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Impact of the variation in the nutritional blood parameters of women during childbirth on those of their newborn in yopougon (Abidjan)

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Abstract
Objective: Pregnancy is a period of increased metabolic needs linked to physiological changes in the pregnant woman and the needs of the fetus. The objective of the study is to assess the impact of the variation in the nutritional blood parameters of women during childbirth on those of their newborn in Yopougon.
Methods: For 28 days, 50 pregnant women who came to give birth at the maternity ward of the Yopougon Attié General Hospital were recruited, based on inclusion and non-inclusion criteria. Blood samples were taken from the women at childbirth and then from the umbilical cord. Blood samples are collected in two types of tubes. Some contain the anticoagulant EDTA for the determination of haematological parameters and the others, without anticoagulant, for the evaluation of biochemical parameters.
Results: The results showed high proportions of anemia (20%) in women giving birth and (32%) in their newborns. In addition, four types of anemia which are normochromic hypochromic anemia (NHA), hypochromic microcytic anemia (AHm), hypochromic macrocytic anemia (AHM) and normochromic microcytic anemia (ANm) have been revealed in both women in childbirth than in their newborns. To these is added normochromic normocytic anemia (ANN) seen only in women during childbirth. Biochemically, hypercholesterolemia and hypertriglyceridemia were observed in women during childbirth, while these parameters were low in newborns. In addition, other biochemical parameters indicated higher mean values in newborns than in women giving birth.
Conclusion: Ultimately the study reported high proportions of anemia, higher in newborns, the appearance of different types of anemia and significant variations in lipidemia and other biochemical parameters both in women during childbirth as newborns.

Keywords: hematology, biochemistry, childbirth, umbilical cord, newborn, yopougon (Abidjan)

Introduction

Pregnancy is a unique metabolic situation where adaptation phenomena tend to favor foeto-placental unity. This is a period during which there is an increase in metabolic needs (Oumarou *et al.*, 2018) [29]. These needs are linked to the physiological changes of the pregnant woman and the needs of the fetus. These modifications normally ensure a sufficient supply of nutrients to the fetus during its growth period, because the latter depends exclusively on nutritional intake and storage of maternal nutrients for its growth (Armessen and Faure, 2009; Woldeamanuel *et al.*, 2019) [4, 34]. An abnormal nutritional state thereof leads to poor availability of nutrients for the fetus. This can be manifested, according to Amosu and Degun (2014) [3], as a growth retardation expressed by the low birth weight of the newborn (Weight <2500 g). According to UNICEF and WHO estimates, low birth weight affects one in seven newborns, or around 20.5 million worldwide in 2015 (UNICEF-WHO, 2019). In addition, the global prevalence of underweight in 2015 was 14.6%. It concerns 91% of developing countries. In Africa, 5.7 million newborns have a low birth weight, of which 2.1 million are in West Africa (Hannah *et al.*, 2019). The consequences of stunted growth are numerous, in particular cognitive, physical and metabolic disorders which can lead to subsequent cardiovascular diseases, a decrease in intellectual capacities, a decrease in economic productivity in adulthood or even perinatal or neonatal mortality. Low birth weight is an indicator of intrauterine malnutrition. It may be due to micronutrient deficiencies, maternal malnutrition or infections (Amosu and Degun, 2014) [3]. However, maternal malnutrition appears to be the most critical. Indeed, it is known that nutrition and maternal health have an impact on the well-being of the fetus and can predict the health of the child. Thus, nutritional status during pregnancy can influence the outcome of pregnancy and childbirth (Tomedi *et al.*, 2013). In Côte d'Ivoire, the nutritional status of pregnant women has only been the subject of a few studies dealing with nutritional status in relation to micronutrient reserves, particularly iron metabolism (Bléyéré *et al.*, 2007; Bléyéré *et al.*, 2013; Kamagaté *et al.*, 2012a and 2012b; Bléyéré *et al.*, 2014). The objective of the present study is to assess the impact of the variation in the nutritional blood parameters of women during childbirth on those of their newborn in the commune of Yopougon.

Material and Methods

Type, setting and study population

This is a prospective cross-sectional study that took place at the Yopougon Attié general hospital located in the commune of Yopougon (Abidjan, Ivory Coast). It involved 50 pregnant women who came to give birth and their newborns (50) to the obstetric gynecology service of the said hospital. After consultation of the individual health records, full-term pregnant women (≥ 38 weeks), without rheumatism, high blood pressure, diabetes, HIV and hepatitis B are included in this study. In addition, all selected women are informed of the purpose of the study, and their informed consents are obtained prior to blood sampling. An interview is conducted with the selected women in order to obtain their anthropometric characteristics. It emerged from this interview that the average age of the women selected is between 18 and 35 years old (26.7 ± 0.7 years). The average body mass index was 29.7 ± 0.5 kg.m-2. According to this index, no woman (0%) was underweight, on the other hand, 88% of women giving birth were overweight. The gestation of these women is between 1 and 8 (2.62 ± 0.19), with 80% of multigestes against 20% of primigeste. The study reported parity ranging from 1 to 8 (2.24 ± 0.2), with 66% multiparas versus 34% first-time mothers. Ranging from 12 to 108 months (9 years), the mean birth interval for these women was 35.5 ± 4.47 months. In addition, a proportion of 56% of women observed less than 3 years between pregnancies, while 44% observed a time greater than or equal to 3 years. In addition, more than 74% of the women in this study live in cohabitation, 94% have taken an anti-anemic and 90% have more than 3 meals per day during pregnancy. In addition, 32% of these women have no education.

As for the children, there were more newborn males (58%) than females (42%), with a birth weight between 1700 and 4050 g (3075 ± 73 g). 86% of these newborns presented a normal birth weight. However, 12% of them were born underweight. In addition, the average size of these newborns is between 34 and 54 cm (48.3 ± 0.54 cm), and that of the head circumference ranged from 28 to 39 cm (31.9 ± 0.29 cm). As for the average weight of the placenta, it was 530 ± 13.4 g with ends between 350 and 850 g (Table I).

Table 1: Characteristics of the study population

Anthropometric parameters and socio-demographic	**Women at childbirth N = 50**		**Newborns N = 50**	
Newborn sex	**M±SEM and Effective**	**Proportions (%)**	**M±SEM And Effective**	**Proportions (%)**
Female	-	-	21	42
Male	-	-	29	58
Weight (g)	-	-	3075 ± 73	
< 1000	-	-	-	-
1000 – 1500	-	-	-	-
1500 – 2500	-	-	6	12
2500 – 4000	-	-	43	86
> 4000	-	-	1	2
Size (cm)	-	-	48,3 ± 0,54	
Head circumference (cm)	-	-	31,9 ± 0,29	
Placenta weight (g)	-	-	530 ± 13,4	
Age (Years)	26,7 ± 0,7	-		
BMI (Kg.m^{-2})	29,7 ± 0,5	-		
< 18,5	0	0		
18,5 – 26	6	12		
> 26	44	88		
Gestity	2,62 ± 0,19			
Primigravida	10	20		
Multigravida	40	80		
Parity	2,24 ± 0,2			
Primiparous	17	34		
Multiparous	33	66		
Intergenesis interval (Month)	35,5 ± 4,47			
< 36	28	56		
≥ 36	22	44		
Study level				
Unschooled	16	32		
Primary school	9	18		
Secondary school	13	26		
Higher education	12	24		
Marital status				
Married	6	12		
Concubine	37	74		
Single	7	14		
Number of meals per day	3,30 ± 0,1			
< 3	5	10		
≥ 3	45	90		
Antianemic				
Yes	47	94		
No	3	6		

BMI: Body mass index; M ± SEM: Mean followed of standard error of mean; N: Total number of subject; n: Number of subject observed in each groupe; %:Percentage; -:No prevalence is observed.

Blood samples and determination of biological parameters

Blood samples are taken from pregnant women in labor from the veins at the bend of the elbow and from the umbilical cord after childbirth. This blood is taken and collected under aseptic condition, in sterile blood collection tubes of 5 mL in volume, containing the anticoagulant EDTA (purple tube), sodium fluoride + potassium oxalate (gray tube) and without anticoagulant (Dry tube). A few minutes after the blood sample, the haematological parameters are determined with the tubes containing the anticoagulant EDTA, using a Rayto RT 7600S automatic hematological analyzer (Shenzen, China). After 1 hour, the red and gray tubes are centrifuged at 3000 rpm for 5 minutes. The blood sugar and creatinine assay are performed on the same day. The serum in the dry tube is stored in the freezer at -20oC, for the subsequent determination of nutritional biochemical parameters using a Prietest Touch Robonik semi-automated spectrophotometer (Mahape, Navi Mumbaï, India). Blood glucose, creatinemia, total protein, calcium, chlorine, total and direct bilirubin are determined by a colorimetric method with their respective reagents. Total cholesterol, HDL cholesterol and triglycerides are estimated by a colorimetric method and LDL cholesterol is determined by the calculation method of Friedewald *et al.* (1972) (LDL Cholesterol = Total Cholesterol - HDL Cholesterol - Triglyceride / 5). The serum potassium concentration is estimated by a turbidimetric method.

The protocol and experimental procedures used during this study are approved by the Ministry of Higher Education and Scientific Research of Côte d'Ivoire, the authorities of Nangui Abrogoua University, the Directorate of Health Establishments and Professions (DEPS) and the General Hospital of Yopougon.

Statistical analysis of data

Statistical analysis of the results and graphical representations (histograms of means and proportions) are performed with GraphPad prism version 5.01 software (San Diego, California, USA). Results are presented as the mean followed by the standard error of the mean (M ± ESM). Student's t test is used for comparison of means between different groups of subjects. The significance level is set at P <0.05 for the expression of the results. The G test, a likelihood test, made it possible to compare the proportions of the main biological parameters estimated in the groups of subjects in this study. The comparison of the proportions of the different biological parameters is carried out between the mother and the newborn. This statistical processing is carried out by the statistical program R.2.0.1 Windows version (Ihaka and Gentleman, 1996).

Results

Behavior of haematological parameters

The mean values of the erythrocyte parameters at childbirth and in newborns are presented in Figure 1. These results indicated that with the exception of red blood cells all the erythrocyte parameters of newborns were significantly higher (p <0.05) to those of women during childbirth. However, all erythrocyte parameters at delivery were in accordance with the reference values, unlike those of the newborns.

The leukocyte and thrombocyte parameters of women giving birth and newborns from Yopougon are shown in Figure 2. The newborns showed higher leukocyte and thrombocyte parameters than those of women at childbirth. This superiority was significant at the level of white blood cells (9466 ± 496 103 / mm3; 14240 ± 861 103 / mm3), eosinophils (138 ± 10 103 / mm3; 209 ± 23.1 103 / mm3) and lymphocytes (2618 ± 344 103 / mm3; 6351 ± 526 103 / mm3). In addition, monocytes (940 ± 53.1 103 / mm3; 1174 ± 52.3 103 / mm3) and thrombocytes (195 ± 9.32 103 / mm3; 228 ± 10.2 103 / mm3) of newborns were also significantly higher compared to those of women in childbirth.

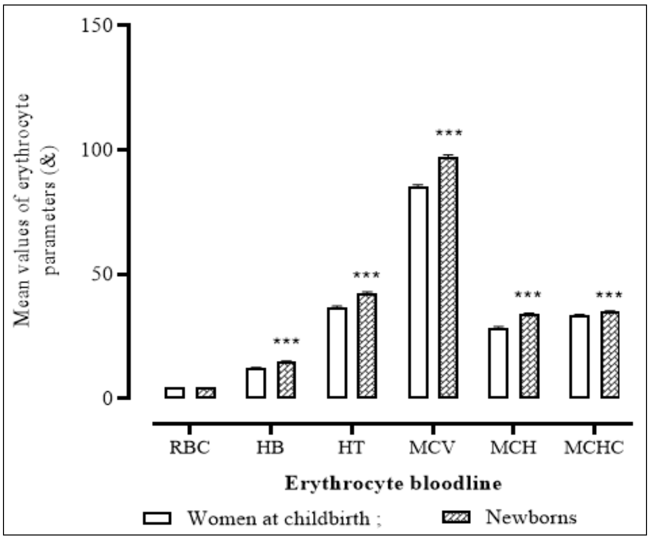

Fig 1: Comparison of erythrocyte parameters (&): Each parameter is expressed in its unit; RBC: Red Blood Cells ($10^6/mm^3$); HB: Hemoglobin (g/dL); HT: Hematocrit (%); MCV: Mean Corpuscular Volume (fL); MCH: Mean Corpuscular Hemoglobin (pg); MCHC: Mean Corpuscular Hemoglobin Concentration (g/dL); ***: p <: 0.001: Significant difference between women at childbirth and newborns.

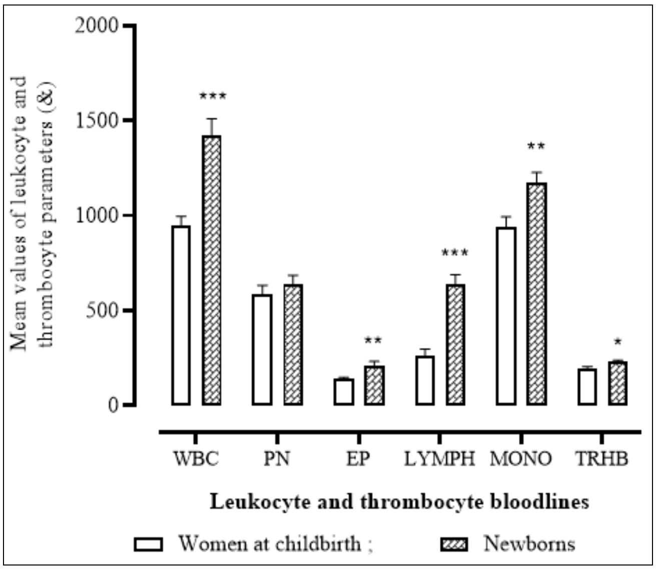

Fig 2: Comparison of leukocyte and thrombocyte parameters (&): Each parameter is expressed in its unit; WBC: White Blood Cells ($10^3/mm^3$); PN: Polynuclear neutrophils ($10^3/mm^3$); EP: Eosinophilic Polymorphonuclear cells ($10^3/mm^3$); LYMPH: Lymphocytes ($10^3/mm^3$); MONO: Monocytes ($10^3/mm^3$); THRB: Thrombocytes ($10^3/mm^3$); *: p < 0,05, **: p < 0,01, ***: p <: 0,001: Significant difference between women at childbirth and newborns.

Behavior of biochemical blood parameters

Figure 3 shows the comparison of blood sugar and lipid parameters of women giving birth and newborns. These results indicated that newborns' blood sugar, triglycerides, total, HDL and LDL cholesterols were significantly lower ($p < 0.01$) than those of women in childbirth. In addition, these results reported that the mean values of triglycerides (1.82 ± 0.121 mg / L) and total cholesterol (2.5 ± 0.124 g / L) of women during childbirth were higher than the reference values.

On the other hand, the mean values of total cholesterols (0.975 ± 0.123 g / L) and LDL (0.571 ± 0.121 g / L) of the newborns were lower than the reference values. The comparison of renal and hepatic parameters between women at childbirth and newborns is shown in Figure 4. These results indicated that ASAT (39.6 ± 1.7 IU / L) and conjugated bilirubin (2.96 ± 0.32 mg / L) of newborns were significantly superior to those of women at delivery (20.6 ± 0.844 IU / L and 2.08 ± 0.239 mg / L). On the other hand, with the exception of the total bilirubin of the newborns (7.28 ± 0.601 mg / L), all renal and hepatic parameters of the women at birth and of the newborns were similar to the reference values.

The results in Figure 5 represent the comparison of minerals between women in childbirth and newborns. Calcium (110 ± 3.11 mg / L) and potassium (5.40 ± 0.18 meq / L) of newborns were significantly higher ($p < 0.05$) than those of women at delivery (101 ± 3.35 mg / L; 3.25 ± 0.17 meq / L). In contrast, the mean chlorine value of newborns (103 ± 1.65 meq / L) was significantly lower ($p < 0.001$) than that of women at childbirth (112 ± 1.72 meq / L).

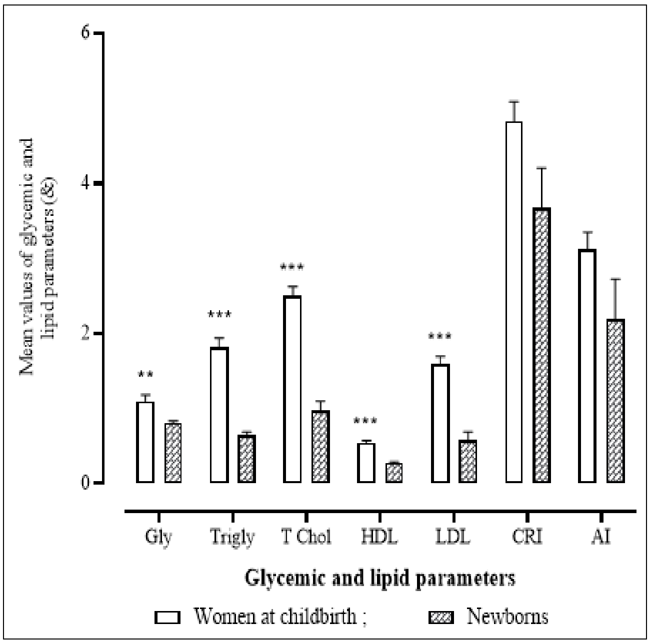

Fig 3: Comparison of glycemic and lipid parameters (&): Each parameter is expressed for glycemic and lipid parameters; Gly: Glycemic (g/L); Trigly: Triglycerides (g/L); T Chol: Total Cholesterol (g/L); HDL: High density lipoprotein (g/L); LDL: Low density lipoprotein (g/L); CRI: Coronary risk index; AI: Atherogenic index; **: p < 0,01, ***: p < 0,001: Significant difference between women at childbirth and newborns.

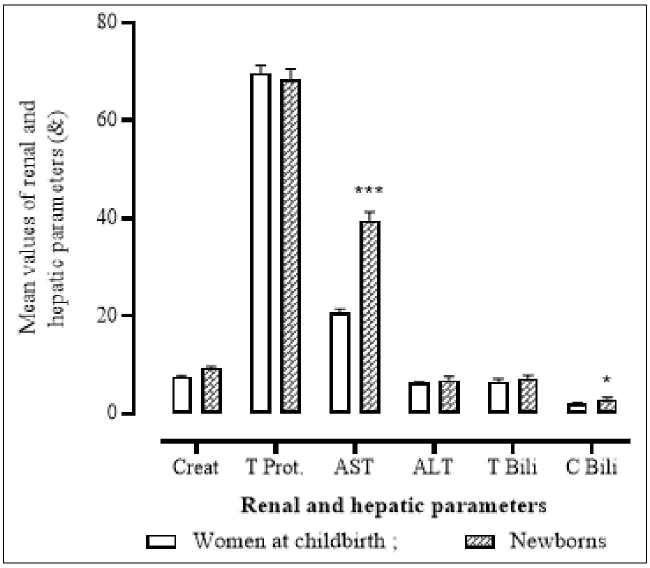

Fig 4: Comparison of renal and hepatic parameters (&): Each parameter is expressed in its unit; Creat: Creatinine (mg/L); T Prot.: Total Protein (g/L); AST: Aspartate aminotransferase (UI/L); ALT: Alanine aminotransferase (UI/L); T Bili: Total bilirubin (mg/L); C Bili: Conjugated bilirubin (mg/L); *: p < 0,05, ***: p < 0,001: Significant difference between women at childbirth and newborns.

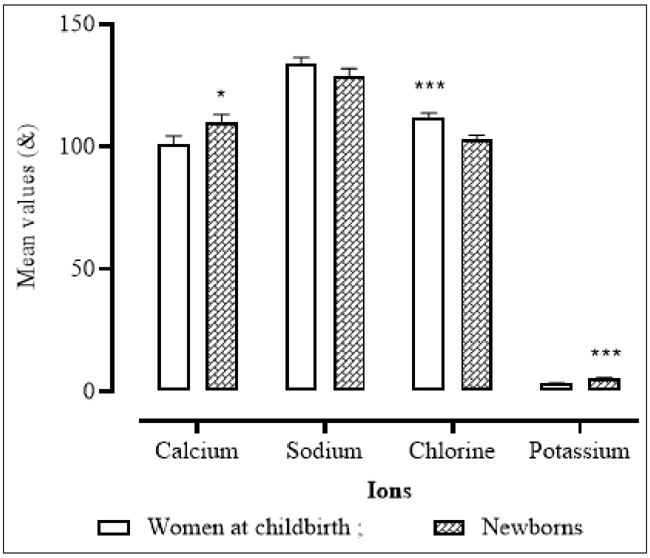

Fig 5: Comparison of some ions (&): Each parameters is expressed in its unit; Calcium (mg/L); Sodium (meq/L); Chlorine (meq/L); Potassium (meq/L); *: p < 0,05, ***: p < 0,001: Significant difference between women at chilbirth and newborns

Distribution of proportions of main haematological parameters

Table 2 shows the proportions of hematological status and erythrocyte parameters in women giving birth and newborns in Yopougon. The analysis revealed that 80% of women giving birth and all newborns (100%) had an abnormal hematologic status. These results also indicated 20% anemia in women giving birth versus 32% in newborns without significant differences ($p = 0.10$). Hemodilution (60%), microcytosis (72%) and hypochromia (90%) were significantly elevated ($p < 0.001$) in newborns compared to women at delivery whose respective rates were 18%, 20% and 46%. In addition, the results reported a normal hemoglobin level in 80% of women giving birth compared to 68% of newborns. The hematocrit level varied in the same direction as the hemoglobin with normal proportions of 82% in women giving birth against 40% in newborns. In addition, the proportions of normocytosis (78%) and normochromia (54%) of women at childbirth were significantly higher (*p* <0.001) than those of newborns (26% and 10%).

Furthermore, the analysis of the types of anemia (Table 3) revealed a significant increase (p = 0.02) of fruste anemia in newborns (32%) compared to women at childbirth (16%). In addition, no severe anemia (0%) in both women giving birth and newborns was observed. Similarly, no newborn (0%) reported moderate anemia. However, 4% of women giving birth developed this type of anemia. A preponderance of microcytic hypochromic anemia (AHm) (8%) followed by normocytic hypochromic anemia (NHA) (6%) was observed in women giving birth. These anemias were followed by normochromic normochromic (ANN), normochromic microcytic (ANm) and hypochromic macrocytic (AHM) anemias with a similar rate of 2%. In newborns, at 12%, normocytic hypochromic anemia (NHA) was highest. It was followed by microcytic hypochromic (AHm) (10%), microcytic normochromic (ANm) (8%) and macrocytic hypochromic (AHM) (2%) anemia. In contrast, ANN and ANM were absent in neonates.

The proportions of leukocyte and thrombocyte parameters of women at childbirth and newborns are reported in Table 4. The comparison reported that the proportions of leukopenia (20%) and neutropenia (50%) of newborns were reported. significantly higher than those of women during childbirth (2% and 6%). In contrast, the rates of leukocytosis (36%) and lymphopenia (18%) of women giving birth were significantly higher (p <0.05) than those of newborns (6%). In addition, no newborn (0%) presented with neutrophilia, while 30% of women reported this parameter. In contrast, newborns reported 10% lymphocytosis and 30% monocytosis, while these parameters were 6% and 20%, respectively, in women giving birth. In addition, no woman (0%) observed monocytopenia and thrombocytosis, yet respective levels of 2% of these parameters were observed in newborns. These results also indicated that 62% of women giving birth had normal white blood cell counts compared to 74% of newborns. Normal rates of neutrophils in women giving birth were 64%, compared to 50% in newborns. In terms of eosinophils, 100% of women giving birth presented normal proportions compared to 30% of newborns. These results also showed that 76% of women giving birth have normal lymphocyte counts compared to 84% of newborns. As for monocytes, normal levels of 80% at delivery and 68% in newborns were observed. As for thrombocytes, 74% of women giving birth and 84% of newborns had a normal level.

Table 2: Proportions of hematologic status and erythrocyte parameters

Erythrocyte parameters	**Women at childbirth N = 50**	**Newborns N = 50**	**p**
Hematological Statut	**n (%)**	**n (%)**	
Normal	10 (20)	0 (0)	--
Abnormal	40 (80)	50 (100)	0,14
Hemoglobin (g/dL) &			
Low < 11 / 14	10 (20)	16 (32)	0,10
Normal 11-16/14 – 20	40 (80)	34 (68)	0,32
Hematocrit (%) &			
Low < 33 / 44	9 (18)	30 (60)	$1,04.10^{-6}$
Normal 33-47/44-62	20 (40)	20 (40)	0,0001
MCV (fL) &			
Low < 80 / 100	10 (20)	36 (72)	$2,33.10^{-8}$
Normal 80-100/100-110	39 (78)	13 (26)	$1,83.10^{-7}$
High > 100 / 110	1 (2)	1 (2)	1
MCH (pg)			
Low or high <27 ou > 31	23 (46)	45 (90)	0,0001
Normal 27 – 31	27 (54)	5 (10)	$8,11.10^{-9}$
MCHC (g/dL)			
Low or high < 32 ou > 36	11 (22)	19 (38)	0,04
Normal 32 – 36	39 (78)	31 (62)	0,18

N: Total number of each group of subjects; n: Number observed for each variation of the parameters; 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 3: Type of anemia in women at childbirt and newborns

Type of anemia	**Women at childbirth N = 50**	**Newborns N = 50**	**p**
Crude anemia &	n (%)	n (%)	
(9 – 11/14)	8 (16)	16 (32)	0,02
Moderate anemia			
(8 – 9)	2 (4)	0 (0)	--
Severe anemia			
(< 8)	0 (0)	0 (0)	-
NNA	1 (2)	0 (0)	--
NMA	0 (0)	0 (0)	-
NmA	1 (2)	4 (8)	0,05
HNA	3 (6)	6 (12)	0,15
HMA	1 (2)	1 (2)	1
HmA	4 (8)	5 (10)	0,64

N: Total number of each group of subjects; n: Number observed for each type of anemia; NNA: Normochromic normocytic anaemia; NMA: Normochromic macrocytic anaemia; NmA: Normochromic microcytic anaemia; HNA: Hypochromic normocytic anaemia; HMA: Hypochromic macrocytic anaemia; HmA: Hypochromic microcytic anaemia; -: No prevalence observed; --: No comparison possible.

Table 4: Proportions of leukocytes and thrombocytes parameters leucocytaires

Leukocyte and thrombocytes Parameters	Women at childbirth N = 50	Newborn N = 50	p
Leukocyte ($10^3/mm^3$) &	n (%)	n (%)	
Low < 4 ou 10	1 (2)	10 (20)	$3,56.10^{-5}$
Normal 4 – 10 / 10 – 25	31 (62)	37 (74)	0,30
High > 10 ou 25	18 (36)	3 (6)	$1,08.10^{-6}$
P. Neutrophils ($10^3/mm^3$) &			
Low < 1,7 ou 6	3 (6)	25 (50)	$3,29.10^{-10}$
Normal 1,7 – 7 / 6 – 25	32 (64)	25 (50)	0,19
High > 7 ou 25	15 (30)	0 (0)	--
E. Polymorphonuclear ($10^3/mm^3$) &			
Low < 0 ou 0,2	0 (0)	33 (66)	--
Normal 0 – 0,5 / 0,2 – 0,5	50 (100)	15 (30)	$2,86.10^{-10}$
High > 0,5	0 (0)	2 (4)	--
Lymphocyte ($10^3/mm^3$) &			
Low < 1,5 ou 2	9 (18)	3 (6)	0,01
Normal 1,5 – 4 / 2 – 11	38 (76)	42 (84)	0,53
High > 4 ou 11	3 (6)	5 (10)	0,32
Monocyte ($10^3/mm^3$) &			
Low < 0,1 ou 0,5	0 (0)	1 (2)	--
Normal 0,1 – 1 / 0,5 – 1,2	40 (80)	34 (68)	0,32
High > 1 ou 1,2	10 (20)	15 (30)	0,16
Thrombocyte ($10^3/mm^3$)			
Low < 150	13 (26)	7 (14)	0,06
Normal 150 – 400	37 (74)	42 (84)	0,43
High > 400	0 (0)	1 (2)	--

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

Distribution of proportions of biochemical blood parameters

Table 5 shows the proportions of blood sugar and lipid parameters of women giving birth and newborns in Yopougon. The proportions of hyperglycemia, hypertriglyceridemia, total hypercholesterolemia, HDL and LDL were significantly higher (p <0.001) in women giving birth compared to newborns. Likewise, the high proportions of the coronary and atherogenic risk indices of women at childbirth were significantly lower (p <0.001) than those of newborns. In contrast, the proportions of total hypocholesterolemia and LDL of newborns were significantly higher (p <0.01) than those of women at childbirth. Furthermore, these results indicated that 58% of women giving birth versus 86% of newborns had normal blood sugar levels. Regarding triglycerides, 30% and 88% of women giving birth and newborns, respectively, had normal triglyceridemia. In terms of cholesterol, 40% of women giving birth compared to 2% of newborns presented normal proportions of total cholesterol. As for HDL and LDL, normal levels were respectively 66% and 38% in women giving birth against proportions of 2% each in newborns. These results also indicated that 60% of women giving birth had a normal rate of the atherogenic risk index compared to 94% of newborns.

Table 6 shows the proportions of renal and hepatic parameters of women giving birth and newborns in Yopougon. The proportions of total hyperproteinemia (8%), and conjugated hyperbilirubinemia (18%) of women giving birth were significantly lower than those of newborns (24% and 44%). No woman in childbirth had a high level of hypercreatinemia compared to 22% of newborns. In contrast, the proportions of total hyperbilirubinemia in women giving birth was 36%, while no newborn (0%) observed this parameter. These results indicated that all women giving birth (100%) had normal creatinine levels compared to 74% of newborns. In addition, 60% and 72% respectively of women giving birth and newborns had normal levels of total protein. As for transaminases, 98% and 48% of women giving birth, respectively, showed normal levels of ASAT and ALAT. Whereas, it is respectively 100% and 72% of the newborns who presented normal levels of these parameters. In terms of bilirubin, these results indicated that 22% of women giving birth had a normal level of total bilirubin compared to 38% of newborns. As for conjugated bilirubin, 82% of women giving birth had a normal level, while 34% of newborns had a normal level of this parameter.

The comparison of the proportions of some minerals in women giving birth and newborns in Yopougon is presented in Table 7. The analysis revealed 46% of hypernatremia in newborns against 6% in women in Yopougon. childbirth. As for the normal proportions of serum sodium, they were significantly lower (p <0.001) in newborns (14%) compared to women at childbirth (48%). Regarding hypokalaemia (6%) and hyperchloremia (40%) of newborns, the results showed a significant decrease (p <0.001) in these proportions, compared to those of women at childbirth. (78% and 76%). On the other hand, the normal proportions of serum potassium (60%), as well as the proportions of hyperkalaemia (34%) of newborns were significantly higher (p <0.001) than those of women at childbirth (16% and 6 %). Likewise, newborns presented significantly higher hypochloremia (36%) (p <0.001) than women at delivery.

Table 5: Proportions of glycemia and lipid parameters

Biochemical parameters	Women at childbirth N = 50	Newborn N = 50	p
Glycemia (g/L)	**n (%)**	**n (%)**	
Low < 0,6	5 (10)	5 (10)	1
Normal 0,6 – 1,10	29 (58)	43 (86)	0,019
High > 1,10	16 (32)	2 (4)	$6{,}391.10^{-7}$
Triglycerides (g/L) &			
Low < 0,4 ou 0,3	1 (2)	4 (8)	0,05
Normal 0,4 – 1,4 / 0,3 – 1,1	15 (30)	44 (88)	$4{,}829.10^{-8}$
High > 1,4 ou 1,1	34 (68)	2 (4)	$< 2{,}2.10^{-16}$
Total Cholesterol (g/L) &			
Low < 1,5 ou 1,6	6 (12)	48 (96)	$< 2{,}2.10^{-16}$
Normal 1,5 – 2,32 / 1,6 – 2,2	20 (40)	1 (2)	$8{,}483.10^{-11}$
High > 2,32 ou 2,2	24 (48)	1 (2)	$4{,}258.10^{-13}$
HDL Cholesterol (g/L) &			
Low < 0,4 ou 0,12	10 (20)	0 (0)	--
Normal 0,4 – 0,75 / 0,12 – 0,5	33 (66)	48 (96)	0,018
High > 0,75 ou 0,5	7 (14)	2 (4)	0,002
LDL Cholesterol (g/L) &			
Low < 1,08 ou 1,1	14 (28)	48 (96)	$3{,}402.10^{-10}$
Normal 1,08 – 1,88 / 1,1 – 1,6	19 (38)	1 (2)	$3{,}164.10^{-10}$
High > 1,88 ou 1,6	17 (34)	1 (2)	$4{,}355.10^{-9}$
Coronary risk index			
Normal < 4,85	30 (60)	47 (94)	0,006
High > 4,85	20 (40)	3 (6)	$1{,}125.10^{-7}$
Atherogenicity index			
Normal < 3,55	34 (68)	48 (96)	0,03
High > 3,55	16 (32)	2 (4)	$6{,}391.10^{-7}$

N: Total number of each group of subjects; n: Number observed for each parameters; HDL: High density lipoprotein; LDL: Low density lipoprotein; --: No comparison possible; &: Reference values are defined for each group, the first for women at childbirth and the second for newborns.

Table 6: Proportions of some renal and hepatic parameters

Biochemical parameters	Women at childbirth N = 50	Newborns N = 50	p
Creatinine (mg/L) &	**n (%)**	**n (%)**	
Low < 6 ou 7	0 (0)	2 (4)	--
Normal 6 – 17 / 7 – 10	50 (100)	37 (74)	0,048
High > 17 ou 10	0 (0)	11 (22)	--
Total Protein (g/L) &			
Low < 66 ou 45	16 (32)	2 (4)	$6{,}391.10^{-7}$
Normal 66 – 83 / 45 - 75	30 (60)	36 (72)	0,296
High > 83 ou 75	4 (8)	12 (24)	0,004
AST (UI/L) &			
Low < 7 ou 20	0 (0)	0 (0)	-
Normal 7 – 37 / 20 – 80	49 (98)	50 (100)	0,887
High > 37 ou 80	1 (2)	0 (0)	--
ALT (UI/L) &			
Low < 6 ou 5	26 (52)	14 (28)	0,007
Normal 6 – 40 / 5 – 35	24 (48)	36 (72)	0,028
High > 40 ou 35	0 (0)	0 (0)	-
Total bilirubin (mg/L) &			
Low < 3 ou 8	21 (42)	31 (62)	0,049
Normal 3 – 10 / 8 – 25	11 (22)	19 (38)	0,038
Elevé > 10 ou 25	18 (36)	0 (0)	--
Conjugated bilirubin (mg/L) &			
Low * < 1	0 (0)	11 (22)	--
Normal < 4 ou 1 – 3	41 (82)	17 (34)	$6{,}052.10^{-6}$
High > 4 ou 3	9 (18)	22 (44)	0,0008

N: Total number of each group of subjects; n: Number observed for each parameters; AST: Aspartate aminotransferase; ALT: Alanine aminotransferase; &: Reference values are defined for each group, the first for women at childbirth and the second for newborns; *: The reference values only concerned newborns; -:No prevalence observed; --:No comparison possible.

Table 7: Proportions of some minerals

Biochemical parameters	Women at childbirth N = 50	Newborns N = 50	p
Calcium (mg/L) &	n (%)	n (%)	
Low < 81 ou 100	15 (30)	19 (36)	0,460
Normal 81 – 104 / 100 – 115	16 (32)	12 (24)	0,284

High > 104 ou 115	19 (38)	19 (36)	0,816
Sodium (meq/L) &			
Low < 135 ou 130	23 (46)	20 (40)	0,518
Normal 135 – 155 / 130 – 145	24 (48)	7 (14)	$8{,}99.10^{-6}$
High > 155 ou 145	3 (6)	23 (46)	$3{,}48.10^{-9}$
Potassium (meq/L) &			
Low < 3,5 ou 3,6	39 (78)	3 (6)	$< 2{,}2.10^{-16}$
Normal 3,5 – 5 / 3,6 – 5,6	8 (16)	30 (60)	$1{,}90.10^{-7}$
High > 5 ou 5,6	3 (6)	17 (34)	$3{,}30.10^{-6}$
Chlorine (meq/L) &			
Low < 90 ou 100	1 (2)	18 (36)	$1.18.10^{-9}$
Normal 90 – 105 / 100 – 110	11 (22)	12 (24)	0,768
High > 105 ou 110	38 (76)	20 (40)	0,0008

N: Total number of each group of subjects; n: Number observed for each parameters; &: Reference values are defined for each group, the first for women at childbirth and the second for newborns.

Discussion

In this study, the evaluation of the erythrocyte parameters of women in childbirth and of newborns revealed that, with the exception of red blood cells, all erythrocyte parameters of newborns were significantly higher than those of women at birth. delivery. Paiva *et al.* (2007) states that haematological 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 (HSC) (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 the increase in infantile hematologic parameters. 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, monocytes and thrombocytes of newborns are significantly higher ($p < 0.01$) than those of women during childbirth. Furthermore, the results of this study reported insignificant anemia prevalence of 20% in women giving birth and 32% in newborns. The 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 an increased demand for iron. However, iron stores before pregnancy are generally low (Bléyéré et al. 2014), because the diet of women in developing countries is low in iron. Furthermore, endemic parasitic infections in these geographic areas, lifestyle and socio-economic conditions are also associated with high prevalence of anemia (Ayano *et al.* 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 during childbirth and their newborns corroborate the work of Agrawal and Srivastava (2018). They have reported a direct relationship between maternal and fetal hemoglobin levels. In addition, analysis of the types of anemia revealed a significant increase ($p = 0.02$) in frustum anemia in newborns (32%) compared to women during childbirth (16%). The study of the different types of anemia revealed a preponderance of microcytic hypochromic anemia (MAH) (8%), followed by normocytic hypochromic anemia (NHA) (6%) in women giving birth. These anemias were followed by normochromic normochromic (ANN), normochromic microcytic (ANm) and hypochromic macrocytic (AHM) anemias with a similar rate of 2%. In newborns, normocytic hypochromic anemia (NHA) was highest with a rate of 12%. It was followed by microcytic hypochromic (AHm) (10%), microcytic normochromic (ANm) (8%) and macrocytic hypochromic (AHM) (2%) anemia. All of these types of anemia have also been observed, in varying proportions, by Amani *et al.* (2020) in this work carried out in Abobo in Ivory Coast among women giving birth and their newborns. The study of the distribution of biochemical parameters shows in women giving birth a significant increase in blood sugar, triglycerides, total cholesterols, HDL and LDL compared to those of newborns. Serum cholesterol and triglyceride concentrations increase in late pregnancy. This hyperlipidemia is 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) who state that hyperlipidemia may be an additional nutritional source for fetal development. In addition, the results of this study report a significant increase in the level of transaminases in the mean ASAT value of newborns, compared to that of women during childbirth. This rise in neonatal AST may be explained by the immaturity of liver cells (Kove *et al.* 1957). Studies by Kessel and Politzer in 1960 reported that ASAT levels in umbilical cord blood are elevated. Regarding bilirubin, newborns in this study show a significant increase in the mean value of conjugated bilirubin, compared to women at childbirth. This may be because 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 Suchonska *et al.* (2003) who reported that neonatal bilirubin is higher in newborns than in laboring women. Regarding minerals, the study indicates that the calcium of newborns increases significantly compared to that of women during childbirth. 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. This stimulus 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 during 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 chlorine level is significantly low in newborns compared to women during childbirth.

Conclusion

The study of the haematological profile is characterized by an increase in the haematological parameters of newborns compared to those of women during childbirth. High prevalence of anemia was observed in women giving birth (20%) and newborns (32%). In addition, the forms of anemias observed were ANN, ANm, AHN, AHM and AHm. This study showed that lipid parameters increase in women giving birth, while they are low in newborns. Finally, AST, conjugated bilirubin, calcium and chlorine are higher in newborns compared to women during childbirth.

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