Research Article

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Evaluation of the martial status of the mother-child pairs in the delivery room at the Libreville mother-child university hospital in 2023

Abstract

Introduction: Iron deficiency is responsible for serious neurodevelopmental disorders in newborns. Our objective was to study the martial status of the mother-child couple in the birth room of the CHUME-FJE.

Patients and methods: Prospective cross-sectional and analytical study, carried out from November 2022 to January 2023 at the CHUME-FJE including 150 pregnant women carrying a full-term, single pregnancy, without any sign of infection and their newborns who were to be born by vaginal route with good adaptation to extrauterine life. The iron metabolism was assessed by measuring serum iron, ferritin, transferrin and his biological consequence was appreciated by haemoglobin level.

Results: 14.6% (n=22) of parturients had an insufficient iron reserve and 36.0% (n=54) had anemia, the mild stage of which represented 63.0% of cases. Among these anemic parturients, 18.5% had an insufficient iron reserve. In newborns, an iron reserve was insufficient in 8.0% (n=12) of cases and 30.7% (n=46) had anemia. Regular iron intake significantly improved maternal reserve (p=0.03). This positive influence of iron on the maternal martial reserve had not been observed on the martial reserve of their newborns (p=0.56). The increase in hemoglobin and serum iron levels of newborns were associated with the increase in hemoglobin (r= 0.05, p=0.0001) and serum iron levels of their mothers (r= 0.452, p=0.0001).

Conclusion: The rate of iron deficiency in the mother-child couple is considerable and challenges. This suggests a real intervention in the population of pregnant women.

Keywords: martial status, mother-child couple, CHUMEFJE, Gabon, Sub-Saharan Africa

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Introduction

Iron is one of the most important trace elements for proper functioning of the human body.[1] Iron deficiency, especially due to inadequate intake, is the most widespread nutritional disease in the world, both in developing and industrialized countries.[2] This deficiency particularly affects women during pregnancy, as pregnancy increases the maternal demand for iron. This is related to the increase in the mother's blood mass, the needs of the foetus and placenta, as well as blood loss during childbirth.[3] Hence the importance of having sufficient iron reserves during pregnancy. The new-born, especially the one born prematurely, is also affected by iron deficiency.[3] In sub-Saharan Africa, iron deficiency is the main cause of anaemia found in over 11 million pregnant women.[4] Iron deficiency can lead to several complications. In pregnant women, it causes a decrease in physical and mental performance, a reduction in resistance to infections, asthenia, and a postpartum reduction in peripheral blood volume, which may require blood transfusion in some cases.[5] In new-borns, it can lead to prematurity, low birth weight, and even psychomotor delay that can persist until adolescence despite iron treatment.[5,6] Therefore, in several high-risk countries, the World Health Organization (WHO) recommends systematic iron supplementation for pregnant women, knowing that the consequences of this deficiency can sometimes be serious and irreversible, especially on the neurocognitive development of the new-born.[7] Also, in some countries, new-borns are also systematically supplemented with iron.[8] In our context, pregnant women are systematically supplemented but not new-borns. Additionally, no iron assessment is performed on new-borns at birth to screen for and correct any potential iron deficiency. Therefore, through this study, we wanted to evaluate the iron status of the mother-child pairs in the delivery room at CHUME FJE, with the aim of improving the care of new-borns in our context.

Patients and methods

This is a prospective, transversal and analytical study which took place from November 22, 2022 to March 31, 2023, i.e. a duration of 4 months at the Jeanne Ebori Mother-Child University Hospital Center (CHUME-FJE) in Libreville, which is a third generation Hospital dedicated to the health of mothers and children and which is located at the top of the healthcare pyramid in our country.

Studied population

The target population consisted of mother-child pairs, selected from parturient admitted to the delivery room of CHUME-FJE in the active phase of labour. Non-random sampling was based on voluntary participation. The minimum sample size was determined using the Schwartz formula, considering the prevalence of iron deficiency anaemia in pregnant women in Gabon, which was 11.1% in 2011.[9] The application of this formula allowed us to obtain a minimum sample size of 150 mother-child pairs.

Inclusion criteria

The pregnant women included in the study had to be carrying a single pregnancy obtained spontaneously, followed or not, to term (37-41 weeks +6 days), with or without iron supplementation during pregnancy. The delivery had to be vaginal and informed consent had to be given by the patient. After delivery, the new-borns had to show good adaptation to extra uterine life (APGAR ≥7) at the first minute of life.

Non exclusion criteria

The pregnant women who refused to participate, those carrying a hemoglobinopathy or presenting criteria for maternal-foetal infection upon admission to the delivery room were not included in this study. Also, those whose new-borns presented vital distress or a visible malformation at birth were not included.

Exclusion criteria

We excluded from our selection the pregnant women whose vaginal delivery ended in a caesarean section and all those whose blood sample was haemolysed.

Parameters studied

In pregnant women, the clinical parameters studied were sociodemographic data, background and comorbidities, pregnancy follow-up, iron intake during pregnancy, and delivery methods. In new-borns at birth, gestational age, sex, and anthropometric data were recorded. In the mother-child pairs, the Para clinical parameters studied were iron status (serum iron, ferritin, and transferrin) and haemoglobin levels in the complete blood count (CBC).

Definition of concepts

Irregular intake of iron was considered for any woman who did not receive any iron supplementation for at least one trimester, or who received non-daily supplementation during all three trimesters of pregnancy. Regular intake of iron was considered daily iron supplementation throughout the entire duration of pregnancy. In pregnant women, iron deficiency was referred to as a serum ferritin level below 15 µg/l, low iron reserves if it was between 15-30 µg/l, and normal if it was between 30 and 150 µg/l,[10,11] and anaemia when the haemoglobin (Hb) level was below 11 g/dl during the first and third trimesters of pregnancy.[12]

In new-borns, the recommended threshold value for ferritin concentration to define iron deficiency is a level below 12 µg/l, between 12 and 70 µg/l is considered low iron reserves, and between 70 and 400 µg/l is considered normal reserves,[11] and anaemia is defined as a haemoglobin level below 13 g/dl.[13]

Iron-deficiency anaemia was defined as a haemoglobin level $\leq$ 11.0 g/dl associated with a ferritin level $\leq$ 30 µg/l in a pregnant woman,[5] and a haemoglobin level $\leq$ 13 g/dl and a ferritin level $\leq$ 70 µg/l in a new-born.[11] We classified insufficient iron reserves as a serum ferritin level < 30 µg/l in a pregnant woman and < 70 µg/l in a new-born. The three severity stages of anaemia in pregnant women were mild anaemia ($10 \leq Hb \leq 11$ g/dl), moderate anaemia ($7 \leq Hb \leq 10$ g/dl), and severe anaemia ($Hb \leq 7$ g/dl).[12] In a new-born, it was also classified into three stages:[13] mild anaemia ($10 \leq Hb \leq 13$ g/dl), moderate anaemia ($8 \leq Hb \leq 10$ g/dl), and severe anaemia ($Hb \leq 7$ g/dl).

Procedure

Once informed consent was obtained, a venous blood sample was taken from the elbow crease. Immediately after the expulsion of the foetus, a blood sample was taken from the umbilical cord, approximately 10 centimetres from the umbilical orifice, before clamping. These different samples were collected in a gel-sealed dry tube and an EDTA tube, and immediately taken to the laboratory. A complete blood count (CBC) was performed immediately using the blood from the EDTA tube with the YUMIZEN H550 automated analyser. The samples from the gel-sealed tubes were centrifuged at 5000 rpm for 5 minutes, and the serum was then aliquoted and stored at -20ºC until the time of testing. The ferritin, transferrin, and serum iron levels were measured in our laboratory using the Cobas c311® analyser. The immuno-turbid metric method was used for the measurement of ferritin and transferrin. The colorimetric method was used for the measurement of serum iron.

Ethical aspects

Informed consent was obtained from the mothers, as well as from their spouse or guardian. Confidentiality and anonymity were respected. Approval from the National Ethics Committee for Research was obtained during its session on November 15, 2022 (No. 0056/2022/CNER/P/SG).

Statistical analysis

The information from the patients and new-borns was recorded in a database using MS Excel 2019 spreadsheet software and analysed using Stat® software (version 14.0). Qualitative variables were described using percentages. The paired t-test or analysis of variance (ANOVA) test was used to compare the means of quantitative variables. Proportions were compared using the Pearson chi-square test or the McNemar chi-square test. The Pearson linear correlation test was used to assess the relationship between biological parameters of the mother-child pairs. For all analyses, the significance threshold was set at 0.05 (5%).

Results

During the study period, 170 mother-child pairs were included. Among them, 20 pairs had haemolysed blood samples. In total, 150 pairs, or 300 individuals, were included in this study.

Sociodemographic characteristics of the study population

At the end of this work, the study population had the characteristics presented in Table 1.

Marital status of the mother-child pairs

In mothers, the median value of ferritinemia was 54.65 µg/l (range from 2.36 to 1463 µg/l), and in the new-born? Insufficient iron reserves were observed in 14.6% (n=22/150) of cases in mothers and 8.0% (n=12/150) of cases in new-borns. Other variables regarding the marital status of these individuals were compiled in Table 2.

In the group of anaemic new-borns (n=46), 17 (37.0%) had normal iron reserves. Among them, 4 were from well-supplemented mothers, 12 from poorly supplemented mothers, and 1 from a non-supplemented mother. Among the 6 new-borns with iron deficiency, 2 had anaemia. They were all born to mothers who did not regularly take iron, were anaemic, and had insufficient iron reserves. Furthermore, a significant association was observed between regular iron intake during pregnancy and circulating iron levels in the mothers. The mean serum iron level of mothers who regularly took iron was lower than that of mothers with irregular iron intake, with a significant difference (p=0.02). Similarly, the mean serum iron level of new-borns born to mothers who regularly took iron was lower than that of new-borns born to mothers who did not regularly take iron, with a significant difference (p=0.03). Additionally, mothers who regularly took iron had a higher mean serum ferritin level than mothers with irregular iron intake (p=0.03) (Table 3).

Table 1 Descriptive characteristics of the study population

Mothers (n=150)	**Averages ± SD or Frequency (%)**
Pregnancy monitoring/number of contacts (*n=127*)	5,7 ± 2,0
Age (years)	29,2 ± 6,4
SBP (mmHg)	120,5 ± 18,4
DBP (mmHg)	77,5 ± 11,1
HR (beats /minute)	86,4 ± 12,3
T (°Celsius)	36,8 ± 0,4
SaO_2 (%)	99,1 ± 8,3
Intercurrent pathologies	
None	119 (79,3%)
Malaria	23 (15,3%)
Urogenital infections	6 (4%)
Others	2 (1,4%)
Geophony	
No	88 (58,7%)
Yes	62 (41,3%)
Iron supplements	
Irregular	100 (64,3%)
Regular	48 (32,0%)
Null	2 (3,7%)
New-borns (n=150)	**Average ± SD or Frequency (%)**
Gestational age at birth (SA)	39,1± 1,32
weight (g)	3202± 34,6
size (cm)	49,5 ± 2,2
Head circumference (cm)	33 ± 0,12
Gender	
Female	76 (50,7%)
Male	74 (49,3%)
Trophicity	
Eutrophic (2500 g - 4000 g)	116 (77,3%)
Macrosome (> 4000 g)	24 (16,0%)
Hypotrophic (< 2500 g)	10 (6,7%)

SBP, systolic blood pressure; DBP, diastolic blood pressure; **HR,** heart rate; **T°,** temperature; **SaO_2,** oxygen saturation of blood in ambient air; **SA,** weeks of amenorrhoea; **g,** grams; cm, centimetres; **mmHg,** millimetres of mercury.

Table 2 Martial status of the mother-child pair

Martial status	***Mothers***	***New-borns***
Serum iron (µmol/l)	16,1 ± 7,3	25,2 ± 9,4
Transferrin (g/l)	3,5 ± 0,8	2,2 ± 1,7
Serum ferritin (µg/l)	97,8 ± 154,9	252,4 ± 155,9
Haemoglobin level (g/dl)	11,4 ± 1,4	14,1 ± 1,8
Iron reserves		
Normal	105 (70,0%)	67 (44,7%)
High	23 (15,3%)	71 (47,3%)
Low	11 (7,3%)	6 (4,0%)
Martial deficiency	11 (7,3%)	6 (4,0%)
Haematological repercussions (n=150)		
Individuals without anaemia	96 (64,0%)	104 (69,3%)
Individuals with anaemia	54 (36,0%)	46 (30,7%)
Characteristics of anaemic individuals		
With regular iron intake by mothers	16 (29,6 %)	16 (34,8 %)
With irregular iron intake by mothers	36 (66,7 %)	29 (63,0 %)
No iron intake by mothers	2 (3,7%)	1 (2,2 %)
Characterisation of anaemia (n= 54 mothers; 46 new-borns)		
Normocytic normochromic / mild	37 (68,0%)	43 (93,5%)
Microcytic, hypochromic / moderate	7 (13,5%)	2 (4,3%)
Iron deficiency / severe	10 (18,5%)	1 (2,2%)

Table 3 Association between iron intake and biological parameters in parturient and newborns. Variables are presented as Means ± SD

Features	**Regular iron intake (n=48)**	**Irregular iron intake (n=102)**	***p***
Parturient			
Serum iron (µmol/l)	14,1 ± 1,1	17,0 ± 0,7	*0,02*
Serum ferritin (µg/l)	139,5 ± 35,5	80,2 ± 9,0	*0,03*
Transferrin (g/l)	3,3 ± 0,1	3,6 ± 0,1	*0,13*
Haemoglobin (g/dl)	11,5 ± 0,2	11,41 ± 0,1	*0,66*
New-borns			
Serum iron (µmol/l)	22,8 ± 1,2	26,4 ± 1,0	*0,03*
Serum ferritin (µg/l)	242,7 ± 23,5	258,8 ± 15,4	*0,56*
Transferrin (g/l)	2,5 ± 0,4	2,0 ± 0,1	*0,11*
Haemoglobin (g/dl)	14,0 ± 1.78	13.9 ± 1.98	*0,39*

However, we did not observe an association between anaemia and iron deficiency in both the mothers (p=0.95) and the new-borns (p=0.21). No association was found between the haemoglobin levels of new-borns and the geophony behaviour of the mothers (geophony yes: 14.3 ± 0.2 g/dl vs. geophony no: 14.9 ± 0.2 g/dl, p=0.5). We found a positive correlation between the serum iron levels of mothers and their new-borns (r=0.452, p=0.0001) (Figure 1). Although weak, there was a correlation between the haemoglobin levels of mothers and their new-borns (r=0.05, p=0.0001) (Figure 2). Finally, no correlation was found between the ferritin (r=0.005, p=0.94) and transferrin (r=0.159, p=0.05) levels of mothers and those of their new-borns.

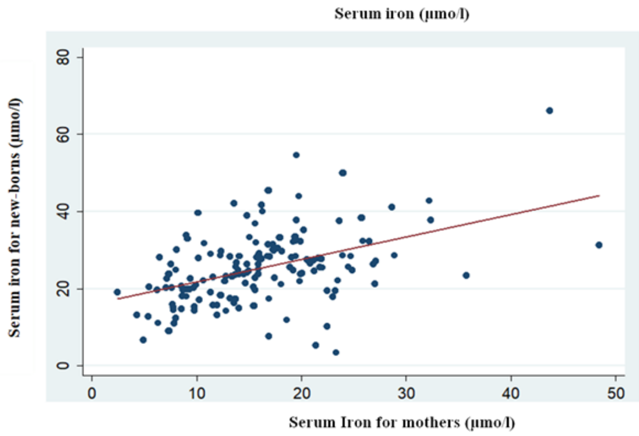

Figure 1 Linear correlation between serum iron in mothers and new-borns.

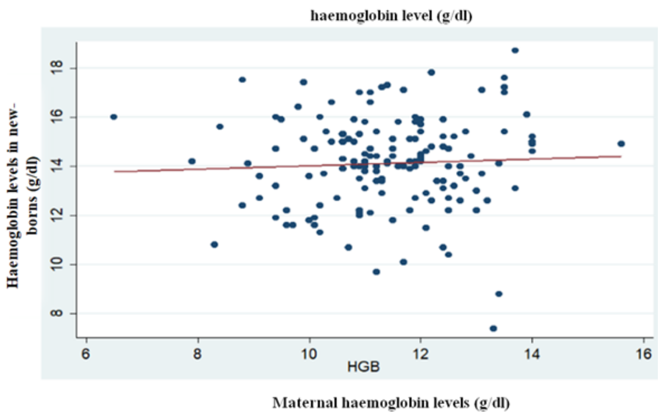

Figure 2 Linear correlation between the haemoglobin levels of mothers and their new-borns.

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Discussion

Iron reserve in parturient

In our study population, 14.6% of parturient have insufficient iron reserves. Our results are likewise those obtained by Ovono Abessolo et al in 2011 in Libreville, where 11.1% of pregnant women in their study population had low iron reserves.[9] However, it is lower than that observed by Adebo et al in Benin (25%),[14] Jutcha et al in Cameroon (45.15%),[15] and Tang et al in Canada (91.3%).[16] This relatively low prevalence of iron deficiency in pregnant women in our context may reflect an improvement in the follow-up of pregnant women, particularly better iron supplementation. This was certainly facilitated by the fact that since 2009, the Gabonese government has implemented a National Health Insurance and Social Security Fund (CNAMGS), which covers all pregnancy-related carefree of charge.

However, in the literature, several factors influence the iron reserve of pregnant women in developing countries (nutrition, taboos, infections, poverty, short duration of iron supplementation during pregnancy).[14,17,18] These different factors are present within the population of pregnant women in our context.

We did not observe a link between anaemia in parturient and iron deficiency. This can be explained by the fact that iron-deficiency anaemia is considered the final stage of the iron deficiency process. Indeed, iron reserves are mobilized during the first stage of iron deficiency, and iron is prioritized for red blood cells. This process reflects the body's attempt to maintain iron supply to red blood cells and non-hems tissues, including the brain.[3]

Iron reserve and iron supplementation in parturient

In our study, well-supplemented mothers have a statistically significantly higher mean serum ferritin level (indicating iron reserve) compared to poorly supplemented mothers ($p = 0.03$). Iron supplementation is therefore the intervention of choice to improve iron reserves and prevent anaemia in pregnant women. Similarly, the mean serum iron level of well-supplemented mothers was lower than that of poorly supplemented mothers with a significant difference ($p = 0.02$). The massive release of iron into the bloodstream by storage organs in case of deficiency can easily explain this difference.

This influence of iron supplementation on the iron reserve of pregnant women has been observed in several studies.[17,18] However, the best preventive approach remains iron supplementation in women of childbearing age, as iron deficiency in this group sets the stage for iron deficiency during pregnancy. In 2009, to better protect pregnant women, the WHO made a strong recommendation[19] for iron supplementation in women of childbearing age in population groups where anaemia has a prevalence of more than 20%.

In our context, iron supplementation is systematically recommended and prescribed only during pregnancy. The problem lies in treatment adherence, as 68.0% of the parturient in our study report irregular intake of the iron prescribed by healthcare providers during antenatal care visits. This finding was also observed by Guillaume M et al in France in 2020, where only 50% of pregnant women had good adherence to prescribed iron supplementation.[20] The main factor associated with this poor adherence in our context is likely the lack of awareness among the population about the dangers of iron deficiency during pregnancy. Guillaume et al demonstrate this well because in their study, more than one in three women who received a prescription for supplementation did not know its purpose.[20] This justifies the fact that in Canada, the levels of ferritin and haemoglobin are systematically monitored in pregnant women during the first visit and at 28 weeks of amenorrhea.[5]

New-borns' iron reserves in the delivery room

In the population of new-borns in our study, only 8.0% (n=12/150) had insufficient iron reserves, and among them, 6 new-borns had iron deficiency. There was no relationship between new-borns' serum ferritin and maternal iron supplementation. Additionally, we did not find a significant link between iron-deficient mothers and iron-deficient new-borns (p=0.3). This can be explained by the fact that iron transfer to the foetus remains normal regardless of the mother's iron status.[3] Indeed, the placenta can store iron in resident reticuloendothelial cells to provide a buffer against periods of low maternal iron supply.[3] Additionally, the placenta serves as a regulator in the maternal-foetal transport of iron, which is transferred from the placental concentration guardian to the foetus.[6] Therefore, in cases of low iron concentration in the foetus, the placenta ensures supplementation from its own reserves, minimizing the influence of maternal iron deficiency on the foetus.

Marital status of new-borns and iron supplementation of mothers

In the literature, it is well established that the iron reserve of the foetus and therefore the new-born at birth is formed in the third trimester of pregnancy and depends entirely on the amount of iron in the mother. We did not observe a significant difference in the martial reserve of new-borns from poorly supplemented mothers compared to those from well-supplemented mothers. The regulation of the foetal iron pool by the placenta probably justifies this finding.[3] Additionally, we observed that the average serum iron level of new-borns from well-supplemented mothers was lower than that of new-borns from poorly supplemented mothers. This can be explained by the fact that an insufficient pool of circulating iron leads to the mobilization of iron from reserves to maintain iron supply to red blood cells and non-hems tissues,[3,6] thereby increasing the level of circulating iron. The importance of iron in foetal metabolism, especially in brain development, justifies this mobilization. Indeed, foetal iron deficiency leads to disruption of neurotransmission, growth and neuronal differentiation, myelination, and gene expression both acutely and in the long term until adulthood. New-borns born with low foetal iron load are at the highest risk.[3,6]

Conclusion

The prevalence of insufficient iron reserve in the parturient in our study is considerable and concerning, even though it does not influence the quality of the martial reserve of new-borns. It is therefore important to ensure the quality of iron reserve in mothers to ensure adequate iron reserve in the foetus and subsequently in the new-born. Additionally, the identification of new-borns at risk of martial deficiency should become routine in the management of these infants.

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Conflicts of interest

The authors declare that there are no conflicts of interest.

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