NUTRITIONAL ANEMIA IN WEST-AFRICA : USE OF SOME " IN VITRO" TESTS : DATA OF SOME INCIDENCE SURVEYS

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The analysis or iron deficiency anemia, encountered in African among women and children, poses the problem of choosing the best diagnostic criteria. The classic methods of diagnosis involve measurement of hemoglobin concentration, of the mean corpuscular volume, of serum iron and the transferrin saturation. These measurements, however, produce abnormal values only when the subject is already anemic that is to say the total body iron stores are depleted and the treatment is essentially curative.

More interesting is to detect the prior condition of marginal iron deficiency which could develop into true anemia : measurements of free erythrocyte protoporphyrin and ferritin serum make it possible to determine the threshold of this iron pre-deficiency status.

Free erythrocyte protoporphyrin, the intermediate stage in the synthesis of hemoglobin, combines with iron to form heme : if there is an iron deficiency, there is a greater concentration of erythrocyte protoporphyrin. The lack of iron for erythropoesis seems to be, a priori, the only cause of this increase of protoporphyrin. In fact, the synthesis of hemoglobin is disrupted only when these iron stores are exhausted.

The ferritin serum concentration, on the other hand, is in close co relation with iron stores in bone marrow and liver. The results of its measurements are quantitative, reproduceable and far more praticable than bone marrow anemia. The value of ferritin serum reflects the total iron stores of the body (1 µg/l equals approx. 10 mg of iron) and makes possible the detection of a negative balance or iron well before that the clinical signs of anemia may be detected.

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I) USE OF SOME LABORATORY TESTS

Our study consisted of the application of these tests to the research in the etiology of anemia in Dakar.

We found that 75 % of the anemic subjects were mainly hypochromic, microcyt and sideropenics. If one looks at the values of transferrin which is related also to the protein metabolism this population can be divided in two groups :

	Group A : 63 %	Group B : 12 %	
Hemoglobin	86 ± 23	82 ± 30	g/l
M. C. V.	75 ± 9	79 ± 16	f.l
Serum iron	30 ± 150	280 ± 51	µg/l
Serum ferritin	14 ± 14	42 ± 38	µg/l
F. E. P.	3,80 ± 1,79	4,95 ± 1,63	mg/l
Transferrin	1,53 ± 0,77	2,72 ± 0,82	g/l

In these two groups, serum iron and serum ferritin are equally depressed. The concentration of F. E. P. is increased. Only 63 % (Group A) of the subjects present a straightforward hyposideremic anemia : their serum transferrin is elevated and clearly differs from that of group B which is largely depressed.

The assessment of nutritional status of this group B shows that the serum concentration of albumin and prealbumin are low, respectively 29,8 g/l and 60 mg/l versus the control group 40,6 g/l and 204 mg/l. Weight for height is on the average of ± 10 % of the expected standards. The anemia in this group would therefore be linked also to protein - energy malnutrition whereas in the group the subjects have an uncomplicated iron deficiency.

The remaining 25 % anemic subjects present yet another hematological and biochemical profile and may be also divided in two sub-groups :

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	Group C : 14 %	Group D : 11 %	
Hemoglobin	97 ± 11	75 ± 33	g/l
M. C. V.	86 ± 11	118 ± 12	f.l
Serum iron	129 ± 123	100 ± 63	µg/l
Serum ferritin	184 ± 216	276 ± 343	µg/l
F. E. P.	4,25 ± 2,09	4,63 ± 1,19	mg/l
Transferrin	3,60 ± 1,41	3,02 ± 0,95	g/l

There is a discrepancy between the severity of anemia and the level of the ferritin values.

11 % of the subjects (group D) are hypochromic and macrocytic and their hematological profile would correspond to that of a vitamin deficiency type (folates or vitamin B 12).

For the group C the mean corpuscular volume is normal or slightly microcytic with an increased concentration of F.E.P. The serum iron and ferritin are normal or increased. Weight for height is 85 ± 6 % of the standards. This abnormality of iron utilisation by erythropoiesis would suggest that the anemia is associated with infection. The gamma globulins concentration is significantly higher in these subjects.

In summary, 63 % of the anemic subjects represented a classic hematological profile : low hemoglobin with a depression in stores of iron (degree of saturation of transferrin low, F.E.P. and transferrin increased). The remaining 37 % would be subjects whose anemia can be traced to marginal protein-energy malnutrition and/or an infection or inflammatory process. Here the biochemical parameters no longer follow hematological data. Tests to determine the protein-energy malnutrition status or determine whether or not infection exists, should be obligatory, in order to assess the etiology of these anemias. Keeping in mind that an iron fortification or supplementation will not cure the anemia of 37 % of these subjects, one must always seek other causes of anemia : protein-energy malnutrition, infection and parasitosis.

II) DATA OF SOME INCIDENCE SURVEYS

1) Hematological and biochemical values of pregnant women (1rst three months) in Senegalese cities (Dakar, Saint Louis, Louga, Thies)

	MEDIAN	MEAN	S.D.	RANGE	NUMBER
Erythrocytes x 10^6	3.790	3.750	0.43	2.5 - 4,8	79
Hemoglobin g/l	125	123	15	55 - 150	79
Hematocrit %	36	36	4.5	22 - 50	79
M. C. V. f.l	97	97	8	78 - 115	79
M.C.H.C. %	33.8	33.5	2.3	24.7 - 40.4	79
Serum iron mg/l	1.14	1.13	0.35	0.48- 2.45	66
Ferritin ug/l	16.7	22.9	19.5	4.0 - 98	51

The analysis of the results show that 44 % of the women have a hemoglobin concentration less than 120 g/l. 72 % have a concentration of ferritin serum lower than 25 µg/l. On the other hand, 60 % of the women have albumin serum less than or equal to 35 g/l.

The correlation between the albumin and hemoglobin levels ($r = 0.4$, $P < 1‰$) underlines the necessity to take in accompt the protein status when interpreting the significance of low hemoglobin level.

2) Comparison of hemoglobin concentration (mean ± 1 S. D. Range, number) : Diourbel area (Senegal).

	COUNTRIES			Global
	MBACKE	DIOURBEL	BAIBEY	Number
Children 0- 10 years	97 ± 18 (40 - 132) n = 112	88 ± 19 (34 - 132) n = 116	90 ± 17 (40 - 130) n = 135	91 ± 18 (34 - 132) n = 363
Males	134 ± 18 (78 - 176) n = 58	126 ± 19 (34 - 162) n = 65	123 ± 12 (84 - 142) n = 64	127 ± 17 (34 - 176) n = 187
More than 15 years Females	113 ± 23 (62 - 150) n = 55	100 ± 20 (24 - 158) n = 68	101 ± 20 (34 - 134) n = 72	104 ± 21 (24 - 158) n = 195

Evaluation in relation to with age of hematological parameters of children in Diourbel area (mean ± 1 S. D., number)

	0-2 YEARS	3-4 YEARS	5-6 YEARS	7-10 YEARS
Hemoglobin g/l	84 ± 15 (162)	93 ± 19 (78)	99 ± 18 (112)	107 ± 19 (11)
Hematocrit %	32.0 ± 4.5 (155)	35.9 ± 5.7 (75)	35.6 ± 5.0 (108)	38.6 ± 5.1 (10)
M. C. H. C. %	26.3 ± 3.7 (155)	27.6 ± 4.7 (75)	27.6 ± 3.4 (108)	28.1 ± 3.8 (10)

3 a) Hemoglobin and serum iron in relation with age and sex :

MALI : South of Bamako (rural and semi-urban areas).

	Hemoglobin g/l	Fer serique µg/l
0 – 5 Years	n = 17 116 ± 22	n = 8 830 ± 200
6 –10 Years	n = 48 123 ± 22	n = 47 720 ± 190
11 –20 Years females	n = 22 125 ± 26	n = 20 760 ± 290
11–20 Yars males	n = 66 133 ± 18	n = 58 830 ± 210
21–60 Yars females	n = 87 125 ± 25	n = 92 800 ± 300
21–60 Years males	n = 83 142 ± 21	n = 78 900 ± 280

Frequencies of anemics in relation with age (WHO norms)

Children subjects	0 – 10 years	40 %
	11 – 14 years	40 %
Adults	15 – 80 years	43 %

3) b – Hemoglobin and serum iron in relation with age and sex :

Upper-Volta (rural and semi-urban areas)

	Hemoglobin g/l	Serum iron ug/l
0 – 5 years old	n = 28 114 ± 23	n = 12 620 ± 162
6 – 10 years old	n = 76 120 ± 16	n = 70 786 ± 238
11 – 20 years old females	n = 26 123 ± 16	n = 29 767 ± 248
11 – 20 years old males	n = 72 129 ± 19	n = 73 748 ± 206
21 – 60 years old females	n = 114 127 ± 20	n = 175 818 ± 288
21 – 60 years old males	n = 102 147 ± 18	n = 114 932 ± 286

Frequencies of anemics in relation with age (WHO norms)

0 – 10 years	32 %	More frequent for males
11 – 14 years	51 %	No significant difference
15 – 80 years	41 %	between males and females

These tables offer a comparison of hemoglobin and serum iron concentrations according to sex and show the high rate of anemia found in each age group especially the 11-14 years old. There is very little relationship between hemoglobin and serum iron. Only 14% of the hemoglobin concentration variations can be explained by variations in serum iron ; therefore, 86 % of the variations in hemoglobin concentration are linked to other factors.