemia in childhood and pregnancy can be given at this time.

A. Anemia in Children

There is at this time no way of eradicating malaria in tropical Africa. Therefore, it is inadvisable to offer to large numbers of children antimalarial prophylaxis which would prevent them from acquiring immunity to malaria and expose them to risk whenever the prophylaxis is no longer available. Every attempt should be made to make available adequate supplies of chloroquine for the treatment of children suffering from febrile episodes. Such children will either be infected with malaria or have their immunity to malaria suppressed by some other infection.

The laboratory investigation of an anemic child should include a minimum of Hb, thick film for malaria, and examination of feces for ova of hookworm. Pending the results of investigations, the anemic child should be started on a regimen of:

a. Curative doses of chloroquine, followed by prophylactic proguanil for two to three weeks.

b. Oral iron therapy, in a dose calculated from weight and Hb.

c. Oral folic acid, 5 mg. per day for two to three weeks.

d. Such antibiotics as are indicated by the presence of infection.

Whenever the diagnosis of sickle cell disease is suspected, iron should be withheld until hemoglobin-electrophoresis can be performed. If the physician remains in doubt about the diagnosis, a trial of iron therapy is probably justified.

B. Prevention of Anemia in Pregnancy

Every woman presenting in pregnancy should receive the following regimen (Fleming, Hendrickse and Allan, 1968):

a. Chloroquine, 600 mg. base in a single dose at first attendance.

b. Proguanil, 100 mg. per day until after delivery.

c. Ferrous sulphate, 200 mg. per day until after delivery.

d. Folic acid, 5 mg. per day until after delivery.

The widespread application of this regimen would have probably a greater impact on the health of the community than any other single medical intervention.

C. Treatment of Severe Hookworm Anemia

The following regimen is recommended (Werblinska and Fleming, 1979):

a. Chloroquine, 600 mg. base once, followed by proguanil, 100 mg. per day for two to three weeks.

b. Folic acid, 5 mg. per day for two to three weeks.

c. Bephenium hydroxynaphthoate, 5 g. per day for three days, followed by tetrachlorethylene, 4 ml. as soon as the Hb is above 6 g/dl. (It is the general experience in West Africa that bephenium hydroxynaphthoate has limited usefulness. Tetrachlorethylene is highly effective and extremely cheap; however, its use leads to cerebral intoxication in severely anemic patients.)

c. Oral ferrous sulphate, 200 mg. twice a day until six weeks after the Hb has ceased to rise. (Despite its much greater cost, consideration should be given to the use of intramuscular iron when available, in view of the unlikelihood that oral therapy will be taken by some illiterate rural farmers.)

The dose is calculated from the formula

$$\frac{\text{Wt in Kg} \times (14.0 - \text{Hb g/dl})}{10} \text{ ml.}$$

to give the dose (ml.) of intramuscular iron using a preparation containing elemental iron (50 mg. per ml.).

1. Prophylaxis Against Malaria

Chloroquine is highly effective both as a prophylaxis and for treatment of malaria. However, resistance to chloroquine has been reported in strains of P. falciparum in both East and West Africa (Campbell et al., 1979; Eke, 1979; anonymous, 1979), and the continued use of chloroquine as a prophylactic will favor the selection and spread of these resistant strains (Nguyen-Dinh and Strager, 1978; Jopling, 1979). For this reason, a distinction should be drawn between prophylaxis and treatment. The authors recommend proguanil as the drug of choice in the prevention of malaria. Some authorities prefer the combinations of pyrimethamine and sulfonamide (Jopling, 1979), but the costs of these drugs are higher and the administration of sulfonamides for long periods of time may lead to microbiological and hematological problems. Chloroquine undoubtedly remains the first drug of choice for the treatment of malaria. However, it should be noted that this recommendation is at variance with that of both the U.S. Center for Disease Control and the World Health Organization, both of which favor the use of chloroquine prophylaxis.

Further Investigations in Selected Villages

Although the treatment of anemia is undoubtedly important, it is unlikely that the present prevalence will be significantly reduced unless preventive measures are implemented at a reigonal or national level. Neither the current investigation nor investigations previously carried out in Cameroon provide sufficient information to recommend suitable preventive public health or nutritional measures. Two important pieces of information are missing. The first is the pattern of anemia in other segments of the population (men, non-pregnant women, older children); the second lies in the fact that the relative contribution of each of the etiological factors that have been identified to the genesis of anemia remains undefined. The following investigations are. therefore, recommended in selected villages.

a. A survey should be conducted along the lines of the United Republic of Cameroon National Nutrition Survey, but on a much more limited scale. The aim should be to establish the pattern of anemia in the population as a whole. This should not involve hospital patients, but it should be conducted in selected villages and include men, non-pregnant women, and older children, as well as the two groups already studied.

b. The baseline investigations would:

   1. Determine whether anemia is sufficiently widespread to suggest that preventive measures would be necessary for the whole population, or whether anemia occurs predominately in certain groups (e.g., children and pregnant women) at whom specific intervention might be aimed.

   2. Determine the frequency and density of malarial infections and relate these to hemoglobin concentrations.

   3. Determine the frequency and density of hookworm infections and relate these to hemoglobin concentrations.

   4. Determine the prevalence of iron deficiency.

c. The initial survey outlined above should be designed to lead, at an early stage, to pilot intervention studies. The only accurate means of determining the relative contribution of each of the etiological factors already identified would be selective intervention, in which each factor or a combination of factors is eliminated. A study of this type would provide a basis for national planning aimed at combating anemia and would prevent the investment of time and funds in the treatment of factors which might be of secondary importance. The relative geographic stability of the population in Cameroon would facilitate this type of investigation. Particular emphasis should be placed on the impact of intervention measures which have already been shown to be effective in other countries and which would correct the etiological factors already identified in the anemias seen in Cameroon. The measures which could be considered immediately would include:

   1. Malarial prophylaxis.

   2. Treatment of acute malaria without prophylaxis.

3. Treatment of hookworm and an attempt to interrupt transmission by education.

4. Iron supplementation.

5. Folate supplementation.

6. Combinations of the above.

This type of investigation would provide the correct focus for planned intervention measures at a national level in the future.

d. While it would be appropriate to define the impact of iron supplementation on anemia in the Cameroon before examining the feasibility of food fortification, the vegetable-based diet which the majority of people eat is likely to be a poor source of available iron. The Division of Hematology at the University of Kansas Medical Center has a special interest in food iron availability and the facilities to study this problem. It would be very willing to participate in any further investigations of this aspect of the problem.

e. The folate content of foods could be assayed on the same samples that are used for the studies of iron availability.

I. INTRODUCTION

I. INTRODUCTION

The United Republic of Cameroon National Nutrition Survey (1978) revealed that the prevalence of anemia was 38.1 percent in children aged six months to 59 months. Anemia was defined as a hemoglobin (Hb) concentration of less than 10 g/dl in the six months to 23 months age group, and less than 11 g/dl in the 24 months to 59 months age group, a correction being made for altitude (Sauberlich, Dowdy and Shela, 1971). The highest prevalence (57.6 percent) was encountered in the Eastern Province, followed by the Central Southern Province (53.3 percent) (see Table 1). The Nutrition Survey did not include any investigation of the etiology of anemia, except that sickle cell disease was found to make only a small contribution to the overall incidence. The report of the Nutrition Survey included a recommendation that a study be made to identify the major causes of anemia.

Only a few studies have been conducted into the etiology of anemia in Cameroon. A high prevalence of iron deficiency in pregnancy has been reported in Yaoundé; it is associated with infestation by hookworm (Eya Eyong, 1975; Joseph, 1979). Lower than normal percentage saturation of transferrin was reported in 66 out of 92 children in the Northern Province (Delpeuch, Cornu and Chevalier, 1980). Investigations conducted in the neighboring state of Nigeria have shown that anemia in childhood is commonly the result of combinations of acute Plasmodium falciparum malaria, bacterial or viral infection, iron deficiency, and folate deficiency (Werblinska, Fleming and Atachakwa, 1975). Studies from Nigeria indicate also that anemia is particularly common during first pregnancies, as a result of a loss of resistance to malaria (Gilles et al., 1969) and of folate deficiency, largely secondary to the erythroid hyperplasia resulting from malarial hemolysis (Fleming, Allan and Stenhouse, 1969; Fleming, 1970). The most severe deficiencies of iron result from heavy infestations with hookworm (Gilles, Watson-Williams and Ball, 1964; Fleming, 1977; Azubuike, Izuora and Obi, 1977). Although it is dangerous to extrapolate from results in another environment, these findings influenced the design of the present work.

Due to the limited time available, it was decided that the study would be concentrated on two areas of Cameroon. The Eastern Province was chosen because it had the highest prevalence of anemia and is ecologically similar to the Central Southern Province, including Yaoundé and Douala, where anemia was also found to be most frequent (see Table 1). The Northern Province, which is ecologically different from the East and Central South, was included since high prevalence rates for malnutrition and anemia (41.0 percent) were reported by the Nutrition Survey and because interesting contrasts in the etiology of anemia might be expected in the two different environments.

It was thought that a maximum of information would be derived from an in-depth study of a small number of children and pregnant women attending clinics in these areas. The laboratory investigations were confined to the estimation of the concentration of Hb, the study of blood- l morphology, the search for malarial parasites, hemoglobin-electrophoresis, the examination of smears of bone marrow aspirates, and the measurement of the concentration of ferritin in serum.

II. PATIENTS AND METHODS

II. PATIENTS AND METHODS

Patients Studied

Samples of blood and bone marrow were obtained from 28 children aged two months to five years presenting at outpatient clinics with a variety of complaints and 24 women attending a prenatal clinic for the first time in the present pregnancy (see Table 2). Eighteen women were pregnant for the first time and six had had at least five previous pregnancies. Eleven children and 10 women were living in the Eastern Province; the remainder were from the North. None was known to have received any medication during the previous month, except for one pregnant woman who was taking supplements of iron (No. 41; see Table 10). One pregnant woman (No. 12) absconded immediately after the collection of the specimen of blood, so that information on her is incomplete (see Table 5). Investigations were conducted on two older siblings (Nos. 23 and 25) of one child at the request of their mother; the results are included in Table 4, but have not been analyzed further.

Methods

A brief history was taken in each case and a limited physical examination performed. The period of gestation was estimated from the height of the fundus in pregnant women. Blood was obtained by finger-stick for the measurement of hemoglobin (Hb) and serum ferritin concentration; thick and thin blood-films were prepared and hemoglobin-electrophoresis performed. Bone marrow was then aspirated from the anterior iliac crest using 1 percent xylocaine for local anesthesia. Slides were made for routine morphological interpretation and assessment of marrow iron stores.

Hemoglobin estimations were carried out by the cyanmethemoglobin technique (Dacie and Lewis, 1975); 0.02 ml. blood was diluted in 5 ml. Drabkin's solution in the field and transported to the hematology laboratory at CUSS, care being taken to avoid evaporation and exposure to light. Readings were made on an Eppendorf Photometer 1101M. Anemia has been defined as Hb less than 10 g/dl below 23 months of age, less than 11 g/dl in the 24 months to 59 months age group, and less than 11 g/dl in pregnant women. All areas visited in this study were at least 700 m. above sea level; no corrections were made for altitude.

Thin peripheral blood films were dried and then fixed for 20 minutes in absolute methanol; thick films were merely dried before being transported to the hematology laboratory at CUSS for staining. The thin and thick peripheral blood films were stained by the May-Grunwald and Giemsa techniques, respectively.

Blood for serum ferritin estimation was drawn into four plain microhematocrit tubes, allowed to coagulate, and then centrifuged in a microhematocrit centrifuge in the field. The red cell and serum fractions were separated by breaking the tubes, which were immediately resealed and transported on ice to Yaoundé, where they were deep frozen. The serum was sent to the Division of Hematology, University of Kansas Medical Center, for

estimation of serum ferritin concentration by the two-site immunoradiometric method (Miles et al., 1974). The frozen cells were used to prepare a hemolysate for hemoglobin-electrophoresis on cellulose acetate (Lehmann and Huntsman, 1975); this was performed in the hematology laboratory at CUSS, Yaoundé.

Four bone marrow slides were obtained from each patient, dried, and then fixed in absolute methanol for 20 minutes. Two were stained with May-Grunwald and Giemsa stain for routine morphological assessment and one by the Perl's method for examination of bone marrow iron stores; the iron stores in the bone marrow were quantitated on a scale 0-6 (Gale, Torrance and Bothwell, 1963). Megaloblastic erythropoiesis was assumed to be evidence of a deficiency of folates. The slides stained for the examination of iron were used also to record the presence of malarial pigment. The diagnosis of iron deficiency was based on the absence of stainable marrow iron and that of malarial infection on the finding of malarial pigment in the bone marrow (Edington and Gilles, 1969).

III. RESULTS

III. RESULTS

Eastern Province

A. Children

Seven children in Abong-Mbang and four in Bertoua were studied (see Tables 2, 3, and 4). Splenomegaly was observed in four children in Abong-Mbang and in one of the children under five years of age in Bertoua. Ten children were anemic, but one (No. 7) was included only at the insistence of her mother, who was a nurse. The Hb concentration in the 10 anemic children ranged from 4.6 g/dl to 10.4 g/dl. Only the least anemic child (No. 24) had a single cause of anemia. Malaria was diagnosed in nine, other infections in eight, iron deficiency in six, and folate deficiency in six (see Table 12). The bone marrow specimen from patient No. 2 was insufficient to judge iron and folate status. Patients Nos. 23 and 25 were studied also at the request of their mother; they illustrated that malaria was a problem in this family, even up to the age of 12 years.

B. Pregnant Women

All 10 women were seen in the third trimester of their pregnancies (see Tables 5 and 6). One primigravida (No. 11) had palpable splenomegaly. Seven women were anemic, but one primigravida and two multigravida had Hb values in the normal range. The lowest Hbs were recorded in anemic primigravida (6.1 g/dl - 10.3 g/dl). Malarial pigment was present in five of the six anemic women in whom the marrow was examined and in one of those with normal Hb values (see Table 13). Only one patient (No. 11) had evidence of another infection. None of the nine women whose marrows were examined had stainable iron. Folate deficiency was present in four women, three of whom were anemic and two of whom had concurrent malaria. The two most anemic patients on whom there were data had two or three causes of anemia.

It should be noted that iron deficiency was seen in all of the women with normal Hb and that one was also folate-deficient.

Northern Province

A. Children

Seventeen children were studied in four centers in the Northern Province (see Tables 2, 7, 8, and 9); 10 of these children were anemic. The severest anemias were in two children at Oura-Tada (Mokolo) (Nos. 70 and 72; see Table 8). Patient No. 70 (Hb 4.2 g/dl) had clinical evidence of having sickle cell disease, and the diagnosis was confirmed on hematological investigation. Patient No. 72 (Hb 4.0 g/dl) showed large quantities of malarial pigment in the bone marrow and grossly megaloblastic erythropoiesis.

The predominant hematological diagnoses in these children were malaria, other infections, and folate deficiency (see Table 14). In this small sample, only four were iron-deficient, whereas 12 were folate-deficient.

B. Pregnant Women

Nine primigravida were studied at Maroua and four primigravida and one multigravida at Mokolo (see Tables 2, 10, and 11). All were in the second trimester, except one who was in the sixteenth week of pregnancy (No. 64). None had any complaint, clinical evidence of infection, or splenomegaly. Five patients from Maroua and three from Mokolo were anemic, but in only one (No. 33) was the anemia severe (Hb 7.1 g/dl).

Iron deficiency appeared to be the sole cause of anemia in the patient with the lowest Hb and was found in combination with malaria and folate deficiency, respectively, in two other patients (see Table 15). Malaria appeared to be the sole cause in two patients and folate deficiency in one anemic patient. Myeloid hyperplasia suggested that patient No. 60 had some undiagnosed infection.

Hemoglobin Electrophoresis and Serum Ferritin Concentrations

Hemoglobin electrophoresis results were obtained from a total of 47 patients (see Tables 3-11). Four had sickle cell trait (Hb-AS) and one child, aged 18 months, had sickle cell anemia (Hb-SS) with some persistent Hb-F (No. 70; see Table 8). All other patients had a normal Hb pattern.

Serum ferritin concentrations were assayed in 54 patients. The relationship between serum ferritin and bone marrow iron is shown in Figure 1 for the 45 patients for whom both measurements were available.

IV. DISCUSSION

IV. DISCUSSION

This pilot study has demonstrated the feasibility of carrying out a fairly sophisticated laboratory evaluation of anemia in patients located in the rural areas of Cameroon. The partial processing of samples in the field, combined with further measurements done in Yaoundé, yielded satisfactory results. It is also evident that most of the essential information required for a field study could be obtained from a single finger-stick blood sample.

Bone marrow samples were collected in this study and the procedure was well accepted by all patients. Although this test may be important in the diagnosis of anemia in some patients admitted to hospitals, it would clearly not be appropriate in field studies. Since an electricity supply was available in most areas, the microhematocrit could be substituted for the hemoglobin estimation in future studies. As discussed below, although not as accurate as bone marrow examination, the serum ferritin, as the observations made in this study suggest, may have sufficient predictive value to be useful in field studies of iron deficiency in adults. Its value in children is less certain.

Inferences drawn from the observations made in this investigation are of necessity tentative, because the subjects were highly selected and included only pregnant women and children who were sick and attending hospital clinics. The groups chosen are among those in whom anemia is known to be particularly prevalent throughout the world. Generalizations for the whole population cannot be made.

The identification of etiological factors responsible for anemia was based largely on the interpretation of bone marrow morphology. The frequency of active malarial parasitemia has probably been underestimated because of technical errors in the preparation of thick peripheral blood smears. The films from the Eastern Province were fixed accidentally with methanol in the field, and a few of the unfixed films from the North were eaten partially by flies. The diagnosis of malarial infection in this study is based, therefore, mainly on the finding of malarial pigment in the bone marrow. Whenever the species of parasite could be identified on thick blood film (see Tables 3-11), P. falciparum predominated.

The current observations support the conclusions reached during the Nutrition Survey and indicate that anemia is common and more prevalent in the East than in the North of Cameroon. Of the 52 patients studied, 35 (67 percent) were anemic, the prevalence being higher in both children (10 of 11) and women (7 of 10) in the Eastern Province than in the North, where only 10 of the 17 children and eight of the 14 women had low Hb concentrations. The importance of a combination of etiological factors is readily apparent. In only six of the 35 anemic patients was a single factor identified.

Malaria

It may be assumed that malaria is holoendemic in the rain forests, which include the areas of Abong-Mbang and Bertoua. The high frequency of splenomegaly observed in children in Abong-Mbang (4 of 6) is in agreement with this. In the Savanna and the Mandara Mountains, malaria is hyperendemic, and only one of the 17 children in the North had a palpable spleen. Malarial infection was present in nine of the 10 anemic children and five of the pregnant women in the Eastern Province. None of the children or women with normal Hb values had evidence of malaria. In the North, only eight of 14 children and six of 13 women on whom complete data sets were available were thought to be suffering from malaria. Furthermore, six of the 12 non-anemic individuals from the North were also suffering from malaria. It is evident, therefore, that the prevalence of malaria was higher and the correlation with the presence of anemia greater in the Eastern Province, although malaria appeared to be an important etiological factor contributing to anemia in both ecological areas.

It should not be overlooked that anemia is only one aspect of the pathology of malaria. In childhood, infections with P. falciparum disturb profoundly the functions of many organs and systems, notably the central nervous system (Edington, 1967). In pregnancy, malaria is associated with abortion, infection of the placenta, impaired fetal nutrition, low birthweight, and perinatal mortality (Jelliffe, 1968; Gilles et al., 1969; Harrison and Ibeziako, 1973). Infants of low weight are, in turn, at hazard from infections and malnutrition.

Other Infections

Significant infections other than malaria were common in all children in both areas surveyed and they were considered to be making an important contribution to the etiology of the anemias. It should be noted, however, that this finding is dependent on sample selection, since all studies were performed on children presenting at outpatient clinics. Infection would be expected to be the predominant cause of illness in such a group. Nevertheless, other studies have shown that infections are commonly associated with anemia among children in the tropics (Werblinska et al., 1975). The importance of this factor should not be discounted.

Iron Deficiency

An important nutritional component in the anemia was present in all groups. Iron deficiency appeared to be a limiting factor at the time of the study in six of nine anemic children and in all of the anemic women in the Eastern Province. These findings are in agreement with the earlier reports of a high prevalence of iron deficiency in pregnancy in Yaoundé (Eya Eyong, 1975; Joseph, 1979).

In the North, however, storage iron was absent in only three out of seven anemic children and in three of the seven anemic women. This finding might lead to the conclusion that iron deficiency is less important in the anemias seen in the North. However, there are three observations which should temper this interpretation. First, a reduced percentage saturation of transferrin with iron was reported in 66 of 92 children in North Cameroon by Delpeuch et al. (1980). Second, Dr. Jacques Steveny, who has worked at the Hopital Adventiste, Kora, for several years, was of the opinion that most anemias in children and pregnant women responded to iron and that its prevalence was related to hookworm infestation. Third, only small quantities of iron were present in five of the eight women and three of the nine children who had stainable iron in the marrow. This would be insufficient to support the repair of even moderate anemia, implying that although iron deficiency was not limiting Hb production at the time of study, total body iron was reduced.

While serum ferritin concentration is closely correlated with the size of iron stores in health and pure iron deficiency (Jacobs et al., 1975), inflammation, liver disease, and neoplastic disorders disturb the relationship (Lipschitz et al., 1974). In uncomplicated iron deficiency, the serum ferritin concentration is $<12\mu g/l$. The fact that this was the case in only six of the 22 patients with an absence of stainable iron in the bone marrow provides further evidence that anemia was multifactorial in these patients. It also demonstrates a serious limitation to the usefulness of the serum ferritin estimation as the sole measure of iron deficiency in populations where inflammatory diseases are prevalent. The serum ferritin estimation, which can be performed on a sample of blood obtained by finger-stick, may nevertheless still have some value in predicting iron deficiency in field studies where bone marrow specimens cannot be obtained. In the presence of inflammatory disease, a serum ferritin concentration of $<50\mu g/l$ indicates probable iron deficiency (Cook et al., 1980). Thirteen of the 18 women and seven of the 14 children with markedly reduced iron stores (0 or 1+) had serum ferritin values below $50\mu g/l$, while only one of the three women and two of the 10 children with iron stores $>1+$ had values in this range (see Table 16). The increase of serum ferritin associated with inflammation was more apparent in iron-deficient children than in iron-deficient women.

Folate Deficiency

In the Eastern Province, folate deficiency was diagnosed in six anemic children and four pregnant women, of whom three were anemic. In no patient was folate deficiency the sole cause of anemia. It was associated with malaria in five, other infections in five, and iron deficiency in four. In four of the children, there was hypoplasia of the erythroid series, associated with infections, with minimal evidence of any change towards megaloblastic erythropoiesis; however, there was granulocytic proliferation showing numerous giant metamyelocytes. In the four women with folate deficiency, there was associated iron deficiency in four and malaria in two; these patients' bone marrows were characterized by erythroid hyperplasia with frank megaloblastic changes.

In the Northern Province, folate deficiency was observed in 12 children, nine of whom were anemic, and in seven pregnant women, three of whom were anemic. As in the East, folate deficiency was never a solitary hematological abnormality in children, being associated with malaria (six), infection (eight), iron deficiency (four), and sickle cell anemia (one child). Megaloblastic erythropoiesis was obvious, or even gross, in nine children, possibly because erythroid activity was less depressed by infection than was the case in the East. Folate deficiency was the sole hematological abnormality discovered in two pregnant women, one of whom was not anemic; the other was mildly anemic.

These observations suggest that folate deficiency was occurring as a secondary complication in most patients. Folate metabolism may be disturbed during infections by various mechanisms. They include insufficient intake due to anorexia; malabsorption (Karney and Tong, 1972); increased requirement secondary to the erythroid hyperplasia following hemolysis (Fleming et al., 1968; Strickland and Kostinas, 1970; Mati, Hatima and Gebbie, 1971); and pyrexia leading to inactivation of the essential enzyme dihydrofolate-reductase at around 39° C (Chanarin and Davey, 1964; Panders and Rupert, 1965). Of these, the high demand for folates secondary to erythroid hyperplasia induced by malarial hemolysis is of supreme importance. Protection against malaria during pregnancy in Ibadan resulted in higher serum-folate activities than in the unprotected (Fleming et al., 1968) and was sufficient to prevent the development of megaloblastic erythropoiesis in the majority of patients in Zaria (Northern Nigeria), even without the addition of folate supplements (Fleming, A.F. et al.; unpublished observations).

Hemoglobinopathies

The prevalence of sickle cell trait varies throughout Cameroon, ranging between 11.9 percent to 22.2 percent in the sample of the population tested in the United Republic of Cameroon National Nutrition Survey (1978). A much higher prevalence is reported from areas where malaria is hyperendemic: 32 percent in North West Province (Mbantenkhu, 1979), which is in agreement with the 32 percent reported at Obudu (Udeozo and Ele, 1975), just across the Nigerian frontier near Ashunda, Cameroon. High frequencies are reported also in the Kanuri (27.9 percent) and Bede (32.6 percent) in Bornu State, Nigeria (Roberts, Lehmann and Boyo, 1960). Similar figures may be anticipated in the far north of Cameroon.

Hb-AC has a frequency of 5 percent in two isolated tribes, the Wakura and Hidkala (Roberts et al., 1960), who practice terrace agriculture on the hillsides above Gwoza in Northern Nigeria. It is possible that Hb-AC will be found at similar frequency in Cameroon in areas of the Mandara Mountains around Koza.

Where sickle cell trait occurs in the adult population at 20 percent prevalence, 1 percent of newborn infants will have sickle cell anemia (Hb-SS); where the prevalence of Hb-AS in adults is 30 percent, 2 percent of infants will have Hb-SS. About 2 percent of all newborns have sickle

cell disease in Zaria, Northern Nigeria, but among children aged three months to three years presenting at hospital with a PCV <30, 20 percent have sickle cell disease (Werblinska et al., 1975). Experience in Cameroon will certainly be similar once children's outpatients clinics become established. Hemoglobin-SC disease in pregnancy may be anticipated as a problem in the Mandara Mountains.

In the future, sickle cell disease will have increasing importance, but at present, hemoglobinopathies as causes of anemia are overshadowed by malaria, other infections, and iron deficiency.

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TABLES AND FIGURES

Table 1

PREVALENCE OF ANEMIA (w) - BY PROVINCE

AFTER ADJUSTING FOR ALTITUDE †
Children Aged 6-59 Months

PROVINCE	PERCENT	SAMPLE SIZE
Central South[x]	53.3	165
East	57.6	163
North	41.0	200
North-West/West	23.1	164
South-West/Littoral[x]	38.9	172
Total Provinces	37.6	864
Yaounde/Douala	42.8	156
TOTAL CAMEROON	38.1	1020
Special Group	37.9	225

[x]Excluding Yaounde/Douala

(w) Weighted Percent

† United Republic of Cameroon National Nutrition Survey (1978). p 107

Table 2

PATIENTS STUDIED

Location of Clinic	Children	Adult Women	
		Primigravida	Multigravida
Eastern Province			
Abong-Mbang	7	5	5
Bertoua	4	0	0
Northern Province			
Maroua	8	9	0
Mokolo[x]	6	4	1
Koza	3	0	0
Totals	28	18	6

[x]Two clinics

ABBREVIATIONS USED IN TABLES 3-11

Eosin	=	eosinophilia
GM	=	giant metamyelocytes
Hyper	=	hyperplasia
Hypo	=	hypoplasia
Meg	=	megaloblastic
Nil	=	unmarried mother
Norm	=	normoblastic
NR	=	not recorded
P.falc.	=	*Plasmodium falciparum*
Trans.lyc.	=	Transformed lymphocytes
Unemp.	=	unemployed
URTI	=	upper respiratory tract infection

CLINICAL AND HEMATOLOGICAL RESULTS ON CHILDREN

AT ANONG-NDANG, EASTERN PROVINCE

Series number	1	2	3	4	5	6	7
Sex	M	M	F	M	F	M	F
Age (months)	24	27	36	36	23	8	28
Father's occupation	Nil	Laborer	Farmer	Nil	Farmer	Nil	Clerk
Clinical observations	Otitis media, edema	Conjunctivitis, Diarrhea	Fever, Scabies	Fever, Diarrhea	Diarrhea	URTI	Nil
Liver (cm below costal margin)	8	4	4	4	0	2	6
Spleen (cm below costal margin)	6	2	0	4	0	2	0
Hb (g/dl)	5.1	9.2	9.5	8.2	9.3	9.7	11.2
Blood cell morphology							
Anisocytosis	3	2	2	2	2	2	1
Macrocytosis	2	2	1	2	2	1	0
Microcytosis	2	2	1	1	2	2	0
Poikilocytosis	0	0	0	0	0	0	0
Target cells	0	1	0	0	0	0	0
Hypochromia	2	0	0	0	1	2	0
Other features	0	0	0	Eosin	*P.falc*	0	Eosin
Malaria							
P. falciparum asexual	NR	NR	NR	NR	NR	NR	NR
P. falciparum gametes.							
P. malariae							
P. ovale							
Bone-marrow							
Erythron.	Meg.	NR	Norm.	Norm.	Meg.	Hypo.	Norm.
Granulocytes	GM+		Hyper.	GM++	GM+	GM+	Norm.
Other elements	-		-	-	-	Lymphocytosis	-
Malarial pigment	2	2	2	3	0	0	0
Iron stores	0	NR	0	2	3	0	1
Serum ferritin (µg/l)	191	257	23	773	71	33	65
Hb electrophoresis	AA	AA	AS	AA	AA	AA	AA
Causes of anemia							
Malaria	+	+	+	+	+	0	0
Other infections	+	+	+	+	+	+	0
Iron deficiency	+	?	?	0	+	+	0
Folate deficiency	+	?	0	+	+	+	0
Other	0	0	0	0	0	0	0

CLINICAL AND HAEMATOLOGICAL RESULTS OF CHILDREN

AT LUNGONA, EASTERN PROVINCE

Series number	20	21	22	23*	24	25*
Sex	M	F	M	M	M	F
Age (months)	36	52	8	12 year	48	7 year
Father's occupation	Carpenter	Electrician	Gendarme	Clerk	Clerk	Clerk
Clinical observations	Malaria, Ascaris, treated 2 days	Kwashiorkor	Measles	Malaria, treated 2 days	Malaria, treated 2 days	Malaria, treated 2 days
Liver (cm below costal margin)	0	0	0	0	0	0
Spleen (cm below costal margin)	0	0	0	0	4	4
Hb (g/dl)	8.6	4.6	7.4	10.0	10.4	9.3
Blood cell morphology						
Anisocytosis	2	2	3	2	2	1
Macrocytosis	2	1	2	1	1	0
Microcytosis	2	1	3	1	2	0
Poikilocytosis	0	0	2	0	0	0
Target cells	0	0	2	0	0	0
Spherocytosis	0	1	2	0	0	0
Other features	Polychromasia	Leukocytosis	Trans. lyc.	P.falc	P.falc	P.falc
Malaria						
P. falciparum asexual	NR	NR	NR	NR	NR	NR
P. falciparum gametes.						
P. malariae						
P. ovale						
Haematinics						
Erythrocytes	Norm	Norm	Norm	NR	Norm	NR
Granulocytes	CN*	Lyper	CN*		Norm	
Other elements	-	Lymphocytosis	-		-	
Malarial pigment	3	2	2		3	
Iron stores	2	0	0		3	
Serum ferritin (µg/l)	381	328*	3	300	85	148
Hb electrophoresis	AA	AA	AS	AA	AA	AA
Causes of anaemia						
Malaria	*	*	*	*	*	*
Other infections	0	*	*	?	0	?
Iron deficiency	0	*	*	?	0	?
Folate deficiency	*	0	*	?	0	?
Other	0	0	0	0	0	0

Ie 5

CLINICAL AND HEMATOLOGICAL RESULTS ON PRIMIGRAVIDA

AT ABONG-MBANG, EASTERN PROVINCE

Series number	9	10	11	12*	14
Sex	F	F	F	F	F
Age	20	15	17		20
Husband's occupation	Unemp.	Nil	Soldier		Soldier
Clinical observations Para	0	0	0	0	C
Weeks of Gestation	32	34	28		28
Liver (cm below costal margin)	0	0	0		0
Spleen (cm below costal margin)	0	0	6		0
Hb (g/dl)	11.9	10.3	8.3	6.0	6.1
Blood cell morphology					
Anisocytosis	2	1	2	2	2
Macrocytosis	2	0	2	2	2
Microcytosis	1	0	0	1	2
Poikilocytosis	0	0	0	0	0
Target cells	0	0	1	0	0
Hypochromia	0	0	1	0	2
Other features	0	0	Trans. lyc.	0	0
Malaria	NR	NR	NR	NR	NR
P. falciparum asexual					
P. falciparum gametes.					
P. malariae					
P. ovale					
Bone-marrow					
Erythron.	Meg.	Norm.	Norm.		Norm.
Granulocytes	GMP	Norm.	Hyper.		Norm.
Other elements	-	-	-		-
Malarial pigment	0	2	1		1
Iron stores	0	0	0		0
Serum ferritin (µg/l)	62	20	146	276	66
Hb electrophoresis	NR	NR	NR	NR	NR
Causes of anemia					
Malaria	0	+	+		+
Other infections	0	0	+		0
Iron deficiency	+	+	+		+
Folate deficiency	+	0	0		0
Other	0				

CLINICAL AND HEMATOLOGICAL RESULTS ON GRANDE MULTIGRAVIDA AT ABONG-MBANG, EASTERN PROVINCE

Series number	8	13	15	16	17
Sex	F	F	F	F	F
Age (years)	28	32	38	28	26
Husband's occupation	Catechist	Soldier	Laborer	Teacher	Unemployed
Clinical observations					
Para	5	5	6	7	5
Wks. of Gestation	32	32	32	32	28
Liver (cm below costal margin)	0	0	0	0	0
Spleen (cm below costal margin)	0	0	0	0	0
Hb (g/dl)	10.8	11.6	11.0	10.8	10.8
Blood cell morphology					
Anisocytosis	2	2	2	1	1
Macrocytosis	1	1	1	1	0
Microcytosis	2	1	1	1	0
Poikilocytosis	0	0	0	0	0
Target cells	0	0	0	0	0
Hypochromia	1	0	0	0	0
Other features	D. Perstans	0	D. Perstans	0	0
Malaria	NR	NR	NR	NR	NR
P. falciparum asexual					
P. falciparum gametes.					
P. malariae					
P. ovale					
Bone-marrow					
Erythron.	Meg.	Norm.	Norm.	Norm.	Meg.
Granulocytes	GM+	Norm.	Norm.	GM+	GM+
Other elements	-	Eosin.	-	-	P.falc
Malarial pigment	2	0	0	0	2
Iron stores	0	0	0	0	0
Serum ferritin (µg/l)	77	88	28	11	36
Hb electrophoresis	NR	NR	AA	AA	AA
Causes of anemia					
Malaria	+	0	0	0	+
Other infections	0	0	0	0	0
Iron deficiency	+	+	+	+	+
Folate deficiency	+	0	0	+	+
Other	0	0	0	0	0

Table

CLINICAL AND HEMATOLOGICAL RESULTS ON CHILDREN

AT MAROUA, NORTHERN PROVINCE

Series number	30	32	34	36	38	40	42	44
Sex	F	M	F	M	M	M	F	F
Age (months)	30	24	24	14	2	12	17	48
Father's occupation	Farmer	Trader	Mechanic	Trader	Mechanic	Driver	Mechanic	Driver
Clinical observations	Bronchitis	Malnutrition	Gastroenteritis	Fever	URTI	Gastroenteritis	Fever	Fever, URTI, Gastroenteritis
Liver (cm below costal margin)	2	5	0	0	0	4	0	4
Spleen (cm below costal margin)	0	0	0	0	0	0	0	0
Hb (g/dl)	12.6	9.7	11.7	8.2	8.9	11.5	10.6	9.7
Blood cell morphology								
Anisocytosis	1	2	2	2	1	2	1	2
Macrocytosis	0	1	2	2	0	1	0	1
Microcytosis	0	1	2	2	0	1	0	1
Poikilocytosis	0	0	0	0	0	0	0	0
Target cells	0	0	0	1	0	0	0	0
Hypochromia	±	0	0	1	0	0	0	0
Other features	Trans. lyc.	0	Trans. lyc.	0	0	0	0	Trans. lyc.
Malaria								
P. falciparum asexual	0	0	0	0	NR	0	0	++
P. falciparum gametes.	0	0	0	0		0	0	0
P. malariae	0	0	0	0		0	0	0
P. ovale	0	0	0	0		0	0	0
bone-marrow								
Erythron.	Hyper.	Hyper.	Meg.	Meg.	NR	Norm.	Norm.	Meg.
Granulocytes	Norm.	GM+	GM+	GM+++		Norm.	Norm.	GM+
Other elements	-	-	-	-		-	-	-
Malarial pigment	1	NR	1	0		1	0	2
Iron stores	2	NR	2	0		3	1	1
Serum ferritin (µg/l)	25	46	184	6	17	40	150	342
Hb electrophoresis	AA	AA	AA	AA	AA	AA	AA	AA
Causes of anemia								
Malaria	+	?	+	0	?	+	0	+
Other infections	+	+	+	+	+	+	0	+
Iron deficiency	0	?	0	+	?	0	0	0
Folate deficiency	0	+	+	+	?	0	0	+
Other	0	0	0	0	0	0	0	0

CLINICAL AND HEMATOLOGICAL RESULTS ON CHILDREN

AT MOKOLO, NORTHERN PROVINCE

Series number	63	70	71	72	73	74
Sex	F	M	F	M	F	M
Age (months)	12	18	9	7	36	32
Father's occupation	Farmer	Laborer	Cook	Farmer	Messenger	Farmer
Clinical observations	Marasmus	Fever, Diarrhea Sickle-celldisease	Measles	Fever	Fever	Fever
Liver (cm below costal margin)	0	6	4	0	0	4
Spleen (cm below costal margin)	0	10	0	0	0	0
Hb (g/dl)	8.8	4.9	10.5	4.0	11.2	6.3
Blood cell morphology						
Anisocytosis	2	3	1	3	2	2
Macrocytosis	3	3	1	3	1	1
Microcytosis	0	1	1	0	1	0
Poikilocytosis	0	2	0	0	0	0
Target cells	0	2	0	0	0	0
Hypochromia	0	2	0	0	0	0
Other features	0	Polychromasia Sickle cells Leukocytosis	0	Megalo-blastosis	0	P.falc
Malaria						
P. falciparum asexual	0	0	0	0	NR	+++
P. falciparum gametes.	0	0	0	0		0
P. malariae	0	0	0	0		0
P. ovale	0	0	0	0		0
Bone-marrow						
Erythron.	Meg.	Meg.*	Norm.	Grossly Meg.	Norm.	Meg.
Granulocytes	Hyper	Hyper	Hyper	GM+++	Hyper	GM++
Other elements	GM++	NR	GM++	-	-	-
Malarial pigment	0	NR	1	3	0	3
Iron stores	0	NR	0	3	1	2
Serum ferritin (µg/l)	40	68	74	441	320	64
Hb electrophoresis	AA	SS+F	AA	AA	AA	AA
Causes of anemia						
Malaria	0	0	+	+	0	+
Other infections	0	+	+	0	+	0
Iron deficiency	+	?	+	0	0	0
Folate deficiency	+	+	+	+	0	+
Other	0	Sickle-cell dis.	0	0	0	0

*Megaloblastic from blood film

CLINICAL AND HEMATOLOGICAL RESULTS ON CHILDREN

AT KOZA, NORTHERN PROVINCE

Series number	50	51	52
Sex	M	M	M
Age (months)	18	32	12
Father's occupation	Farmer	Farmer	Farmer
Clinical observations	Diarrhea, Marasmus	Marasmus	Marasmus
Liver (cm below costal margin)	0	0	0
Spleen (cm below costal margin)	0	0	0
Hb (g/dl)	9.1	8.7	11.2
Blood cell morphology			
Anisocytosis	1	2	2
Macrocytosis	0	2	2
Microcytosis	0	0	1
Poikilocytosis	0	0	0
Target cells	0	0	0
Hypochromia	0	0	0
Other features	Leukocytosis	0	Tran. lyc. Leukocytosis
Malaria			
P. falciparum asexual	0	0	0
P. falciparum gametes.	0	0	0
P. malariae	0	0	0
P. ovale	0	0	0
Bone-marrow			
Erythron.	Hypo.	Meg.	Meg.
Granulocytes	Hyper	GM+	GM+
Other elements	GM++	-	-
Malarial pigment	0	2	NR
Iron stores	3	0	NR
Serum ferritin (µg/l)	57	22	76
Hb electrophoresis	AA	AA	AA
Causes of anemia			
Malaria	0	+	?
Other infections	+	0	+
Iron deficiency	0	+	?
Folate deficiency	+	+	+
Other	-	0	0

CLINICAL AND HEMATOLOGICAL RESULTS ON PRIMIGRAVIDA

AT MAIDUA, NORTHERN PROVINCE

Serial number	31	33	35	37	39	41*	43	45	46
Sex	F	F	F	F	F	F	F	F	F
Age (years)	16	17	19	18	18	15	20	14	18
Husband's occupation	Wizard	Driver	Driver	Trader	Driver	Village Head	Driver	Mason	Laborer
Clinical observations									
Para	0	0	0	0	0	0	0	0	0
Wks. of Gestation	32	32	32	28	28	36	36	28	32
Liver (cm below costal margin)	0	0	0	0	0	0	0	0	0
Spleen (cm below costal margin)	0	0	0	0	0	0	0	0	0
Hb (g/dl)	9.7	7.1	10.3	12.3	12.2	12.1	9.9	9.6	11.7
Blood cell morphology									
Anisocytosis	2	2	1	1	1	2	1	1	2
Macrocytosis	2	0	0	0	2	2	1	1	1
Microcytosis	1	2	0	0	0	0	1	1	1
Poikilocytosis	0	0	0	0	0	0	0	0	0
Target cells	1	0	0	0	0	0	0	0	0
Hypochromia	0	1	0	0	0	0	0	0	0
Other features	0	0	0	0	Poly-chromasia	0	0	0	0
Malaria									
P. falciparum asexual	0	0	0	0	0	0	0	+++	0
P. falciparum gametes.	0	0	0	0	0	0	0	0	0
P. malariae	0	0	0	0	0	0	0	0	0
P. ovale	0	0	0	0	0	0	0	+	0
Bone-marrow									
Erythroid	Hyper.	Hyper.	Norm.	Norm.	Meg.	Meg.	Meg.	Norm.	Hyper.
Granulocytes	GM+	Norm.	Norm.	GM+	GM+	GM++	GM+	Norm.	Norm.
Other elements	-	-	-	-	-	-	-	P.falc	-
Malaria: pigment	0	0	1	0	0	1	0	2	1
Iron stores	0	0	0	0	0	1	1	2	1
Serum ferritin (µg/l)	8	2	8	26	29	45	8	410	31
Hb electrophoresis	AA	AS	AA	AA	AA	AA	AA	AA	AA
Causes of anemia									
Malaria	0	0	+	0	0	+	0	+	+
Other infections	0	0	0	0	0	0	0	0	0
Iron deficiency	+	+	+	+	+	0	0	0	0
Folate deficiency	+	0	0	+	+	+	+	0	0
Other	0	0	0	0	0	0	0	0	0

*Received oral iron therapy.

CLINICAL AND HEMATOLOGICAL RESULTS ON PRIMIGRAVIDA AND

ONE MULTIGRAVIDA AT MOKOLO, NORTHERN PROVINCE

Series number	60	61	62	64	65
Sex	F	F	F	F	F
Age	16	25	16	21	18
Husband's occupation	Vet. Nurse	Laborer	Farmer	Warden	Nurse
Clinical observations					
Para	0	5	0	0	0
Wks. of Gestation	28	28	28	16	36
Liver (cm below costal margin)	0	0	0	0	0
Spleen (cm below costal margin)	0	0	0	0	0
Hb (g/dl)	10.3	11.6	9.0	11.6	98
Blood cell morphology					
Anisocytosis	3	2	1	1	1
Macrocytosis	2	1	1	1	0
Microcytosis	2	1	1	1	0
Poikilocytosis	0	0	0	0	0
Target cells	0	0	0	0	0
Hypochromia	0	0	0	0	0
Other features	0	0	Nucleated RBC	0	0
Malaria					
P. falciparum asexual	0	0	+++	0	0
P. falciparum gametes.	0	0	0	0	0
P. malariae	0	0	0	0	0
P. ovale	0	0	0	0	0
Bone-marrow					
Erythroc.	Hypo.	Norm.	Norm.	Norm.	Norm.
Granulocytes	Hyper.	Norm.	Norm.	GM+	Norm.
Other elements	GM++	-	-	-	-
Malarial pigment	NR	0	1	0	2
Iron stores	NR	1	2	2	1
Serum ferritin (ug/l)	18	29	418	20	4
Hb electrophoresis	AA	AS	AA	AA	AA
Causes of Anemia					
Malaria	2	0	+	0	+
Other infections	+	0	0	0	0
Iron deficiency	2	0	0	0	0
Folate deficiency	+	0	0	+	0
OL			0		0

TABLE 12

HEMATOLOGICAL DIAGNOSES ON CHILDREN IN THE EASTERN PROVINCE

	Anemic (n=10)			Non-anemic (n=1)			All children (n=11)		
	Present	Absent	NR	Present	Absent	NR	Present	Absent	NR
Malaria	9	1	0	0	1	0	9	2	0
Other infectons	8	2	0	0	1	0	8	3	0
Iron-deficiency	6	3	1	0	1	0	6	4	1
Folate-deficiency	6	3	1	0	1	0	6	4	1
Sickle-cell anemia									

TABLE 13

HEMATOLOGICAL DIAGNOSES ON PREGNANT WOMEN IN THE EASTERN PROVINCE

	Anemic (n=7)			Non-anemic (n=3)			All patients (n=10)		
	Present	Absent	NR	Present	Absent	NR	Present	Absent	NR
Malaria	5	1	1	0	3	0	5	4	1
Other infectons	1	5	1	0	3	0	1	8	1
Iron-deficiency	6	0	1	3	0	0	9	0	1
Folate-deficiency	3	3	1	1	2	0	4	5	1

TABLE 14

HEMATOLOGICAL DIAGNOSES ON CHILDREN IN THE NORTHERN PROVINCE

	Anemic (n=10)			Non-anemic (n=7)			All children (n=17)		
	Present	Absent	NR	Present	Absent	NR	Present	Absent	NR
Malaria	4	4	2	4	2	1	8	6	3
Other infections	7	3	0	5	2	0	12	5	0
Iron-deficiency	3	4	3	1	5	1	4	9	4
Folate-deficiency	9	0	1	3	4	0	12	4	1
Sickle-cell anemia	1	9	0	0	7	0	1	16	0

TABLE 15

HEMATOLOGICAL DIAGNOSES ON PREGNANT WOMEN IN THE NORTHERN PROVINCE

	Anemic (n=8)			Non-anemic (n=6)			All patients (n=14)		
	Present	Absent	NR	Present	Absent	NR	Present	Absent	NR
Malaria	4	3	1	2	4	0	6	7	1
Other infectons	1	7	0	0	6	0	1	13	0
Iron-deficiency	3	4	1	2	4	0	5	8	1
Folate-deficiency	3	5	0	4	2	0	7	7	0

FIGURE 1

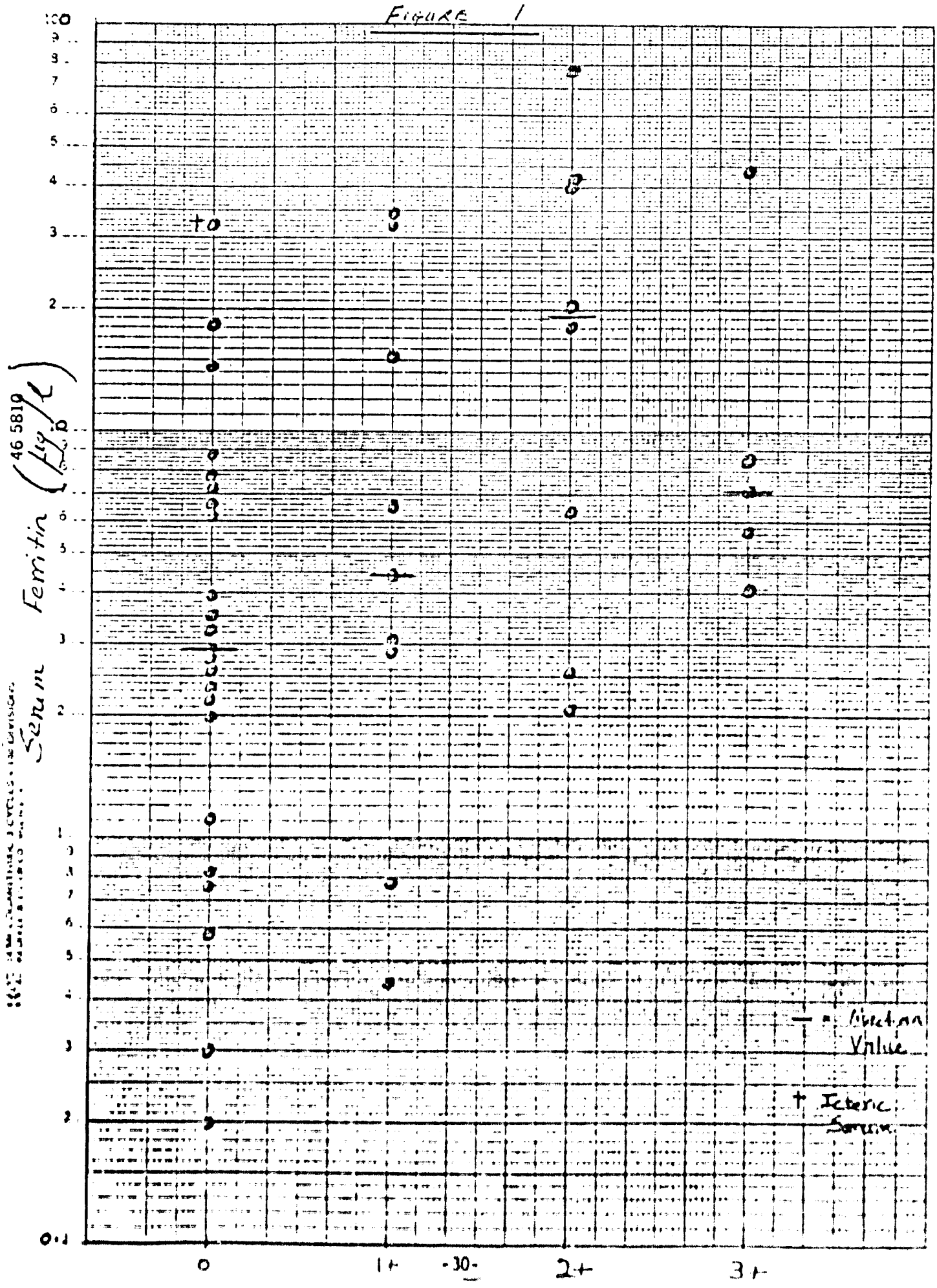
Serum Ferritin (μg/l)
46 5819
0
1+
2+
3+
— = Direct on Value
+ Icteric Serum

Table 16

COMPARISON OF SERUM FERRITIN AND BONE MARROW IRON

	CHILDREN Number of Subjects	
Marrow Iron	Serum Ferritin < 50 ug/l	Serum Ferritin > 50 ug/l
0 - 1+	7	7
2 - 3+	2	8
Total	9	15
	PREGNANT WOMEN Number of Subjects	
Marrow Iron	Serum Ferritin < 50 ug/l	Serum Ferritin > 50 ug/l
0 - 1+	13	5
2 - 3+	1	2
Total	14	7

APPENDICES

Appendix A

TIMETABLE OF ASSIGNMENT

Appendix A

TIMETABLE OF ASSIGNMENT

Wednesday, 18 June 1980:	AFF traveled Zaria, Kaduna, Lagos; obtained visa for Cameroon and attended to other administrative matters. SRL traveled Kansas, Paris, Douala, Yaoundé.
Thursday, 19 June:	AFF traveled Lagos, Douala, Yaoundé; reported at USAID Mission; SRL arrived Yaoundé.
Friday, 20 June to Wednesday, 25 June:	Yaoundé: Briefing at USAID Mission. Visits to Department of Hematology at CUSS and Blood Transfusion Center to prepare material for field trips and hold discussions with Cameroonian hematologists.
Thursday, 26 June:	Traveled by road to Abong-Mbang.
Friday, 27 June:	Data and specimen collection, Hopital Départemental d'Abong-Mbang (Haut Nyong). Afternoon: Traveled to Bertoua.
Saturday, 28 June:	Data and specimen collection, Hopital Provincial de Bertoua. Afternoon: Returned to Yaoundé.
Monday, 30 June, Tuesday, 1 July:	Processing and interpretation of specimens at CUSS, Yaoundé.
Wednesday, 2 July:	Flight to Maroua.
Thursday, 3 July:	Morning: Data and specimen collection, Prevention Maternale et Infantile (PMI), Maroua. Afternoon: Traveled by road to Mokolo.
Friday, 4 July:	Morning: Traveled by road to Koza; data and specimen collection, Hopital Adventiste de Koza. Afternoon: Returned to Mokolo; data and specimen collection, Hopital Départemental de Mokolo.
Saturday, 5 July:	Morning: Data and specimen collection, Dispensaire Mission Catholique, Oura-Tada, Mokolo. Afternoon: Traveled by road to Maroua.
Sunday, 6 July:	Flight to Yaoundé.

Monday, 7 July to Thursday, 10 July:	Yaoundé: Processing and interpretation of specimens at CUSS; debriefing, USAID Mission, Yaoundé.
Thursday, 10 July:	SRL returned Yaoundé, Douala, Paris, Kansas.
Friday, 11 July:	AFF returned Yaoundé, Douala, Lagos.
Saturday, 12 July:	AFF traveled Lagos, Kaduna, Zaria.

Appendix B

LIST OF PERSONS MET ON ASSIGNMENT

Appendix B

LIST OF PERSONS MET ON ASSIGNMENT

Lagos

His Excellency Alhadji Yerima Lamine, Ambassador of the United Republic of Cameroon to the Federal Republic of Nigeria

Yaoundé

Professor V. Ngu, Vice Chancellor, University of Yaoundé

Professor L. Kaptué-Noche, Chef de Service d'Hematologie, Hopital Central de Yaoundé, Professeur d'Hematologie et Immunologie, CUSS, Yaoundé

Dr. Fosi Joseph Mbatenkhu, Médecin Assistant en Hematologie, Hopital Central, Yaoundé

Professor Dan Lantum, Assistant Director, CUSS

Mr. Peter Lord, U.S. Chargé d'Affaire, Yaoundé

Mr. James Williams, Director, USAID, Yaoundé

Abong-Mbang

Mr. John Acha, Prèfet du Haut-Nyong

Dr. Mbog Emmanuel, Chef de la Section Départementale de la Medécine Préventive et Rurale du Haut-Nyong

Souer Marie-Ange Privat, Infirmière Sage-Femme, D.E.

Bertoua

Dr. Philippe Issom, Conseiller-Medical, Hopital Provincial de Bertoua

Dr. Otto Dondinjiki, Pediatre

Dr. Wefuan Jonah Ndifoa, Medécine Generale

Maroua

M. Oumarou Koué, Prèfet

Dr. Pierre Le Jeannie, Conseiller-Medical, Hopital de Maroua

Dr. Abba Liman, Chef de Section Départementale de la Medécine Préventive et Rurale, et Chef de Service de Pediatrie à l'hopital de Maroua

Mme. Malmadi, Infirmière, PMI

Mme. Tenguen, Sage-Femme

Mokolo

M. Mohamadou Labarang, Premier Adjoint Prefectural, Mokolo

Dr. Granier Jean-Claude, Pediatrie, Hopital Départemental de Mokolo

Dr. Owona Essomba René, Medécine

Dr. Kedi à Nwatsok, SDNPR et Gynéco-obstétrique

Koza

Dr. Jacques Steveny, Hopital Adventiste de Koza

Oura-Tada

Souer Anuncia Morale, Dispensaire Mission Catholique, Oura-Tada