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Original/*Pediatría*

Anemia in pregnancy: impact on weight and in the development of anemia in newborn

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Abstract

Introduction: **nutritional deficiencies are still a common problem during pregnancy causing anemia. Gestational anemia is still considered a public health problem in Brazil, because it is hazardous to both mother and fetus, and is associated with increased risk of maternal-fetal morbidity, as well as the nutritional status of child.**

Objective: **to evaluate the frequency of maternal gestational anemia in newborns and its relation to the nutritional status of the child at birth.**

Methods: **anthropometric data of pregnant women and their newborns were obtained. Blood was collected from pregnant women and the umbilical cord of newborns for analysis of hemoglobin, hematocrit, RDW, iron, ferritin and transferrin saturation index in automatic devices. The results are presented such as the arithmetic mean and the standard deviation. GraphPadinStat® Software version 3.0 was used, with a maximum significance level of 5%.**

Results: **the frequency of maternal anemia was 53.7%, and 32.6% in newborns. Half the newborns were anemic children of anemic mothers. 79.3% of the anemic pregnant women had mild anemia and in 20.7% moderate. The average concentration of hemoglobin and hematocrit was lower in anemic pregnant women (9.7 ± 0.9 g/dL and 29.8 ± 3.2%) compared with non-anemic (11.9 ± 0.7 g/dL and 36.5 ± 2.7%). The maternal iron was positively correlated with ferritin (r = 0.3889, p = 0.01) from umbilical cord blood. The newborns' weight, length and head circumference of anemic mothers were 3 375.9 ± 506,9 g, 51.2 ± 1.7 cm and 34.5 ± 1.5 cm, respectively, while of nonanemic mothers were 3 300.2 ± 458,4 g, 50.3 ± 2.0 cm**

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ANEMIA GESTACIONAL: INFLUENCIA DE LA ANEMIA SOBRE EL PESO Y EL DESARROLLO DEL RECIÉN NACIDO

Resumen

Introducción: **la anemia gestacional todavía se considera un problema de salud pública en Brasil y se asocia con un mayor riesgo de morbilidad materno-fetal y el estado nutricional de los niños en el período posparto.**

Objetivo: **evaluar la frecuencia de la anemia gestacional materna en recién nacidos y su relación con el estado nutricional del niño al nacer.**

Métodos: **se obtuvieron datos antropométricos de las mujeres embarazadas y los recién nacidos. Se recogieron muestras de sangre de mujeres embarazadas y de cordón umbilical de los recién nacidos para su posterior análisis de hemoglobina, hematocrito, ADE, hierro, ferritina e índice de saturación de transferrina en dispositivos automatizados. Los resultados se presentan como media y la desviación estándar. Fue utilizado el software GraphPadinStat®, versión 3.0 y se aceptó un nivel de significación del 5%.**

Resultados: **la frecuencia de anemia materna era de 53,7% y 32,6% en los recién nacidos. La mitad de los recién nacidos eran niños anémicos de madres anémicas. De las mujeres embarazadas con anemia, el 79,3% tenían anemia leve y el 20,7% moderada. La concentración media de hemoglobina y hematocrito fue menor en las mujeres embarazadas con anemia (9,7 ± 0,9 g/dl y 29,8 ± 3,2%) en comparación con las no anémicas (11,9 ± 0,7 g/dl y 36,5 ± 2,7%), como se esperaba. El nivel de hierro de la madre se correlacionó positivamente con ferritina (r = 0,389; p = 0,01) a partir de la sangre del cordón umbilical. El peso, la longitud y la circunferencia de la cabeza de los niños nacidos de madres anémicas fueron: 3.375,9 ± 506,9 g, 51,2 ± 1,7 cm y 34,5 ± 1,5 cm, respectivamente, mientras que entre los recién nacidos de madres no anémicas fueron: 3.300,2 ± 458,4 g, 50,3 ± 2,0 cm y**

and 34.2 ± 2.0 cm, respectively. There were no significant correlations between maternal hemoglobin, iron and ferritin with weight, length and head circumference of newborns.

Conclusion: **the results of this study show that maternal iron deficiency anemia (mild to moderate) can affect the blood profile and iron concentrations in umbilical cord blood of newborns, but without interfering with the child's anthropometric parameters.**

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Key words: *Pregnancy. Anemia. Newborn. Iron deficiency.*

34,2 ± 2,0 cm, respectivamente. No se encontraron correlaciones significativas entre la hemoglobina, el hierro y la ferritina de la madre, y el peso, la longitud y la circunferencia de la cabeza de los recién nacidos.

Conclusión: **la frecuencia de anemia leve es elevada tanto en la madre como en el nenonato. Sin embargo, no influye en los parámetros antropométricos del recién nacido.**

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Palabras clave: *Embarazo. Anemia. Deficiencia de hierro del recién nacido.*

Abbreviations

NB: Newborn.
LBW: Low birth weight.
HMON: Hospital Maternidade Oswaldo Nazaré.
UCB: Umbilical cord blood.
GA: Gestational age.
BMI: Body Mass Index.
WHO: World Health Organization.
IOM: Institute of Medicine.
LABNE: Laboratório de Nutrição Experimental.
UFF: Universidade Federal Fluminense.
RDW: Red Cell Distribution Width.
TSAT: Transferrin saturation.

Introduction

Maternal anemia is considered a risk factor for pregnancy and can be a cause of anemia in newborns (NB), besides being related to higher miscarriage rate, intrauterine growth restriction (low birth weight - LBW), prematurity, fetal death and anemia in the first year of life due to low iron stores[1].

Its origin may be due to several factors including acute infections, chronic inflammation, hemoglobinopathies and single or combined deficiency of nutrients such as folic acid, vitamin B_{12} and iron deficiency is the most common cause of known nutritional anemia[2].

Iron is an essential and vital nutrient for many cellular activities and vital for the early development of the nervous system. Thus, it is crucial for intrauterine and postnatal development[3].

The last trimester of pregnancy is the period of most important weight gain and iron storage in the fetus. Therefore, premature or low birth weight children have lower amounts of accumulated iron compared to full-term newborns. After birth, there is a phase of high growth rate, and in a full-term child, reserves acquired during pregnancy will be used during the first 4-6 months of life[4]. Birth weight is thus an important factor in determining the child's survival; therefore, low birth weight children are at increased risk of becoming ill or die in the first year of life.

However, information on the incidence of anemia in the fetus and the relationship with intrauterine growth, especially in Brazil, are insufficient and controversial. The aim of this study was to determine the frequency of anemia in pregnant women and newborns and determine whether there is an association with maternal nutritional status.

Material and methods

This was an observational analytical cross-sectional study with convenience sample conducted at the Hospital Maternidade Oswaldo Nazaré (HMON), Rio de Janeiro - RJ. This maternity hospital is intended for the care of low, intermediate and high risk pregnant women of low socioeconomic level in labor who have done or not prenatal care in the unit. Overall, 54 adult pregnant women with chronological age between 20 and 38 years old admitted to the prenatal maternity sector. Mothers were previously consulted for the inclusion of their children in this study. All deliveries were at full term.

Of the 54 neonates, 50 were included in the survey and 4 neonates were unable to participate due to the impossibility of collecting umbilical cord blood (UCB) at delivery.

Inclusion criteria were: prenatal care card filled in an appropriate and sufficient manner, singleton pregnancy whose fetuses are born alive without congenital malformation and information on gestational age at birth. Exclusion criteria were: smokers, drug users, alcohol and infectious diseases.

The study protocol is in line with the ethical principles of the Declaration of Helsinki and the rules of Resolution 196/96 of the National Health Council and was approved by the Research Ethics Committee in humans of the Municipal Department of Health and Civil Defense of the Rio de Janeiro city, under protocol No. 235/11, CAAE No 0371.0.258.314-11. All pregnant women were given the necessary information to define their participation in the study. Mothers were consulted in advance to obtain the free and informed consent and authorization to enroll their children in

this study. All signed the free and informed consent form for research participation.

Obstetric and prenatal care evaluation

Obstetric and prenatal care information were obtained from medical records with the following data: chronological age, gynecological age, schooling, medications and / or nutritional supplements used during pregnancy, gestational age (GA) according to the last menstrual period and ultrasound, number of pregnancies, interpregnany, and inter-delivery intervals, number of prenatal care visits, previous reproductive history, current obstetric disease.

Nutritional Assessment

To assess the pre-gestational anthropometric status of pregnant women it was used the pre-pregnancy weight (kg) referred to or written on the follow-up card until the 13th gestational week[5].

The pre-pregnancy Body Mass Index (BMI) of pregnant women was classified in accordance with the World Health Organization (WHO)[6], validated by Saunders et al.[7], that classify BMI into the following categories: underweight (BMI <18.5 kg / m^2); normal weight (BMI ≥18.5 and <25 kg / m^2); overweight (BMI ≥ 25 and <30 kg / m^2) and obese (BMI ≥30 kg / m^2).

Gestational weight gain was calculated by subtracting the pre-pregnancy weight from the last weight measured in the ninth month of pregnancy. The weight gain assessment used recommendations of the Institute of Medicine (IOM)[8] according to the recommended weight gain ranges and to BMI categories: underweight: 12.5-18.0Kg; adequate: 11.5-16.0Kg; overweight: 7.0-11.5Kg and obese: 7.0-9.1Kg.

The nutritional status of newborns was assessed using the following information collected from medical records: weight (kg), length (cm), head circumference (cm) and gestational age (weeks) at birth according to the last menstrual period and Capurro. The weight at birth according to gestational age was classified using the Brenelli and Martins curve[9], classifying newborns into small for gestational age (SGA, <P10), adequate for gestational age (AGA between P10 and P90) and large for gestational age (LGA,> P90). Infants weighing less than 2500g were considered low birth weight according to the classification used by WHO[6]. For length and head circumference at birth, the curves of WHO[10,11], respectively, were used as reference.

Blood collection and analyses

Blood collection of pregnant women was performed before delivery with sterile and disposable syringe after previous sterilization of skin with alcohol (70%) by venipuncture in the elbow flexure and the UCB of newborns was collected immediately after delivery, previously the placenta expulsion, manually by the obstetrics team.

Blood samples collected from umbilical cord and pregnant women were placed in BD Vacutainer tubes with and without anticoagulant and then transported to the Laboratório de Nutrição Experimental (LABNE), School of Nutrition, Universidade Federal Fluminense (UFF), where the following hematologic analyses were performed: hematocrit, hemoglobin and Red Cell Distribution Width (RDW); and the following biochemical analyses: iron, ferritin and transferrin saturation index (TSAT). Hematological analyses were made in an automatic device, model BC 2800, and for biochemical analyses was used automatic equipment, model BS 220, both from Bioclin. Ferritin concentration was determined by enzyme-linked immunosorbent assay method (ELISA) kit from DRG Instruments and reading was held in a microplate reader (Thermo Plater Reader) at wavelength of 450nm.

The diagnosis of maternal anemia was characterized by hemoglobin values lower than 11.0 g / dL, being classified as mild and moderate anemia when values were from 9.0 to 11.0 g / dL and from 7.0 to 8.9 g / dL, respectively. Neonates with hemoglobin values lower than 13.5g / dL were considered anemic.

The other analyses performed and the cutoff points used to pregnant women and newborns, respectively, were: hematocrit 33% and 42%, iron 50 μg / dL and 95 μg / dL, ferritin 12ng / ml and 25ng / ml, RDW 14.0 % and 16% and TSAT 16% (only for pregnant women)[12,13,14,15].

Statistical analysis

The results of this study are presented using descriptive statistics such as arithmetic mean, standard deviation and frequency. The Graph Pad Instat® software version 3.0 was used for analyses and the 5% level of significance was adopted. The paired Student t test was used to assess the nutritional status of pregnant women. For comparison of means between mother and the newborn data, the unpaired Student t test was used. The Fisher exact test was used for comparison of frequencies. Pearson's correlation was used to investigate possible associations between variables. The assumption of normality (Gaussian distribution) of data was verified by means of kurtosis and skewness tests to support the use of statistical methods described above. To analyze data without normal distribution, Spearman non parametric correlation was applied as non-parametric test. To determine the sample size, procedure based on the characteristic operating curves was used. This procedure limits the error to be committed when H_0 is not rejected (type II error), based on the relationship between the deviation of the variable analyzed and its standard deviation. A probability of 20% for the oc-

currence of Type II error (β risk) was defined. It was also defined that the "D" deviation among variables analyzed in the study and their variability would be up to 45%, where:

$$D=\frac{(X - \mu 0)}{\sigma}$$

Based on these results, the value of N = 50 was taken from the characteristic operating curve with α = 5%, where N is the minimum number of pregnant women who should be included in the study[16].

Results

Characterization of pregnant women

The general characteristics of mothers are shown in table I. The average age of pregnant women was 24 years, with menarche and gynecological age of 12 years and gestational age of 39 weeks. It was observed that 38.5% of participants had schooling of 8 years and 61.5% had nine or more years of scholarity, including higher education. Most women were multiparous, with 2 pregnancies. Participants had 7 prenatal visits, on average. The use of vitamin and mineral supplement was reported by 84.91% of pregnant women for 6 months, and ferrous sulfate (60 mg / day) was indicated for all and folic acid (400 μg / day) supplementation was used by 66.66% of pregnant women in association with ferrous sulfate.

With regard to pre-pregnancy nutritional status, it was observed that 42.6% of pregnant women started pregnancy eutrophic, 9.2% underweight, 27.8% overweight and 20.4% obese.

Table II shows the gestational weight gain according to pre-pregnancy BMI. It was observed that the majority of women with low pre-pregnancy weight exhibited adequate or excessive gestational weight gain (40%), in the same proportion. Eutrophic women presented insufficient or excessive gestational weight gain (39% and 34%), while those with pre-pregnancy overweight or obesity had excessive weight gain (46% and 63%, respectively).

Table I
General characteristics of mothers (n=54)

Variable	*Mean ± SD*	*Minimum -Maximum*
Age (years)	24.5 ± 4.1	20.0 – 38.0
Education (years)	9.2 ± 3.0	4.0 – 15.0
Menarche (years)	12.2 ± 1.4	9.0 – 15.0
Gynecological age (years)	12.3 ± 7.7	2.0 – 28.0
Gestational age (weeks)	39.1 ± 1.7	34.0 – 42.0
Pregnancies (n)	2.1 ± 1.2	1.0 – 6.0
Supplementation (months)	6.6 ± 2.3	3.0 – 9.0
Pre-gestational weight (kg)	63.3 ± 15.2	40.0 – 100.0
Weight at the end of gestational (kg)	76.9 ± 14.0	55.0 – 112.0
Total weight gain (kg)	13.2 ± 6.6	-2.0 – 35.0
Prenatal consultations (n)	7.3 ± 2.5	1.0 – 12.0
Pre-gestational BMI (kg/m^2)	25.0 ± 6.4	15.4 – 40.2
Current BMI (kg/m^2)	30.2 ± 6.0	20.2 – 45.2

Table II
Adequacy of gestational weight gain according to pre-gestational BMI

	Gestational weight gain		
Pre-gestational BMI	*Insufficient*	*Adequate*	*Excessive*
Underweight	20.0%	40.0%	40.0%
Eutrophia	39.1%	26.1%	34.8%
Overweight	33.3%	20.0%	46.7%
Obesity	36.4%	0%	63.6%

Frequency and level of maternal anemia

Frequency of 53.7% of anemic pregnant women was observed. Of the total anemic pregnant women, 72.4% were multiparous and 27.6% primiparous. Regarding the level of anemia, it was observed that 79.3% of anemic pregnant women had mild anemia and 20.7% moderate anemia, there were no cases of severe anemia.

By analyzing the maternal biochemical variables and their possible relationship, positive and expected correlations were found between hemoglobin concentration and hematocrit in both anemic pregnant women and in those not anemic (r = 0.95 and r = 0.94, p <0.0001, respectively). The same was observed between serum iron concentration and TSAT of anemic and non-anemic pregnant women (r = 0.96 and r = 0.98, p <0.0001, respectively).

Characterization of newborns, frequency and level of anemia

The average weight (3374.8 ± 491,7g), length (50.7 ± 2.0 cm) and head circumference (34.5 ± 1,7cm) of children at birth were adequate. Based on these results, it could be concluded that pregnant women had adequate number of prenatal assistance consultation and, in general, adequate gestational outcome considering weight and length at birth.

Classifying newborns according to weight for gestational age, 85.0% were adequate for gestational age, 2.5% were small for gestational age and 12.5% large for gestational age.

Regarding the general characteristics of newborns, it was observed that birth weight was positively correlated with length (r = 0.72; p = 0.0001) and head circumference (r = 0.57; p = 0.0001), as expected. Head circumference was associated with a tendency to pre-pregnancy BMI (r = 0.30 p = 0.07) and gynecological age (r = 0.28 p = 0.07). No significant correlation between the other characteristics of both mother and newborn was found.

Table III shows the characteristics of newborns from anemic and non-anemic mothers at birth. It was observed that the average weight, length and head circumference of children showed similar results.

The birth weight of infants from anemic mothers according to gestational age showed that 90.9% were adequate for gestational age and 9.1% were large for gestational age. Regarding NB from non-anemic mothers, 4.8% were small for gestational age, 80.9% were adequate for gestational age and 14.3% large for gestational age, with no difference in frequency between anemic and non-anemic mothers.

Based on results, both anemic and non-anemic pregnant women had, in general, adequate gestational outcome considering weight and length at birth.

The frequency of anemia in newborns was 32.6% and of these, 100% had mild anemia and half of them were children from anemic mothers.

Blood parameters of anemic and non-anemic pregnant women and newborns

The blood parameters of pregnant women and newborns are shown in table IV. As expected, hemoglobin, hematocrit and iron concentrations were lower (p <0.01) in anemic pregnant women compared with non-anemic pregnant women. However, ferritin showed tendency to lower concentrations in anemic pregnant women. There was no significant difference in mean RDW concentration and TSAT between anemic and non-anemic pregnant women. However, when the TSAT frequency distribution between anemic and non-anemic pregnant women is analyzed, higher frequently (p <0.0001) of anemic pregnant women with TSAT below the cutoff point was observed.

In relation to newborns from anemic and non-anemic mothers, no significant difference between means and frequencies of hemoglobin, hematocrit, RDW, iron and ferritin distribution was observed.

Significant positive correlation between hemoglobin of non-anemic pregnant women and hematocrit in the UCB was found (r = 0.47; p <0.03). The iron concentration and TSAT both of anemic and non-anemic pregnant women showed a significant positive correlation with ferritin in the UCB of newborns (r = 0.57 and r = 0.52; p <0.02; r = 0 52 r = 0.49; p <0.02, respectively). No other associations between maternal variables and UCB were found.

Table III
General charactheristics of newborns of anemic and non-anemic mothers

Variables	*Anemic (n=26) Mean ± SD*	*Non-Anemic (n=24) Mean ± SD*
Birth weight (g)	3375.9 ± 506.9	3300.2 ± 458.4
Length (cm)	51.2 ± 1.7	50.3 ± 2.0
Head circumference (cm)	34.5 ± 1.5	34.2 ± 2.0

Discussion

The results of this study show that in Brazil, anemia is still a public health problem that is far from being resolved and that might be caused by the combination of several factors. One of the factors considered important for the development of anemia in pregnant women is multiparity, for be able to reduce maternal iron stores in each pregnancy[17]. The results of this study characterized pregnant women mostly as young adults and multiparous. Corroborating literature, the higher frequency of anemia in this study was observed in multiparous pregnant women, and similar results were found in Turkey[17] and Brazil[18]. In addition, maternal age can also influence, according to maturity, positively or not in the pregnancy outcome[19]. However, in this study, no relationship between age and anemia was observed.

When analyzing data on maternal weight gain according to recommendations[8], this study found that more than half of participants had inadequate weight gain. Low-weight pregnant women migrated to normal weight and / or overweight / obesity; those with normal weight to overweight / obesity and obese increased the degree of obesity. Although Beyerlein et al.[20] and Crozier et al.[21] have shown that excessive gestational weight gain is associated with high weight at birth, influence of maternal weight gain on the weight of newborns was not observed in the present study. Similarly to the pre-pregnancy weight, excessive weight gain did not appear to be a protective or triggering factor for anemia in newborns.

The relationship between maternal pre-pregnancy nutritional status and child's birth weight was not clearly identified. Similarly, pre-pregnancy weight has been identified as a factor for the development of anemia in newborns. However, a study by Frederick et al.[22] showed a positive association between pre-pregnancy BMI and the child's birth weight, which is also a source of controversy.

Table IV
Haematological and biochemical parameters of pregnant women and their newborns

Parameters	*Cuttin g point*	*Pregnant women*	*Anemic pregnant women*	*Non-anemic pregnant women*	*p-value*
Pregnant women		*(n=54)*	*(n=29)*	*(n=25)*	
Hemoglobin (g/dL)					
Mean	11.0	10.7 ± 1.3	9.7 ± 0.9	11.9 ± 0.7	
< 11.0		53.7%	100%	0	< 0.0001*
> 11.0		46.3%	0	100%	< 0.0001**
Hematocrit (%)					
Mean	33.0	32.9 ± 4.4	29.8 ± 3.2	36.5 ± 2.7	
< 33.0		40.7%	75.9%	0	< 0.0001*
> 33.0		59.3%	24.1%	100%	< 0.0001**
Iron (μg/dL)					
Mean	50.0	65.4 ± 20.9	58.3 ± 15.2	71.7 ± 22.8	
< 50.0		27.8%	27.6%	28.0%	0.013*
> 50.0		72.2%	72.4%	72.0%	1.0**
Ferritin (ng/ml)					
Mean	12.0	9.6 ± 8.0	7.2 ± 5.2	11.8 ± 9.7	
< 12.0		80.0%	88.9%	71.4%	0.06*
> 12.0		20.0%	11.1%	28.6%	0.08**
RDW (%)					
Mean	14.0	14.1 ± 1.2	14.3 ± 1.1	14.1 ± 0.8	> 0.25*
< 14.0		42.6%	37.9%	48.0%	0.19**
> 14.0		57.4%	62.1%	52.0%	
ISTF(%)					
Mean	16.0	13.4 ± 4.4	12.7 ± 3.2	14.3 ± 4.5	0.12*
<16.0		64.8%	86.2%	52.0%	
>16.0		35.2%	13.8%	48.0%	< 0.0001**

In Brazil, the use of oral iron supplementation to prevent and treat anemia in pregnant women is a traditional resource widely used, although there are some difficulties in relation to the appearance of undesirable side effects. In many cases, the World Health Organization (WHO) recommends supplementation of a single daily dose of 60mg of iron, since problems arising from intolerance to iron supplementation has been often observed when patients make use of higher doses[4].

In this study, over 80% of pregnant women reported using iron supplementation; however, more than half of these women had become anemic. One hypothesis that could explain this result is that the use of the supplement may not have occurred properly or have not been sufficient to prevent anemia, as shown in a study conducted in Spain with pregnant women. The authors showed that no preventive effect on serum iron level was observed with early iron supplementation when compared to late supplementation[23].

The WHO considers anemia in pregnant women as a serious public health problem when the prevalence is greater than 40%[24]. The frequency of anemia in this study (53.7%) was consistent with that expected for developing nations, being classified as severe in epidemiological scale (> 40%) and similar to the few Brazilian studies on the subject[25,26]. Corroborating our results, a study conducted in the semiarid region of the State of Alagoas[25] and in Niterói, Rio de Janeiro[26] found 50% and 41.6% of anemic pregnant women, respectively. The same was observed in other developing countries, such as in eastern Ethiopia[27] and China[28], which had a frequency of anemic pregnant women of 43.9% and 58.6%, respectively, while in developed countries, this prevalence is much lower (≤ 20%)[29]. In an attempt to reduce and control the development of

Table IV(cont.)
Haematological and biochemical parameters of pregnant women and their newborns

Parameters	*Cuttin g point*	*Pregnant women*	*Anemic pregnant women*	*Non-anemic pregnant women*	*p-value*
Newborns		*(n=50)*	*(n=26)*	*(n=24)*	
Hemoglobin (g/dL)					
Mean	13.5	14.1 ± 1.6	13.8 ± 1.4	14.4 ± 1.7	0.17*
< 13.5		32.6%	31.8%	33.3%	
> 13.5		67.4%	68.2%	66.7%	0.88**
Hematocrit (%)					
Mean	42.0	43.4 ± 4.6	42.7 ± 4.7	43.8 ± 4.8	0.45*
< 42.0		34.9%	36.4%	38.1%	
> 42.0		65.1%	63.6%	61.9%	0.88**
RDW (%)					
Mean	16.0	15.1 ± 0.8	15.0 ± 0.8	15.2 ± 0.9	0.87*
< 16.0		83.7%	86.4%	80.9%	
> 16.0		16.3%	13.6%	19.1%	0.44**
Iron (μg/dL)					
Mean	95.0	78.9 ± 18.8	81.2 ± 17.4	75.8 ± 20.1	0.35*
< 95.0		83.7%	81.8%	85.7%	
> 95.0		16.3%	18.2%	14.3%	0.56**
Ferritin(ng/ml)					
Mean	25.0	122.9 ± 62.4	123.0 ± 69.1	121.0 ± 55.4	
< 25.0		0	0	0	0.92*
> 25.0		100%	100%	100%	

* Unpaired t test between anemic and non-anemic
** Fisher's exact test between anemic and non-anemic

nutritional problems such as anemia in pregnant women, Chagas et al, emphasize the importance of increasing the number of prenatal nutrition assistance consultations in order to strengthen the importance of the actions proposed by the Ministry of Health[30] .

For the diagnosis of anemia in populations, hemoglobin and hematocrit are generally used. The importance of these indicators during pregnancy should be highlighted, considering that they are frequently used as a screening test[31,32]. However, Dani et al, in a study using ferritin to assess iron deficiency, showed that this deficiency usually establishes even before hemoglobin levels are reduced. The authors reported that hemoglobin is the only parameter routinely used in the public prenatal care network, which suggests that most pregnant women with iron deficiency are not even identified[32]. For this reason, it has been proposed that the assessment of the hemoglobin concentration should be associated with the assessment of other indicators to better identify the deficiency of this important nutrient, especially during pregnancy.

Serum ferritin has been considered, along with other indicators, the best indicator to detect iron deficiency. Corroborating the findings of Dani et al.[32], this study found that the vast majority of anemic and non-anemic pregnant women had ferritin levels below the reference value, indicating that iron deficiency had already been established, although iron levels were above the reference value. These results suggest that iron supplementation may have been only sufficient to maintain the serum iron concentration within normal range. According to Scholl[2], iron supplementation during pregnancy increases the serum iron concentration, depending on the maternal diet, but does not improve iron stores, and it is therefore important to initiate iron supplementation before pregnancy in order to improve the reserves of this mineral.

The present study showed a strong relationship between serum iron and maternal TSAT. According to Grotto[33], TSAT values below 16% are indicative of iron supply deficiency for the development of red blood cells. In this study, 86% of anemic and 52% of

non-anemic pregnant women had TSAT values lower than 16%. This result shows that reduction in iron supplies in non-anemic and iron deficiency in anemic pregnant women were already established. Another parameter also used in the diagnosis of iron deficiency is RDW, which is a quantitative measure of anisocytosis. Increased RDW levels indicate heterogeneous population of erythrocytes, formed by cells of various sizes. In iron deficiency, RDW levels are always increased[34]. In the present study, RDW of anemic pregnant women was higher when compared to non-anemic ones, corroborating literature.

A similar result was found by Karaoglu et al.[17] in a study with pregnant women in Turkey, where anemic pregnant women with low transferrin saturation also had greater RDW values, indicating iron deficiency.

No relationship was found between maternal iron values and those of newborns in this study. These results are corroborated by the study of Shao et al.[35], who concluded that the maternal iron concentration is only related to that of newborns if maternal iron concentration is low. Most newborns in our study had serum iron levels below the reference value, a possible explanation is the fact that low maternal transferrin saturation index reduces the availability of iron to the infant through the placenta. However, the iron concentration and TSAT, both of anemic pregnant women as non-anemic pregnant women, showed a significant positive correlation with ferritin concentration in the UCB of newborns, showing that these are important maternal factors and are directly related to the child's iron stores at birth.

The results of this study corroborate a survey carried out in a rural area of southeastern China[35], where most of the women had iron deficiency or mild iron deficiency anemia and most newborns did not have anemia and showed elevated ferritin levels. One possible explanation is the fact that iron stores in the fetus are not adversely affected by mild to moderate maternal anemia, reinforcing the theory that iron is transported across the placenta regardless of its level in the maternal blood[36]. These results are in agreement with the study of Chopard et al.[37], who reported that mild or moderate maternal iron deficiency anemia does not cause low iron stores (ferritin) in the fetus, but can progress to preterm labor and newborns with low birth weight.

The result of the RBC indices allows us suggesting that pregnant women were in the transition period between iron deficiency and iron deficiency anemia or under newly installed anemia process.

Conclusion

In conclusion, the results found in this study show that there is a high frequency of mild anemia in pregnant women and in newborns, and that the maternal nutritional status is not associated with the development of anemia in both mother and child at birth.

Anemia due to iron deficiency is still a public health problem in Brazil, and it is important emphasize the importance of the nutritional pre natal assistance to control this and other nutritional deficiencies.

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