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Alteration of iron stores in women of reproductive age with HIV in Abidjan (Côte D'ivoire)

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Abstract

The aim of this study is to evaluate and to characterize the iron metabolism in women of reproductive age infected by VIH in Abidjan. In order to review the iron stores in women of reproductive age, 180 women were recruited in a specialized center for treatment of HIV (ICBRA) based on the criteria for inclusion and exclusion. The mean age of women was 34.7 ± 0.5 years with extremes of 18 and 45 years. These women were classified into two groups of subjects namely 120 HIV positive women and 60 HIV negative as control women. Blood samples were taken from each of the selected women. Assays of various biological indicators (haematological and biochemical parameters) assessment of iron status were performed by different kits adequate for the automatic COBAS INTEGRA 400 Plus. The results of our investigations have demonstrated that all the searched biological has been degraded in enrolled women. Indeed our study found that for all subjects 79.4 % of women reported an abnormal iron status namely 71.7 % and 83.3 % respectively in control women and women with HIV. Abnormal iron status consisted of iron deficiency, iron deficiency anaemia, inflammatory anaemia and inflammatory anaemia associated with iron deficiency. Among the observed various components of iron status, inflammatory anaemia revealed the high prevalence rates in both groups of subjects (46.7 % vs 67.5 %). Our findings have then indicated that HIV infection has dramatically altered iron stores in women of reproductive especially those living with HIV/AIDS.

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Introduction

As from the report of the World Health Organization (WHO) in 2005 (WHO, 2005), iron deficiency anaemia constitutes a silent emergency remains for women of reproductive age, a cause of mortality and morbidity. This is a very common biological symptom which is a real public health problem in developing countries (Fleming, 1989). In Côte d'Ivoire, Asobayire *et al.* (2001) reported that several layers of the population showed a degraded iron status by malaria and other parasitic infections. Among the frank of populations, women of reproductive age have shown a more altered iron status compared to international standards (WHO, 2005; Bléyéré *et al.* 2007; Yapo *et al.*, 2008). In addition to the iron deficiency, folic acid, vitamin B12, malaria, intestinal parasites, hemoglobinopathies, infectious and inflammatory syndromes are also causes of anaemia in women of reproductive age (Meda *et al.*, 1999; Massawe, 2002; Wisaksana *et al.*, 2011).

In recent years, infection with human immunodeficiency virus (HIV) has become a major factor associated with maternal anaemia. This worldwide scourge that decimated the populations of developing countries makes more severe the prognosis of anaemia types among women of reproductive age (Van Den Broek *et al.* 2000; Massawe, 2002).

The prevalence of iron deficiency and anaemia therefore increase among this fringe of the population in Sub-Saharan Africa (Flemiing, 1997, UNICEF/UNU/WHO, 2005). Yet in Cote d'Ivoire, very few investigations have been reported on the prevalence of iron deficiency and anaemia among women of childbearing age living with HIV/AIDS. That is why, this study aims to describe the influence of HIV/AIDS on the iron metabolism in this class of the population of Côte d'Ivoire in consultation within the Integrated Centre for Bioclinical Research of Abidjan, a specialized centre in the care of people living with HIV/AIDS.

Material and methods

Setting and study population

This study was conducted from October 21, 2009 to December 21, 2010 within the Integrated Centre for Bioclinical Research of Abidjan (ICBRA/Côte d'Ivoire). The research covered 180 women in consultation to ICBRA and coming from all social and professional groups. These subjects were divided into two groups of 60 control women tested HIV negative, 120 HIV positive women. Seropositive subjects were screened through two types of HIV serology tests (Test Determines and Test Genie II HIV-1/HIV-2) Integrated Centre for Bioclinical Research of Abidjan. These women of reproductive age were included on the basis of documents provided by health workers and the survey forms. Thus, women who had complications of hypertension, diabetes, rheumatoid arthritis were excluded from the study population. In the same context, subjects recently transfused and those who reported digestive and gynecological pathologies were not enrolled. In the same sense, the women during menstruation were not retained as well as women who were not on antiretroviral therapy at least one year.

The selected women were aged 18 to 45 years with a mean of 34.71 ± 0.49 years. The body mass index, number of pregnancies, childbirth and the period between births or pregnancies had respective mean values of 24.7 ± 0.4 $kg.m^{-2}$; 2.04 ± 0.2; 0.7 ± 0.04 and 17.4 ± 1.4 (Table 1). In the same table, the study has selected a low proportion (3.3 %) compared to those of adolescents whose age is physiologically normal (96.7 %). The body mass index was abnormal (insufficient and overweight) in 45 % (Table 1). For our investigations, women were more multigravidae (83.3 %), multiparous (52.2 %) and more subjects with less than 36 months between pregnancies (68.9 %). However, women had a good education and have included married, single and some living in concubinage (Table 1).

Assays, assessment and statistical analysis of biological parameters

At each of the women recruited, a blood sample collected in dry tubes and tubes with anticoagulant to 5 ml each were made at the elbow fasted in the morning. Whole blood obtained in tubes with anticoagulant (EDTA) has achieved blood cell counts by the Sysmex XT 2000i PLC. Reaping the blood in dry tubes was centrifuged at 3000 rpm during 5 min to obtain the serum. The resulting serum was used to determine HIV status and biochemical data. The quantitative determination of biochemical parameters (serum iron, serum transferrin and serum ferritin) in human serum is based on a colorimetric technique available on most automated COBAS INTEGRA 400. For this determination, the COBAS INTEGRA kits Iron (IRON), Tina-quant Transferrin ver.2 (TRSF2) test TRSF2, test and Ferritin Gen.2 ID 0-567 (FERR2) test, test ID 0-567, containing *in vitro* diagnostic reagents were used. The total iron binding capacity (TIBC) and the saturation coefficient of transferrin (SCT) were obtained by calculations.

To better appreciate the parameters of our biological assays, conventional criteria were selected. They associated the recommendations of international organizations (WHO), the French Society of Clinical Biology (SFBC/France), French Society of Hematology (SFH/France-Group of Cellular Hematology), the Society of Nutrition and Diet of the French Language (France), Centre for Disease Control and Prevention (WHO/CDCP) and the Institute of Medicine (IOM/US) (Vernet et al., 2001; IOM/US, 1990; UNICEF/UNU/WHO, 2001; SNDLF, 2001, WHO/CDCP, 2004).

The mean values of biological parameters obtained were submitted to a Student's t test for independent samples with the computer program Statistica Statsoft Windows version 7.1 (Statsoft, 2005) in order to assess the impact of HIV/AIDS. The different proportions observed of biological indicators iron status were compared by the likelihood test or G test log likehood ratio with the software version R.2.0.1 Windows (Ihaka and Gentleman, 1996). The level of significance was set to a p value < 0.05.

Ethics

Experimental procedures and protocols used in this study were approved by ethical committee of Health Sciences and the University of Abobo-Adjamé (Abidjan/Côte d'Ivoire). These guide line were in accordance with the internationally accepted principles for laboratory use and care.

Then, this study was approved by the Ministry of Higher Education and Scientific Research, the Ministry of Education and the Ministry of Health and Public Hygiene in the Republic of Côte d'Ivoire.

Results

Distribution of mean and proportions values of biological parameters

The results of this study have shown that all haematological parameters except the mean corpuscular volume and mean corpuscular hemoglobin, have indicated abnormal mean values compared to reference standards. Along the same lines, no statistically significant difference ($p < 0.05$) was observed between the two groups of women. However, women with HIV/AIDS presented the lowest mean values compared to control women (Table 2).

At the level of biochemical indicators, only the saturation coefficient of transferrin did not present normal mean values compared to reference set by international organizations. In addition, a significant difference ($p = 0.02$) was observed between the two groups of women at the level of iron stores (serum ferritin). Iron stores in HIV positive women were significantly elevated compared to control women (161.2 ± 24 µg/l vs 85.1 ± 14 µg/l). In contrast, the mean values of other measured biochemical parameters were statistically not different ($p > 0.05$) between the two groups of women selected (Table 2).

Table 1. Characteristics of study population.

Anthropo-socio-demographic parameters	Mean values ± SEM, number of each subjects group and proportions		
	Total population (N = 180)	Control women (N = 60)	HIV positive women (N = 120)
	n (%)	n (%)	n (%)
Age (ans)	34.7 ± 0.5	32.3 ± 0.9	35.9 ± 0.5
18 – 19	06 (3.3)	4 (6.7)	2 (7)
20 – 45	174 (96.7)	56 (93.3)	118 (98.3)
BMI ($kg.m^{-2}$)	24.7 ± 0.4	25.3 ± 0.6	24.4 ± 0.5
< 19.8	23 (12.8)	05 (8.3)	18 (15)
19,8 – 26	99 (55)	33 (55)	66 (55)
> 26	58 (32.2)	22 (36.7)	36 (30)
Gravidity	2.04 ± 0.2	2.1 ± 0.2	2.02 ± 0.2
Primigravidae	30 (16.7)	17 (28.3)	39 (32.5)
Multigravidae	150 (83.3)	43 (71.7)	81 (67.5)
Parity	0.7 ± 0.04	0.7 ± 0,06	0.7 ± 0.04
Nulliparous	56 (31.1)	17 (28.3)	39 (32.5)
Primiparous	30 (16.7)	9 (15)	21 (17.5)
Multiparous	94 (52.2)	34 (56.7)	60 (50)
Space between births (Months)	17.4 ± 1.4	20.2 ± 2.4	15.9 ± 1.6
< 36	124 (68.9)	34 (56.7)	90 (75)
> 36	56 (31.1)	26 (43.3)	30 (25)
Matrimonial status			
Married	48 (26.7)	13 (2.7)	35 (29.2)
Singles	67 (37.2)	19 (31.7)	48 (40)
Concubinage	65 (36.1)	28 (46.7)	37 (30.8)
widowers	0(0)	0(0)	0(0)
Educational attainment			
Uneducated	33 (18.3)	6 (10)	27 (22.5)
Primary school	33 (18.3)	9 (15)	24 (20)
Secondary school	78 (43.3)	38 (63.3)	40 (33.3)
Superior	51 (28.3)	19 (31.7)	32 (26.7)

N: Total number of each subject group; n (%): Number of subjects observed in each group and proportions indicated in each subjects group; SEM: Standard error of mean

Therefore, HIV/AIDS has had an impact on degraded iron stores of women.

Our research through the observed proportions in Table 3 revealed high rates of anaemia (56.7 % vs 67.5 %), macrocytosis (56.7 % vs 52.5 %) and hypochromia (61.7 % vs 62.5 %) in both groups of selected women. Women with HIV/AIDS reported the highest proportions except at the macrocytosis. Furthermore, no significant differences were observed between the two groups of subjects except for normal values of hematocrit (Table 3). The high prevalence of macrocytosis (MCV > 100 fl) compared to the proportions of microcytosis (MCV < 80 fl) have shown an impact of HIV/AIDS on women measured haematological parameters in our study (Table 3).

Table 2. Changes in biological parameters for different women groups

Biological parameters	Total population (N = 180)	Control women (N = 60)	HIV positive women (N = 120)	p values
		Mean ± SEM		
Blood counts				
Red blood cells (10^{12}/l)	3.9 ± 0.1	4.1 ± 0.1	3.9 ± 0.1	0.06 (NS)
Hemoglobin (g/dl)	11.1 ± 0.1	11.8 ± 0.3	11.2 ± 0.2	0.06 (NS)
Hématocrit (%)	35.8 ± 0.3	36.8 ± 0.5	35.3 ± 0.4	0.06 (NS)
Erythrocyte indices				
MCV (fl)	91.6 ± 0.8	91.4 ± 1.3	91.7 ± 1.1	0.9 (NS)
MCH (pg)	29.2 ± 0.3	29.3 ± 0.5	29.1 ± 0.4	0.9 (NS)
MCHC (g/dl)	31.8 ± 0.1	31.9 ± 0.2	31.7 ± 0.1	0.3 (NS)
Plasma compartment				
Serum iron (µmol/l)	11.6 ± 0.02	11.6 ± 0.04	11.8 ± 0.03	0.9 (NS)
Serum transferrin (g/l)	2.5 ± 0.02	2.4 ± 0.1	2.5 ± 0.1	0.8 (NS)
TIBC (µmol/l)	61.5 ± 1.1	61.7 ± 1.7	61.6 ± 1.4	0.8 (NS)
SCT (%)	10.3 ± 0.4	9.3 ± 0.7	10.9 ± 0.5	0.6 (NS)
Compartment of reserves				
Serum ferritin (µg/l)	135.8 ± 15.4	85.1 ± 14	161.2 ± 24	0.02 (S)

SEM: Standard error of mean; N: Total number of each subject group; n: Number of subjects observed in each group; S: Statistically different for p value < 0.05; NS: Not statistically significant for p value > 0.05

MCV: Mean Corpuscular Volume; MCH: Mean corpuscular hemoglobin; MCHC: Mean corpuscular hemoglobin concentration; TIBC: Total iron binding capacity; SCT: Saturation coefficient of transferrin

The combination of several haematological parameters (hemoglobin, mean corpuscular volume and mean corpuscular hemoglobin) indicated in selected women, the prevalence of nornocytic normachromic anaemia (ANN), normocytic hypochromic anaemia (NHA), microcytic hypochromic anaemia (MHA) and macrocytic hypochromic anaemia (mHA) (Table 3). The first type of anaemia (ANN) quoted presented the highest prevalence rates. For these observed types of anaemia, no significant difference (p > 0.05) was indicated between the different prevalence rates in both groups of women (Table 3). However, a statistically significant difference (p = 0.03) was revealed between control women and women living with HIV/AIDS for the proportions of hypochromic normocytic anaemia. These women living with HIV/AIDS have shown in our investigations a rate twice as high as that of women without HIV/AIDS (25.9 % vs 12.5 %). In addition, very highly significant differences (p < 0.00001) were established within each group of subjects (Table 3).

At the level of biochemical parameters, the work reported high proportions of women with normal values of serum iron (6.6 to 26 µmol/l), serum transferrin (2-3.6 g/l), total iron binding capacity (50-90 µmol/l) and serum ferritin levels (15-150 µg/l). In contrast, large proportion of women presented low values (< 15 %) of saturation coefficients of transferrin. Furthermore, no statistically significant difference (p > 0.05) was observed between the two groups of studied women (Table 4).

Table 3. Distribution of proportions of main erythrocyte parameters

Haematological parameters	Total population (N = 180)	Control women (N = 60)	HIV positive women (N = 120)	p values
	n (%)	n (%)	n (%)	
Blood counts				
Hemoglobin (g/dl)				
< 12	115 (63.9)	34 (56.7)	81 (67.5)	0.2 (NS)
> 12	65 (36.1)	26 (43.3)	39 (32.5)	0.1 (NS)
Hematocrit (%)				
< 40	156 (86.7)	47 (78.3)	109 (90.8)	0.3 (NS)
40 - 45	24 (13.3)	13 (21.7)	11 (9.2)	**0.01 (S)**
Erythrocyte indices				
MCV (fl)				
< 80	26 (14.4)	9 (15)	17 (14.2)	0.9 (NS)
80 - 100	57 (31.7)	17 28.3)	40 (33.3)	0.5 (NS)
100 - 114	97 (53.9)	34 (56.7)	63 (52.5)	0.7 (NS)
MCH (pg)				
< 27 ou > 31	112 (62.2)	37 (61.7)	75 (62.5)	0.4 (NS)
27 - 31	68 (37.8)	23 (38.3)	38 (37.5)	0.3 (NS)
Different anaemias				
NNA	41 (35.7)	14 (46.9)	27 (33.3)	0.09 (NS)
NHA	25 (21.7)	4 (12.5)	21 (25.9)	0.03 (S)
MHA	21 (18.3)	6 (18.8)	15 (18.5)	0.96 (NS)
mHA	28 (24.3)	10 (31.3)	18 (22.2)	0.2 (NS)

N: Total number of each subject group; n (%): subject number observed in each group and proportion indicated in each subjects group; SEM: Standard error of mean; S: Statistically different for p value < 0.05; NS: Not statistically significant for p value > 0.05; MCV: Mean Corpuscular Volume; MCH: Mean corpuscular hemoglobin;
NNA: Normochromic Normocytic Anaemia; NHA: Normocytic Hypochromic Anaemia; MHA: Microcytic Hypochromic Anaemia; mHA: macrocytic Hypochromic Anaemia

Prevalence of iron deficiency and types of anaemia

Our study revealed to a figure 1 for all the subjects, 79.4 % of women reported an abnormal iron status namely 71.7 % and 83.3 % respectively in control women and women with HIV. Abnormal iron status consisted of iron deficiency, iron deficiency anaemia, inflammatory anaemia and inflammation anaemia associated with a iron deficiency. Among the components of the iron status of selected women, high prevalences of inflammatory anaemia were observed (46.7 % vs 67.5 %).

In the same context, another type of inflammatory anaemia was revealed, the anaemia of inflammation accompanied by iron deficiency in which proportions were not negligible (10 % and 3.3 % respectively in control women and women with HIV/AIDS). In addition, low prevalences of iron deficiency and iron deficiency anaemia have been reported in our study (Fig. 1). Moreover, the prevalences of the different observed components of iron status (Fig. 1) between the two groups of women showed no significant difference (p > 0.05).

Table 4. Distribution of proportions biochemical parameters

Biochemical parameters	Total population (N = 180)	Control women (N = 60)	Hiv-positive women (N = 120)	p values
	n (%)	n (%)	n (%)	
Plasma compartment				
Serum iron (µmol/l)				
< 6.6	26 (14.4)	8 (13.3)	18 (15)	0.5 (NS)
6.6 - 26	151 (83.9)	52 (86.7)	99 (82.5)	0.7 (NS)
≥ 26	3 (1.7)	0 (0)	3 (2.5)	0.06 (NS)
Serum transferrin (g/l)				
< 2	30 (16.7)	11 (18.3)	19 (15.8)	0.7 (NS)
2 – 3.6	144 (80)	48 (80)	96 (80)	1 (NS)
> 3.6	6 (3.3)	1 (1.7)	5 (4.2)	0.3 (NS)
TIBC (µmol/l)				
< 50	30 (16.7)	11 (18.3)	19 (15.8)	0.7 (NS)
50 - 90	144 (80)	48 (80)	96 (80)	1 (NS)
> 90	6 (3)	1 (1.7)	5 (4.2)	0.3 (NS)
SCT (%)				
< 15	145 (80.6)	49 (81.7)	96 (80)	0.9 (NS)
15 - 35	35 (19.4)	11 (18.3)	24 (20)	0.8 (NS)
Compartment reserves				
Serum ferritin (µg/l)				
< 15	22 (12.2)	7 (11.7)	15 (12.5)	0.9 (NS)
15 - 150	117 (65)	44 (73.3)	73 (60.8)	0.3 (NS)
> 150	41 (22.8)	9 (15)	32 (26.7)	0.7 (NS)

N: Total number of each subject group; n (%): subject number observed in each group proportion indicated in each subjects group; S: Statistically different for p value < 0.05; NS : Not statistically significant for p value > 0.05; TIBC: Total iron binding capacity; SCT: Saturation coefficient of transferrin

Yet again, the results to Figure 1 showed that the origin of the anaemias in our investigations can not only be dietary, but infectious. HIV has therefore had an influence on all biological indicators for evaluating the iron status of selected women.

Discussion

Iron metabolism a set of steps is summarized in a closed cycle. This cycle provides several forms of iron in different compartments of the body. Thus, the iron in the body is 75 % in the functional compartment, 0.1 % in the circulating compartment and 25 % in the reserves (Beaumont and Girot, 2010). The conduct of each indicator assessment of iron status is function of the quantity and quality of iron in each compartment (Levin and Handelman, 2008).

Our investigations performed in women of reproductive age selected from the Integrated Centre for Bioclinical Research of Abidjan (ICBRA) used to

assess iron metabolism in each compartment of the body. This evaluation revealed that four out of five (4/5) selected women in case of our study, show abnormal iron status. This result demonstrates that there are pathological manifestations of iron metabolism in recruited women. Pathological changes known, concern the deficiency state or hyposiderosis, overload or hypersiderosis and the deviation of normal metabolism (Korwin, 2010).

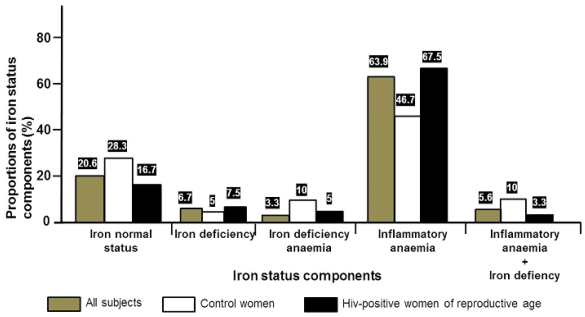

Fig. 1. Evolution of iron status components in different groups of subjects.

In developing countries, the changes of iron metabolism concern hyposiderosis and the deviation of the iron metabolic pathways in general. The work performed in several sections of the population reported that the origins of the changes in iron metabolism are a matter dietary, infectious, inflammatory, and to a lesser extent, genetics (WHO/CDCP, 2004, Lewis et al., 2007; Mata-Marín *et al*., 2010).

The low prevalence of iron depletion (iron deficiency) and iron deficiency anaemia observed could be explained by a deficit of dietary intake among all women in our study (Mburu *et al*., 2008). This is also reflected in reduced rates of microcytosis and proportions of women with values below the normal serum iron, serum transferrin, total iron binding capacity and serum ferritin. This observation is even more plausible for control women without HIV.

This result is contrary to that reported by Yapo *et al.* (2008). According to the work of these authors in Abidjan, the rates of iron deficiency anaemia, microcytosis and hypochromia have been significantly higher. However, a high prevalence of abnormal status as in the case of this study was indicated.

In addition, low levels of inflammatory anaemia were found in women of reproductive age in Abidjan (Côte d'Ivoire) compared to iron deficiency anaemia (Bléyéré *et al.* 2007; Yapo *et al*., 2008). The proportions of women in the normal values of all biochemical parameters and especially macrocytosis, normocytic normochromic anaemia could explain the high prevalence of inflammatory anaemia observed in selected women for this study. There had therefore been a deviation of metabolic pathways in women by the secretion of cytokines which have altered exchanges in the various compartments of the body. The iron was sequestered by HIV in women leading to an apparent increase in reserves to reach spoilage. Indeed, the inflammatory anaemia occurs in situations of immune and inflammatory activation. In these instances, the inflammatory mediators such as interleukin IL1 and IL6, the tumor necrosis factor (TNF), the α1-antitrypsin, etc may:

- inhibit the precursors of erythropoiesis, shortening the lifespan of red blood cells and disrupt the synthesis and action of erythropoietin. This is the initial mechanism;
- alter the metabolism of iron by sequestration of iron released by hemolysis in the reticuloendothelial system. Reserves (assessed by ferritin) are normal or increased, but serum iron and iron readily available for erythropoiesis are reduced (Weiss and Goodnough, 2005; Katodritou and Christakis, 2006).

This mechanism involves a recently identified protein, hepcidin, which prevents the export of iron out of duodenal cells and reticuloendothelial system, but not measured in clinical practice (Levin and Handelman, 2008). In addition, the synthesis of ferritin is directly increased by inflammation, independently and beyond the level of iron stores. Ferritin does not reflect longer

strictly iron stores of the body in this situation. The reduction of serum transferrin is related to its hypercatabolism in the inflammatory focus, and a decrease of its synthesis, since iron stores are high. The coefficient saturation of transferrin is normal or decreased but to a lesser extent from iron deficiency anaemia in this case. This difficulty in mobilization of iron from the reserves leads to a decrease of iron available for hemoglobin synthesis, resulting in a reactive increase of the number of mitoses responsible for microcytosis, hypochromia even in a second step (Levy *et al*., 2008).

Biological table of inflammatory anaemia associated so in terms with haematological markers, a normocytic normochromic anaemia initially moves toward anaemia slightly microcytic and hypochromic if inflammation persists (Amegor *et al*., 2009).

All these events have caused a decrease in circulating pools ferric and functional among all women in the study. This is supported by the types of anaemia observed according to the change in erythrocyte indices and mean values of biochemical parameters that were all normal compared to reference standards. The works carried out in Côte d'Ivoire and Mali have reported the same results (Ahibo *et al*., 2008; Oumar *et al*., 2010).

The investigations conducted in Abidjan showed that the two selected groups of women reported changes in iron metabolism mainly altered iron stores. Moreover, women living with HIV/AIDS and with a high prevalence of inflammatory anaemia are most affected by the deviations of the metabolic pathways of iron.

Conclusion

The human immunodeficiency virus (HIV) is considered for decades as a redoubtable pathogen spreads devastation and sorrow in the populations of developing countries. It was essential for us to investigate the relationship between nutrition and the impact of this virus on the health of populations in Côte d'Ivoire. It is clear from our investigations that the virus acquired immunodeficiency had a significant influence on iron metabolism of all recruited women. All measured parameters in our proceedings have been modified as a whole. The different compartments of their body were involved in a deterioration in performance of iron in their metabolism. The two classes were affected, but women with HIV presented more altered iron stores. A high prevalence of inflammatory anaemia that purpose was observed in the different groups of women. This reflects the reality of different works of several researchers indicate that the main causes for anaemia is diet and infections in the tropics. It is noteworthy that women of reproductive age regularly need antianaemic. But the case of HIV positive women should be treated promptly to prevent iron overload damage their health. Overloading could cause an ease of propagation of the virus in their bodies.

The millennium development objectives that must mobilize all researchers across countries for achieving them at the beginning of 2015. In this context, we must consider the health of all women of reproductive age, in the first instance responsible for our children.

To this effect, work should continue to assess the impact of antiretroviral therapy on iron metabolism and determination of many other biological parameters such as hepcidin and the various nutritional indices.

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Authors' contributions

All authors contributed equally in the study. They made substantial contributions to the design of the study, the collection of the data as well as the preparation and analysis of the data. They also drafted the manuscript and gave final approval for its submission to the journal for consideration of publication.

Declaration of interest

The authors declare that there is no conflict of interest that could be perceived as prejudicing the impartiality of the research reported.

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