Journal of Scientific Research in Medical and Biological Sciences
Website: http://bcsdjournals.com/index.php/jsrmbs
ISSN 2709-0159 (Print) and 2709-1511 (Online)
Vol.1, Issue 2, 2020
DOI: https://doi.org/10.47631/jsrmbs.v1i2.44

Assessment of Haematological and Biochemical Parameters of Women at Childbirth and their Newborn in Abidjan, Côte d' Ivoire

Mathieu Nahounou Bleyere [1], Jean-Baptiste N'Guessan Oussou [2], Jean Paul Aristide Amani [3], Paul Angoué Yapo[4]

[1] Laboratory of Physiology, Pharmacology and Pharmacopoeia, Nangui Abrogoua University, Abidjan – Côte d'Ivoire.

Article Info

Article history:
Received:09 September2020
Revised: 28 October 2020
Accepted: 29 October 2020

Keywords:
Women,
Newborns,
Haematology,
Biochemistry,
Nutrition,
Abidjan

Paper Type :

Research Article

Corresponding Author:
Mathieu Nahounou Bleyere
Email:
chridandre@gmail.com

Abstract

Purpose: *The objective of this study is to compare the hematological and biochemical parameters in women with those of their newborns in order to assess the impact of the nutritional status of the former on the latter.*

Study Design: *A cross sectional and prospective study.*

Subjects and Methods: *The study was conducted on 83 women who came to give birth in the hospitals of Abobo Sud (from April 3 to 20, 2017) and Yopougon Attié (from December 19, 2017 to January 18, 2018). The recruitment was based on their consent and according to specific inclusion and exclusion criteria. The blood, taken from the elbow's vein of the women in labor and in the umbilical cord after childbirth, is put in suitable tubes for the assays of the blood parameters.*

Results: *The results showed that 29% of women in childbirth and 41% of newborns were anemic with the occurrence of almost all forms of anemia such as Normochromic Normocytic Anaemia (ANN), Normochromic Microcytic Anaemia (ANm) and Hypochromic Normocytic Anaemia (AHN), in both groups. The glycemia and lipid parameters studied as well as the atherogenicity indices were increased in women during childbirth, unlike newborns. Regarding hepatic and renal parameters, no significant differences were observed in total proteins, Alanine aminotransferase (ALT) and total bilirubin between women and newborns. However, the other parameters such as creatinine, Aspartate aminotransferase (AST) and conjugated bilirubin were elevated in newborns. As for the blood ion levels, the results showed high levels of calcium and potassium in newborns and high levels of chlorine in women.*

Conclusion: *Women nutritional status significantly influences that of their newborn babies.*

1. Introduction

The metabolism of nutritional blood parameters during pregnancy is important. During this period, demands for energy and nutrients increase in order to meet the nutritional needs of mother and those of the fetus for a harmonious development of the latter. Indeed, the fetus depends exclusively on nutritional intake and storage of pregnant mothers' nutrients for its growth (Woldeamanuel et al., 2019). When a pregnant woman has abnormal nutritional status, it leads to low availability of nutrients for the fetus. This can be manifested, according to Amosu and Degun (2014), as a growth delay showed by a low birth weight of the newborn (Weight <2500 g).

According to estimations done by UNICEF and WHO, low birth weight affects one out of seven newborns (ie. around 20.5 million babies worldwide) in 2015 (UNICEF-WHO,

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2019). In addition, the global prevalence of underweight, in 2015, was 14.6%. It concerns 91% of developing countries. In Africa, 5.7 million babies are born with a low birth weight including 2.1 million in West Africa (Hannah et al., 2019). The consequences of stunted growth are numerous and include cognitive, physical or metabolic disorders which can lead to subsequent cardiovascular diseases, a decrease in intellectual capacities, even perinatal or neonatal mortality. Low birth weight is an indicator of malnutrition. It may be due to micronutrient deficiencies, maternal malnutrition, or infections (Amosu & Degun, 2014).

There are many causes. However, mothers' malnutrition appears to be the most critical. It is, therefore, necessary to set strategies that can improve nutritional status of women during pregnancy and their offspring before, during and after the birth of newborns. Thus, Oumarou et al. (2019), Salunkhe et al. (2018) and Sharma and Mishra, (2014) carried out work for this purpose and the results indicated that, the nutritional status of the mother before and during pregnancy determines the nutritional status of the newborn. In Côte d'Ivoire, some studies have focused on the nutritional status of women during pregnancy (Amani et al., 2018; Bléyéré et al., 2013). However, to our knowledge, no study indicates the link between the nutritional status of the mother and that of her newborn. This study was initiated, in order to assess, through biological parameters, the impact of the mother's nutritional status on her newborn. Specifically, it involves comparing the hematological and biochemical parameters of women during childbirth with those of their newborns.

2. Methodology and Procedures

Type, Setting and Study Population

This is a cross-sectional and prospective study carried out in two hospitals in two different municipalities in the city of Abidjan (Ivory Coast). These are: The General Hospital *Abobo Sud*, located in the municipality of *Abobo* (from April 3 to 20, 2017) and that of *Yopougon Attié*, located in the municipality of *Yopougon* (from December 19, 2017 to January 18, 2018). Pregnant women who came to give birth in the obstetric gynecology departments of the said hospitals whose age varies from 18 to 35 years old and apparently in good health were included in the survey. After consultation of the individual health records, full-term pregnant women (≥ 38 weeks) those suffering from rheumatism, High blood pressure, diabetes, HIV and hepatitis B were excluded from this study. In addition, all the recruited women were informed of the purpose of the study before the study begins.

Blood Samples and Biological Parameters Determination

Blood samples were taken from the elbow's vein of the pregnant women in labor and from the umbilical cord after childbirth. The blood collected is stored in different sterile tubes containing either the anticoagulant EDTA or glucose preservative sodium fluoride + potassium oxalate or either in tubes without anticoagulant (Dry tube). A few minutes after the blood samples were taken, the blood in the tubes containing the anticoagulant EDTA was used for the determination of the hematological parameters using an automatic hematological analyzer (Rayto RT 7600S, China). The tubes without anticoagulant and those containing the

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glucose preservative were centrifuged at 3000 rpm for 5 minutes. Blood glucose and creatinine were determined on the same day using plasma and serum respectively. The serum from the dry tube was stored in a freezer at -20°C, for subsequent determination of biochemical parameters using a semi-automatic spectrophotometer (Prietest Touch Robonik, India). Blood glucose, total protein, calcium, chlorine, sodium, total and direct bilirubin, total cholesterol, HDL cholesterol, and triglycerides were determined using a colorimetric method with the appropriate reagents. LDL cholesterol was determined according to the calculation method described by Friedewald et al. (1972).

LDL Cholesterol = Total Cholesterol - HDL Cholesterol - Triglyceride / 5.

The serum potassium concentration is estimated by a turbidimetric method while the serum creatinine and transaminases (AST, ALT) were determined by a kinetic method. The protocol and the experimental procedures used during this study were approved by the Côte d'Ivoire Ministry of Higher Education and Scientific Research, the authorities of the Nangui Abrogoua University, the Department of Establishments and Professions Sanitary facilities (DEPS), General hospitals of *Abobo Sud* and *Yopougon Attié*.

Statistical Analysis

Data were presented as the mean followed by the standard error on the mean (M±ESM) and the graphical representations (histograms of the proportions) were carried out using the GraphPad prism software version 8.01 (244) (San Diego, California, USA). With Statistica Stasoft version 7.01 software, Student's *t*-test was used to compare means between different groups of subjects. The significance level is set at $p < 0.05$. The G test, a likelihood test was used to compare the proportions of the main biological parameters estimated in the groups of subjects. These proportions were presented under three levels: low, normal and high compared to the standard values. The proportions of the different biological parameters were compared between pregnant women in labor and their newborns. This statistical processing is carried out by the statistical program R.2.0.1 Windows version (Ihaka and Gentleman, 1996).

3. Results and Discussion

Variation of Hematological Parameters

Figure 1 showed the erythrocyte parameters of women and those of their newborns. The results indicated higher ($p < 0.001$) erythrocyte parameters' levels in newborns than women at childbirth. On the other hand, all erythrocyte parameters of women at childbirth were in accordance with the standard values, unlike those of their newborns.

The results of the leukocyte and thrombocyte parameters of the two groups of individuals indicated a significant level of white blood cells (9673 ± 371 vs 13636 ± 756 cells/mm^3) and eosinophils (139 ± 8.1 vs 199 ± 16.3 cells/mm^3) of newborns compared to those of women. Likewise, lymphocytes (2560 ± 227 vs 5907 ± 413 cells/mm^3) and

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monocytes (871 ± 47 vs 1187 ± 67.4 cells/mm^3) of newborns were significantly higher than those of women at childbirth. However, no significant difference was observed in the mean values of polymorphonuclear neutrophils and thrombocytes of women and their newborns (Figure 2).

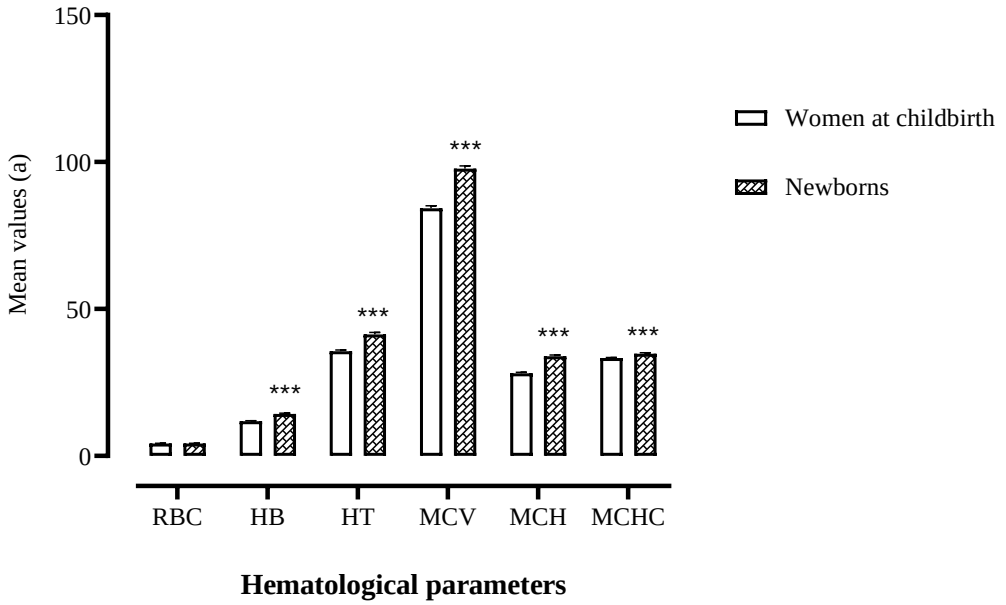

Figure 1: Variation of hematological parameters

(a): Each parameter is expressed in its unit; **RBC** : Red Blood Cells (10^6/mm^3) ; **HB** : Hemoglobin (g/dL) ; **HT** : Hematocrit (%) ; **MCV** : Mean Corpuscular Volume (fL) ; **MCH** : Mean Corpuscular Hemoglobin (pg) ; **MCHC** : Mean Corpuscular Hemoglobin Concentration (g/dL) ; *** : p<0.001 : significant difference between women at childbirth and newborns

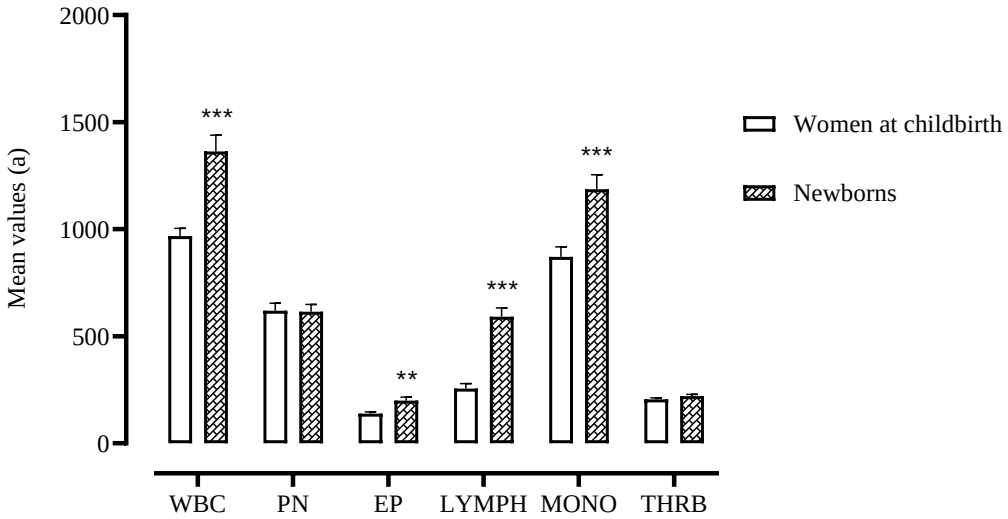

Figure 2: Variation of leukocyte and thrombocyte parameters

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(a): Each parameter is expressed in its unit; **WBC** : White Blood cells (10^1 cells/mm^3) ; **PN** : Polynuclear neutrophils (10^1 cells/mm^3) ; **EP** : Eosinophilic polymorphonuclear cells (cells/mm^3); **LYMPH** : Lymphocytes (10^1 cells/mm^3) ; **MONO** : Monocytes (cells/mm^3) ; **THRB** : Thrombocytes (10^3 cells/mm^3) ; * : $p < 0.05$; ** : $p < 0.01$; *** : $p < 0.001$: significant difference between women at childbirth and newborns.

Change in Biochemical Blood Parameters

Figure 3 showed the comparison of glycemia and lipid parameters of the population of women at childbirth with those of the newborns. The results indicated that the glycemia and lipid parameters of women at childbirth were significantly higher ($p < 0.001$) than those Furthermore, these results also showed that triglycerides (1.81 ± 0.08 mg/L), total cholesterol (2.44 ± 0.08 g/L) and HDL (0.87 ± 0.07 g/L) of women were above the standard values. On the other hand, in newborns, total cholesterol (0.87 ± 0.07 g/L) and LDL (0.52 ± 0.07 g/L) were lower than the reference values. While HDL-cholesterol (0.582±0.0448 g/L) presented by newborns was higher than the standard values.

Figure 4 showed the comparison of renal and hepatic parameters between women during childbirth and newborns. Indeed, these results indicated that creatinine (10.2 ± 0.35 mg/L), ASAT (37.1 ± 1.45 IU/L), and conjugated bilirubin (3.53 ± 0.26 mg/L) of newborns are significantly higher ($p < 0.001$) than those of women. In addition, the mean values of all parameters of women at childbirth were consistent with standard values. Whereas, the creatinine (10.2 ± 0.350 mg/L) and conjugated bilirubin (3.53 ± 0.260 mg/L) of the newborns were higher than the standard values.

The comparison of women serum ions and those of newborn populations were shown in Figure 5. The results indicated that calcium (109 ± 2.39 mg/L) and potassium (5.46 ± 0.18 meq/L) of newborns were significantly higher ($p < 0.05$) than those of women (101 ± 2.96 mg/L; 3.2 ± 0.14 meq/L). In contrast, the mean chlorine value of newborns (104 ± 1.36 meq/L) was significantly lower ($p < 0.001$) than that of women at childbirth (113 ± 1.57 meq/L).

Hematological Status

The results of the proportions of erythrocyte parameters of women at childbirth and newborns were reported in Table 1. These results indicated that 88% of women at childbirth and 100% of newborns had had abnormal hematologic status. In addition, high proportions of anemia were recorded in the two study subpopulations. This is 29% of women and 41% of newborns. The proportions of hemodilution of newborns (64%) were significantly higher than those of women during childbirth (27%). As for MCV, 76% of normocytosis in women were found compared to 29% in newborns. In contrast, microcytosis was 23 and 63% respectively in women and newborns. At the MCH level, the proportions of hypochromia of newborns (87%) were significantly higher than those of women (45%). Regarding normochromia (MCH), the proportions were 55% in women, while 13% of newborns had a normal level of

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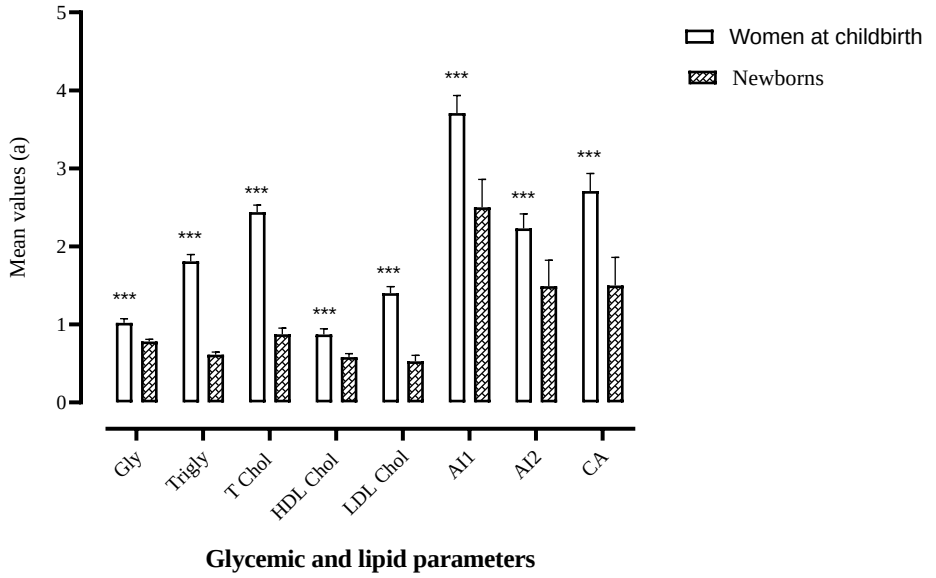

Figure 3: Variation of glycemic and lipid parameters

(a): Each parameter is expressed in its unit; **Gly** : Glycemia (g/L) ; **Trigly** : Triglycerides (g/L) ; **T Chol** : Total Cholesterol (g/L) ; **HDL**: High Density Lipoprotein (g/L) ; **LDL**: Low Density Lipoprotein (g/L) ; **AI** : Atherogenicity Indice; * : $p<0.05$, ** : $p<0.01$, *** : $p<0.001$: Significant difference between women at childbirth and newborns

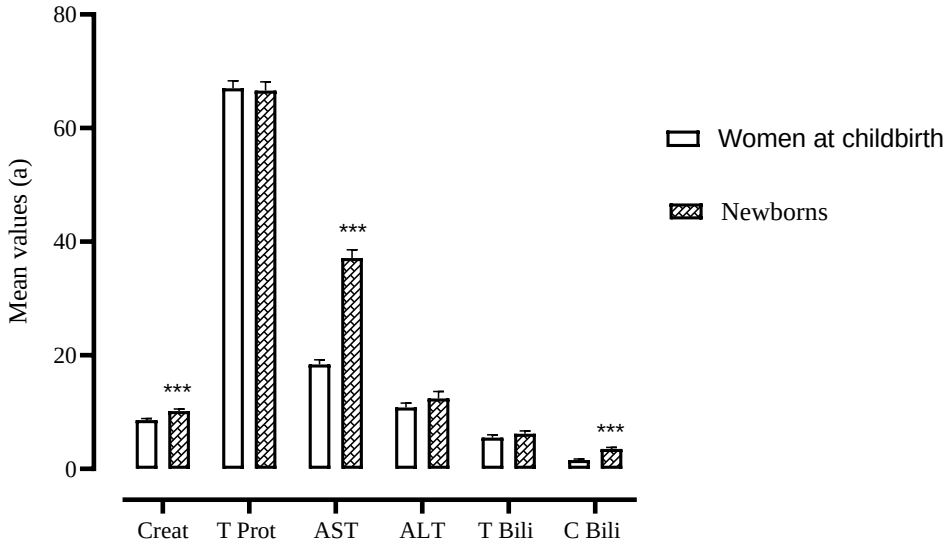

Figure 4: Variation of renal and hepatic parameters

(a): Each parameter is expressed in its unit ; **Creat** : Creatinine (mg/L) ; **T Prot** : Total Protein (g/L) ; **AST** : Aspartate aminotransferase (UI/L) ; **ALT** : Alanine aminotransferase

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(UI/L) ; **T Bili** : total bilirubin (mg/L) ; **C Bili**: Conjugated bilirubin (mg/L) ; * : p<0.05, ** : p<0.01, *** : p<0.001 : Significant difference between women at childbirth and newborns

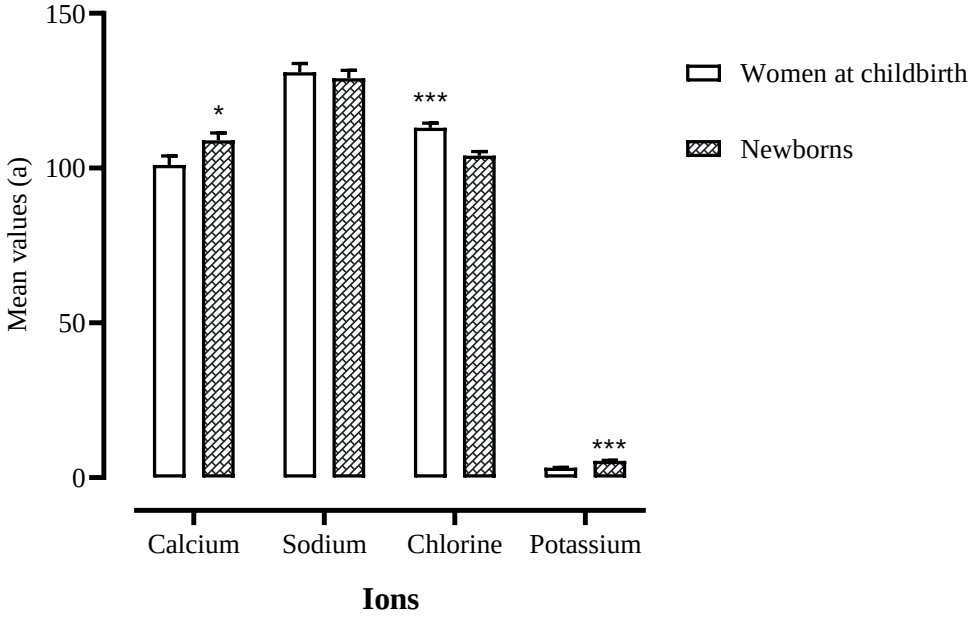

Figure 5: Variation of ions

(a): Each parameter is expressed in its unit; Calcium (mg/L); Sodium (meq/L); Chlorine (meq/L); Potassium (meq/L); *: p<0.05, ***: p<0.001; Significant difference between women at childbirth and newborns this parameter. Furthermore, analysis of the types of anemia (Table 2) revealed rates of 23% and 39% of frustrated anemia in women and newborn, respectively. In contrast, low proportions of moderate (5% vs. 1%) and severe (1%) anemia were observed. In addition, ANN, with a proportion of 1% of newborns was significantly lower than that of women (11%). In contrast, the proportions of ANm of newborns (10%) were significantly higher than those of women at childbirth. Insignificant proportions of AHN, AHM and AHm were also observed in both women at childbirth and newborns. In women, decreasing order of proportions, the anemias were as follows: ANN (11%), AHm (10%), AHN (6%) and 1% (Anm). In neonates, the highest type of anemia was AHN with 15%, followed by AHm (11%), ANm (10%), AHM (5%) and finally ANN (1%).

The proportions of leukocyte and thrombocyte parameters of women at childbirth and newborns were reported in Table 3. These results indicated that the proportions of neutropenia and leukopenia were significantly elevated.

Table 1: Proportions of Hematologic Status and Erythrocyte Parameters

Hematological parameters	Women at childbirth N = 83	Newborns N = 83	p
Hematological status	n (%)	n (%)	
Normal	10 (12)	0 (0)	--
Abnormal	73 (88)	83 (100)	0.38
Hemoglobin (g/dL) & low (< 11 or 14)	24 (29)	34 (41)	0.15

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Normal (11 – 16 / 14 – 20)	59 (71)	49 (59)	0.29
Hematocrit (%) &			
Low (< 33 or 44)	22 (27)	53 (64)	8.30×10^{-5}
Normal (33 – 47 / 44 – 62)	61 (73)	30 (36)	0.00
MCV (fL) &			
Low (< 80 or 100)	19 (23)	52 (63)	1.09×10^{-5}
Normal (80 – 100 / 100 - 110)	63 (76)	24 (29)	3.02×10^{-6}
High (> 100 or 110)	1 (1)	7 (8)	0.01
MCH (pg)			
Abnormal (< 27 or > 31)	37 (45)	72 (87)	0.0002
Normal (27 – 31)	46 (55)	11 (13)	1.27×10^{-7}
MCHC (g/dL)			
Abnormal (< 32 or > 36)	16 (19)	27 (33)	0.05
Normal (32 – 36)	67 (81)	56 (67)	0.25

***N**: Total number; **n**: Number for each parameter; **%**: Percentage; **MCV**: Mean corpuscular Volume; **MCH**; Mean Corpuscular Hemoglobin; **MCHC**: Mean Corpuscular Hemoglobin Concentration; --: No possible comparison; **&**: Reference values are defined for each group, The first for women at childbirth and the second for newborns.*

Table 2: Type of Anemia

Types of anemia Regarding the value of Hb	Women at childbirth < 11 g/dL N = 24	Newborns < 14 g/dL N = 34	p
Crude anemia **&**	n (%)	n (%)	
(9 – 11/14)	19 (23)	32 (39)	0.04
Moderate anemia			
(8 – 9)	4 (5)	1 (1)	0.09
Severe anemia			
(< 8)	1 (1)	1 (1)	1
ANN	9 (11)	1 (1)	0.002
ANm	1 (1)	8 (10)	0.004
AHN	5 (6)	12 (15)	0.05
AHM	1 (1)	4 (5)	0.09
AHm	8 (10)	9 (11)	0.83

***N**: Total number; **n**: Number for each parameter; **Hb**: Hemoglobin ; **ANN**: Normochromic Normocytic Anaemia; **ANm**: Normochromic Microcytic Anaemia; **AHN**: Hypochromic Normocytic Anaemia; **AHM**: Hypochromic macrocytic anaemia; **AHm** : Hypochromic Microcytic Anaemia ; &: Reference values are defined for each group, The first for women at childbirth and the second for newborns.*

Table 3: Proportions of Leukocytes et Thrombocytes Parameters

Leukocyte and thrombocytes parameters	Women at childbirth N = 83	Newborns N = 83	p
P. neutrophils (10^3 cells/mm^3) &	n (%)	n (%)	
Low (< 1.7 or 6)	4 (5)	43 (52)	1.84×10^{-11}
Normal (1.7 – 7 / 6 – 25)	49 (59)	40 (48)	0.29
High (> 7 or 25)	30 (36)	0 (0)	--
E. polymorphonuclear (10^3 cells/mm^3) &			
Low (< 0 or 0.2)	0 (0)	55 (66)	--
Normal (0 – 0.5 / 0.2 – 0.5)	83 (100)	25 (30)	2.86×10^{-10}
High (> 0.5)	0 (0)	3 (4)	--

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Lymphocyte (10^3 cells/mm^3) &			
Low (< 1.5 ou 2)	16 (19)	5 (6)	0.008
Normal (1.5 – 4 / 2 – 11)	60 (73)	71 (86)	0.30
High (> 4 ou 11)	7 (8)	7 (8)	1
Monocyte (10^3 cells/mm^3) &			
Low (< 0.1 ou 0.5)	0 (0)	5 (6)	--
Normal (0.1 – 1 / 0.5 – 1.2)	69 (83)	53 (64)	0.12
High (> 1 ou 1.2)	14 (17)	25 (30)	0.06
Leukocyte (10^3 cells/mm^3) &			
Low (< 4 ou 10)	1 (1)	23 (28)	1.99×10^{-8}
Normal (4 – 10 / 10 – 25)	49 (59)	55 (66)	0.53
High (> 10 ou 25)	33 (40)	5 (6)	1.13×10^{-7}
Thrombocyte (10^3 cells/mm^3)			
Low (< 150)	14 (17)	15 (18)	0.87
Normal (150 – 400)	67 (81)	67 (81)	1
High (> 400)	2 (2)	1 (1)	0.56

***N**: Total number; **n**: Number for each parameter; **P. neutrophils:** Polynuclear neutrophils; **E. polymorphonuclear**: Eosinophilic polymorphonuclear cells; --: No possible comparison; &: Reference values are defined for each group, The first for women at childbirth and the second for newborns.*

($p<0.01$) is the value in newborns compared to women at childbirth. In contrast, the proportion of leukocytosis of newborns was significantly lower ($p < 0.001$) than those of women. Moreover, the results revealed an absence of neutrophilia in newborns (0%). In women giving birth, this absence (0%) was observed in terms of monocytopenia.

In addition, the results of this study reported that 59% of women had normal proportions compared to 48% of newborns. In terms of eosinophils, all women at childbirth (100%) had normal levels, while only 30% of newborns presented normal proportions of this parameter. As for lymphocytes, the normal proportions were 73% and 86% respectively in women and newborns. Regarding monocytes, the results showed normal levels in 83% of women and 64% of newborns. These results also revealed a normal level of 59% of leukocytes in women against 66% in newborns. As for thrombocytes, women and newborns had normal levels (81%).

Distribution of Proportions of Biochemical Blood Parameters

The glycemic and lipid parameters of the studied subpopulation were shown in Table 4. The proportions of hyperglycemia, hypertriglyceridemia, total hypercholesterolemia and LDL are significantly higher ($p<0.001$) in women at childbirth compared to newborns. Likewise, the results show significantly high proportions of atherogenic indexes in 1 and 2 ($p<0.001$).

Table 4: Proportions of Glycemia and Lipid Parameters

Biochemical parameters	Women at childbirth N = 83	Newborns N = 83	p
Glycemia (g/L)	n (%)	n (%)	
Low (< 0.6)	10 (12)	13 (16)	0.44
Normal (0.6 – 1.10)	49 (59)	64 (77)	0.12
High (> 1.10)	24 (29)	6 (7)	0.0001
Triglycerides (g/L) &			

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Low (< 0.4 or 0.3)	2 (2)	10 (12)	0.005
Normal (0.4 – 1.4 / 0.3 – 1.1)	22 (27)	69 (83)	4.57×10^{-8}
High (> 1.4 or 1.1)	59 (71)	4 (5)	$< 2.2 \times 10^{-16}$
Total - Cholestérol (g/L) &			
Low (< 1.5 or 1.6)	9 (11)	81 (98)	$< 2.2 \times 10^{-16}$
Normal (1.5 – 2.32 / 1.6 – 2.2)	33 (40)	1 (1)	5.68×10^{-12}
High (> 2.32 or 2.2)	41 (49)	1 (1)	1.21×10^{-14}
HDL - Cholestérol (g/L) &			
Low (< 0.4 or 0.12)	10 (12)	0 (0)	--
Normal (0.4 – 0.75 / 0.12 – 0.5)	34 (41)	48 (58)	0.087
High (> 0.75 or 0.5)	39 (47)	35 (42)	0.596
LDL - Cholestérol (g/L) &			
Low (< 1.08 or 1.1)	30 (36)	80 (97)	7.04×10^{-8}
Normal (1.08 – 1.88 / 1.1 – 1.6)	33 (40)	2 (2)	8.48×10^{-11}
High (> 1.88 or 1.6)	20 (24)	1 (1)	2.98×10^{-7}
Atherogenicity 1 indice			
Normal (< 4.85)	63 (76)	80 (97)	0.110
High (> 4.85)	20 (24)	3 (3)	1.618×10^{-5}
Atherogenicity 2 indice			
Normal (< 3.55)	67 (81)	82 (99)	0.179
High (> 3.55)	16 (19)	1 (1)	8.66×10^{-6}

***N**: Total number; **n**: Number for each parameter; **LDL**: Low Density Lipoprotein; **HDL**: High Density Lipoprotein women compared to that of newborns; --: No possible comparison; **&**: Reference values are defined for each group, The first for women at childbirth and the second for newborns.*

In contrast, the proportions of hypotriglyceridemia, total hypocholesterolemia and LDL of newborns were significantly higher ($p<0.01$) than those of women at childbirth. Moreover, these results indicated that 77% of newborns had normal glucose levels compared to 59% of women at childbirth. Regarding triglycerides, 27% and 83% of women and newborns, respectively, were normal triglyceridemic. With regard to cholesterol, respectively 40%, 41% and 40% of women had normal levels of total, HDL and LDL cholesterol compared to 1%, 58% and 2% of normal proportions of these same parameters in newborns. As for the atherogenicity indices, 76% of normal proportions in women at childbirth against 97% in newborns for the atherogenicity index 1 were reported. As for the atherogenicity index 2, these are normal rates of 81% and 99% which were observed respectively in women and their newborns.

The results reported in Table 5 showed the proportions of some renal and hepatic parameters of women and newborns. The proportions of hypercreatinemia, total hyperproteinemia and conjugated hyperbilirubinemia of newborns were significantly higher ($p<0.01$) than those of women at childbirth. Likewise, the proportion of total hypobilirubinemia of newborns was significantly higher ($p<0.01$) than those of women. In contrast, the low proportions of total protein and ALT in newborns were significantly lower than those of women at childbirth. In addition, no newborn (0%) presented elevated ASAT and total bilirubin and no woman at childbirth (0%) had a high rate of ALT. In addition, normal creatinine levels were found in 97% of women and 59% of newborns. As for total protein, normal levels of 55% versus 72% were observed in women and newborns, respectively. Regarding transaminases, the results indicated that 94% and 69% of women had normal levels of ASAT and ALT, respectively, versus 95% and 77% of newborns. As for

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total bilirubin, the results indicated 36% of normal proportions in women and 29% in newborns. While 88% and 27% of normal proportions of conjugated bilirubin were observed in women and newborns, respectively.

Table 6 showed the proportions of serum ions in the populations of women and newborns. The results revealed that the proportions of hypokalemia (5%) and hyperchloremia (39%) of newborns were significantly lower compared to those of women at childbirth (78% and 74%). In contrast, the normal proportions of serum potassium (60%), as well as the proportions of hyperkalemia (35%) were significantly higher ($p<0.001$) in newborns compared to women. Likewise, newborns presented significantly higher proportions of hypochloremia (39%) ($p<0.001$) than those of women (4%).

Table 5: Proportions of Some Renal and Hepatic Parameters

Biochemical parameters	Women at chilbirth N = 83	Newborns N = 83	p
Creatinine (mg/L)	n (%)	n (%)	
Low (< 6 or 7)	2 (2)	4 (5)	0.249
Normal (6 – 17 / 7 – 10)	80 (97)	49 (59)	0.002
High (> 17 or 10)	1 (1)	30 (36)	$8.68x10^{-11}$
Total Protein (g/L) &			
Low (< 66 or 45)	32 (39)	4 (5)	$4.6x10^{-8}$
Normal (66 – 83 / 45 – 75)	46 (55)	60 (72)	0.131
High (> 83 or 75)	5 (6)	19 (23)	0.001
ASAT (UI/L) &			
Low (< 7 or 20)	3 (3)	4 (5)	0.477
Normal (7 – 37 / 20 – 80)	77 (94)	79 (95)	0.942
High (> 37 or 80)	3 (3)	0 (0)	--
ALAT (UI/L) &			
Low (< 6 or 5)	26 (31)	14 (17)	0.042
Normal (6 – 40 / 5 – 35)	57 (69)	64 (77)	0.508
High (> 40 or 35)	0 (0)	5 (6)	--
Total bilirubins (mg/L) &			
Low (< 3 or 8)	35 (42)	59 (71)	0.006
Normal (3 – 10 / 8 – 25)	30 (36)	24 (29)	0.385
High (> 10 or 25)	18 (22)	0 (0)	--
Conjugated bilirubins (mg/L) &			
Low (<1)	0 (0)	15 (18)	--
Normal (< 4 ou 1 – 3)	73 (88)	22 (27)	$5.3x10^{-9}$
High (> 4 ou 3)	10 (12)	46 (55)	$4.5x10^{-8}$

***N**: Total number; **n**: Number for each parameter; **ASAT**: Aspartate aminotransferase; **ALAT**: Alanine aminotransferase; **--**: No possible comparison; **&**: Reference values are defined for each group, The first for women at childbirth and the second for newborns.*

Table 6: Proportions of Some Minerals

Biochemical parameters	Women at childbirth N = 83	Newborns N = 83	p
Calcium (mg/L) **&**	n (%)	n (%)	
Low (< 81 or 100)	21 (25)	33 (40)	0.062
Normal (81 – 104 / 100 – 115)	30 (36)	20 (24)	0.120
High (> 104 or 115)	32 (39)	30 (36)	0.729
Sodium (meq/L) **&**			

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Low (< 135 or 130)	38 (46)	40 (48)	0.837
Normal (135 – 155 / 130 – 145)	41 (49)	41 (40)	0.34
High (> 155 or 145)	4 (5)	2 (2)	0.249
Potassium (meq/L) **&**			
Low (< 3.5 or 3.6)	65 (78)	4 (5)	$< 2.2x10^{-16}$
Normal (3.5 – 5 / 3.6 – 5.6)	14 (17)	50 (60)	$4.54x10^{-7}$
High (> 5 or 5.6)	4 (5)	29 (35)	$4.88x10^{-7}$
Chlorine (meq/L) **&**			
Low (< 90 or 100)	3 (4)	32 (39)	$9.24x10^{-9}$
Normal (90 – 105 / 100 – 110)	19 (22)	19 (22)	1
High (> 105 or 110)	61 (74)	32 (39)	0.0009

***N**: Total number; **n**: Number for each parameter the increase in infantile hematological parameters. **&**: Reference values are defined for each group, The first for women at childbirth and the second for newborns.*

Discussion

The assessment of the women at childbirth and their newborns' hematological parameters showed a better hematological status in the latter. Indeed, the erythrocyte parameters of newborns are significantly higher than those of women, except the red blood cell levels. According to Paiva et al. (2007), hematological parameters are generally higher in newborns than in pregnant women. This could be explained by the presence in the newborn's blood of hematopoietic stem cells (Shearer et al., 2017; Ballen, 2017). These stem cells have the ability to make other types of cells. Indeed, at the time of birth, the bone marrow is fully active, and all hematopoietic cell lines undergo cell differentiation and amplification (Esan, 2016). In addition, fetal-maternal blood exchange, through the umbilical cord, may also contribute to Lawton et al. (2015), reported that newborn blood volume increases when umbilical cord clamping is not done immediately after childbirth. Such results concerning erythrocyte parameters in newborns are also reported by Bhattacharya et al. (2017). In addition, the mean values of leukocytes, eosinophils, lymphocytes and monocytes of the newborns were significantly higher ($p<0.01$) than those of women at childbirth. Moreover, the results of this study reported insignificant anemia prevalence of 29% in women and 41% in newborns.

The main causes of anemia are nutritional, infectious or genetic. Indeed, the main cause of anemia during pregnancy is iron deficiency. This happens because physiological changes during pregnancy lead to increased demand for iron. And yet, iron stores before pregnancy are generally low (Bléyéré et al., 2014), because the diet of women in developing countries is poor in iron. Furthermore, endemic parasitic infections in these geographic areas, lifestyle and socio-economic conditions could also be associated with high prevalence of anemia (Ayano and Amentie, 2018). These results are similar to those of Debbarma et al. (2018) who reported 29% anemia at childbirth among women from Imphal in India. The high prevalence of anemia in newborns could be explained by the fact that, the amount of iron transferred to the fetus by the pregnant woman depends on the amount of maternal iron available. According to Chaturvedi et al. (2018), the fetus can only benefit from the iron concentrations available in the mother. High prevalence of neonatal anemia is also reported by N'Guessan-Blao et al. (2016) in Côte d'Ivoire and Koura et al. (2012) in Benin. These authors demonstrated respective proportions of anemia of 56% and 61% in newborns. Furthermore, these findings of anemia in pregnant women giving birth and their newborns

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corroborate the work of Agrawal and Srivastava (2018). They have reported a direct relationship between maternal and fetal hemoglobin levels. As for the different forms of anemia, in our study, the ANN with a proportion of 1% in newborns was significantly lower than that of women during childbirth (11%). In contrast, the proportions of ANm of newborns (10%) were significantly higher than those of women at childbirth.

Although not significant in women compared to newborns, AHm (10%) was the second highest form of anemia in women giving birth. Furthermore, ANN is a form of anemia that is always superior to other forms of anemia regardless of the trimester of pregnancy. These results are corroborated by Tchente et al. (2016), who found a high prevalence of two types of anemia in women in the third trimester of pregnancy, at 53.3% for ANN and 20%. The study of the distribution of biochemical parameters showed significant variations in these parameters. Lipid parameters (triglycerides, total cholesterol, HDL and LDL) are significantly elevated in women compared to newborns. Lipids play several roles. They are involved in maintaining the structure of cell membranes, thus separating it from the external environment. They are also an additional source of energy stored in fat cells. This increase in lipidemia during pregnancy could be, on the one hand, due to overeating due to increased appetite, and on the other hand, the result of metabolic adaptation to pregnancy. This lipid metabolism, throughout pregnancy, helps provide appropriate nutrients to the fetus. These results are corroborated by the work of Geraghty et al. (2016). According to them, hyperlipidemia could be an additional nutritional source for the development of the fetus. Authors have reported similar findings with hyperlipidemia in their work. These include Bartels and O'Donoghue (2011) and Geraghty et al. (2017). In addition, hormonal and enzymatic changes, in particular the increased synthesis of progesterone and the activation of hepatic lipase are believed to be factors promoting hyperlipidemia during pregnancy (Bartels and O'Donoghue, 2011). Atherogenicity indices 1 and 2 are significantly low in newborns compared to women. These indices make it possible to assess the risk of developing cardiovascular diseases.

The results of this study report that renal and hepatic parameters are significantly increased in newborns compared to women. However, no significant difference was noticed in total protein, ALT and total bilirubins. During pregnancy, creatinine drops significantly. This decrease is thought to be due to the expansion of plasma volume and glomerular filtration rate in pregnant women, thus leading to an increase in the clearance of serum creatinine. Several authors have reported similar results of decreased serum creatinine during pregnancy. Especially, Biswajit et al. (2016) in the Rohilkhand region, Uttar Pradesh in India, Obodo et al. (2016) in Ekpoma in Nigeria, Kava and Lad (2019) in Surat in India and Harel et al. (2019) in Ontario, Canada. The increase in creatinine in newborns may be due to a combination of maternal creatinine levels and those of the newborn. Indeed, this association and the immaturity of renal function in newborns lead to an increase in the creatinine level of newborns (Rao and Devabathina, 2017). Guignard and Drukker (1999) believe that this rise in neonatal creatinine is due to the fact that the intra-uterine biochemical balance between the mother and the fetus is broken with the cut of the umbilical cord at birth. The immaturity of renal function is thought to favor tubular reabsorption of creatinine in newborns (Auron and Mhanna, 2006). This result is in agreement with that of Go et al. (2018). In their study in

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Fukushima, Japan, they reported that newborns have higher blood creatinine than women at childbirth.

In terms of transaminases, the results showed that the mean ASAT values were significantly higher in newborns compared to those in women. However, the ASAT values remain consistent with the standard values during pregnancy. This elevation in neonatal AST may be explained by the immaturity of liver cells (Kove et al. 1957). Kessel and Politzer, in 1960, reported that ASAT levels in umbilical cord blood are elevated. As for conjugated bilirubin, it remains low in women. This decrease is believed to be due to increasing hemodilution during pregnancy. Similar results have been demonstrated by Mutua et al. (2018), in Kenya, in women with normal pregnancies. This can be explained by the fact that newborn babies have a large number of red blood cells. Decomposition and replacement of these could be the cause of this increase. In addition, the work of Mani et al. (2020), in India, indicate that giving oxytocin to women during childbirth to speed up labor may also cause an increase in bilirubin in newborns. Our results are in agreement with those of Suchońska et al. (2003) who reported that neonatal bilirubin is higher in newborns than in mothers.

Regarding ions, the study indicated that the calcium level of newborns increases significantly compared to that of women. This difference could be explained by the fact that most of the mother's calcium is transferred to the fetus. Indeed, the regulation of calcium is ensured by parathyroid hormones. In women in labor there is an increase in the parathyroid hormone receptor protein in the maternal circulation. This protein, recognized by parathyroid hormone receptors, stimulates parathyroid hormones which causes the placental transport of calcium to the fetus (Hacker et al., 2012). These results are in agreement with those of Kocylowski et al. (2018), where the calcium level of newborns was significantly higher than that of women at childbirth. As for potassium, the results revealed a significant increase in their level in newborns compared to women during childbirth. The hypokalaemia recorded in pregnant women could be caused by an increase in aldosterone, leading to a loss of potassium. This manifests itself in pregnant women in labor as fatigue, muscle pain and weakness, abdominal contractions and cramps, and an abnormal heart rhythm. According to Brainard et al. (2007), hypokalaemia induces uterine contractions. In contrast, the results indicate that the chlorine level is significantly low in newborns compared to women during childbirth.

4. Conclusion and Suggestion

The study of the hematological profile of women at childbirth and newborns revealed disturbances. These disturbances were characterized by a collapse of certain erythrocyte and leukocyte parameters. In the entire study population, high prevalence of anemia was observed. Indeed, this study showed that 29% of women at childbirth and 41% of newborns were anemic. In addition, almost all forms of anemia (ANN, ANm, AHN and AHm) were observed in both populations. The carbohydrate and lipid parameters studied, as well as the atherogenicity indices 1 and 2, increased in women, unlike newborns. Regarding hepatic and renal parameters, no significant differences were observed in total protein, ALT and total bilirubins between women and newborns. The other parameters such as creatinine, AST and conjugated bilirubin were elevated in newborns. As for the ions' levels of the populations

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studied, the results revealed high levels of calcium and potassium in newborns and high levels of chlorine in women.

The recommendations that we can make are that women should have a balanced diet, also they should respect the treatments prescribed by physicians in order to improve their own health status during pregnancy and that of their baby.

Conflict of Interest

The authors of this article declare that they have no conflict of interest.

Funding:

The authors received no funding for conducting this study

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