National Journal of Physiology, Pharmacy and Pharmacology

RESEARCH ARTICLE

Maternal anemia in various trimesters of singleton pregnancies and its correlation with birth weight: An observational study

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Received: June 03, 2022; **Accepted:** July 15, 2022

ABSTRACT

Background: Anemia is a very important preventable nutritional disorder affecting pregnant ladies which may have some adverse effects on the neonatal survival and development. Birth weight was correlated with changes in maternal hemoglobin concentration in various trimesters as it is important for determining child survival and development. **Aims and Objectives:** The aim of the study was to assess the correlation between maternal hemoglobin levels in various trimesters and neonatal birth weight. **Materials and Methods:** The study enrolled all pregnant women within age group 15–35 years who gave birth at Agartala Government Medical College and GBP Hospital from June 15, 2017 to August 15, 2017. Pregnant women were included into the study following delivery by simple random sampling into cases (Pregnant women who delivered low birth weight babies <2500 g) and control group (Pregnant women who delivered normal birth weight babies ≥2500 g). Antenatal data were collected from hospital case sheet and labor room register. Data were analyzed using descriptive statistics and presented as Mean + SD. $P < 0.05$ ($P < 0.05$) was considered statistically significant. **Results:** Mean hemoglobin concentration was normal (>11 g/dl) in all three trimesters among the controls but it is found to be <11 g/dl in second and third trimesters of the case group. The mean birth weight of the babies was 2.151(± 0.2386) kg in case group and 3.047(± 0.3666) kg in control group. **Conclusions:** It was found that maternal hemoglobin concentration has a positive correlation ($r > 0$) with neonatal birth weight in all three trimesters in both cases and controls which is statistically significant ($P < 0.05$).

KEY WORDS: Anemia; Singleton Pregnancy; Birth Weight; Maternal Hemoglobin; Trimester

INTRODUCTION

According to the WHO, the prevalence of anemia in pregnant women is 14% and 51% in developed and developing countries, respectively. It is approximately 65–75% in India.[1] If the daily need for iron is considered, then ≈0.8 mg Fe is required in the first trimester, between 4 and 5 mg in the second trimester, and >6 mg in the third trimester. Hence, there is an increased chance of anemia during pregnancy if the body does not have enough iron to produce adequate amount of hemoglobin as iron status is one of the most important biological determinant of hemoglobin (Hb) concentration.

Access this article online	
Website: www.njppp.com	Quick Response code
DOI: 10.5455/njppp.2023.13.06259202215072022	

Low birth weight rate in India is nearly 21.5% and in Tripura 27.3%.[2] In India, of all infants who died in postnatal period, 48.1% suffered from LBW and premature delivery.[3] Pregnancy is associated with a greater increase in plasma volume and as compared to increase in total red cell volume causing a physiological hemodilution resulting in reduced hemoglobin concentration that anemia may be suspected.[1]

Some epidemiological studies have found that high maternal Hb% is responsible for an increased risk of poor pregnancy outcomes. Very high Hb% leads to high blood viscosity, which may compromise O_2 delivery to tissues.[4] This has several adverse effects on the uteroplacental circulation, causing placental infarction, LBW babies, IUGR, and fetal death.[5] However, some studies have concluded that maternal anemia is associated with IUGR and increased risk of preterm births and LBW. This, in turn, is associated with higher perinatal morbidity and mortality and higher infant mortality rate.[6] We, therefore, found it worthwhile to compare the neonatal body weight with changes in maternal hemoglobin concentration as child survival and development depends on the birth weight of the infant. Apart from this, we also designed this study that will look into the timing of Hb% estimation in different trimesters of pregnant women and its correlation with their pregnancy outcome. If positive correlation is indeed detected, then timely intervention with iron supplements can bring down the percentage of low birth weight in this part of the country.

MATERIALS AND METHODS

Study Design

This is a retrospective and observational study. Pregnant women were recruited when they came for delivery at the institution.

Study Setting

The study was conducted at Agartala Government Medical College and GBP Hospital, Agartala, Tripura from June 15, 2017 to August 15, 2017. The Institutional ethical committee approval was obtained before commencement of the study. The data were extracted from the antenatal record sheets of patients and labor room record register of Obstetrics and Gynaecology Department. Maternal demographic data were collected including maternal age, gravida, gestational age at first ANC, and hemoglobin level recorded at different trimesters.

Sample Size

The proportion of LBW in Tripura was considered to be 27.3% according to NFHS-III.(National Family Health Survey III).[2] The minimum sample size required for this study was determined to be 262 at 95% confidence interval and 20% relative error, Following the formula, $n= (Z\alpha/2/L)^2 \times pq$

Where, $Z\alpha/2 = 1.96$
P = prevalence of low birth weight = 27.3%
Q = 100–p = 72.7%
L = margin of error = 20%

Therefore, sample size (n) was found out to be 262.

Inclusion Criteria

The following criteria were included in the study:
1. All pregnant women within 15–35 years of age
2. Singleton pregnancies
3. Delivery of the baby by any mode
4. Patients having hemoglobin records in each of the three trimesters were included in this study.

Exclusion Criteria

The following criteria were excluded from the study:
1. Elderly Primigravida
2. Pregnancy induced hypertension
3. Gestational diabetes mellitus
4. Placenta praevia
5. Abruptio placenta
6. Maternal medical complaints
7. Multiple pregnancies.

Choice of Subjects and Controls

a. Group A (Cases): Pregnant women who delivered low birth weight babies (< 2500 g)
b. Group B (Control): Pregnant women who delivered normal birth weight babies (≥ 2500 g).

Sampling

This study was done over a period of 2 months as per requirements of short-term studentship of ICMR. The study enrolled all pregnant women within age group 15–35 years who gave birth at Agartala Government Medical College and GBP Hospital from June 15, 2017 to August 15, 2017. Pregnant mothers who came to the hospital for delivery were recruited provisionally into the study by simple random sampling. After obtaining consent, they were initially interviewed and their antenatal records were checked for each trimester. If a pregnant woman was having more than one antenatal visit in a particular trimester, the last recorded hemoglobin level of that trimester was taken in the study. If a pregnant woman met any one of the exclusion criteria, she was excluded from this study. A Hb% < 11% g in pregnancy was considered anemia according to the WHO.[1]

Statistical Analysis

Statistical analysis was done using SPSS Data Analysis with Comprehensive Statistics Computer Software (SPSS version 17 for Microsoft Windows, SPSS Inc, Chicago, USA). Data were analyzed using descriptive statistics and presented as mean + SD. $P < 0.05$($P < 0.05$) was considered statistically significant.

RESULTS

The mean age of the pregnant women in case group (n = 262) was found to be 23.52(± 4.59) years and in control group

(*n* = 262), it was 23.56 (± 4.66) years. Preterm deliveries (< 37 weeks) were more in case group (55.4%) as compared to control group (44.6%). Mean hemoglobin concentration is normal (> 11 g/dl) in all three trimesters among the controls but it is found to be < 11 g/dl in second and third trimesters of the case group. The mean birth weight of the babies was 2.151(± 0.2386) kg in case group and 3.047 (± 0.3666) kg in control group [Table1].

It is observed that the frequency of anemic mother is more in third trimester as compared to first and second trimester and the severity of anemia increases from early to late trimester in both cases and controls. Anemia was classified as per the WHO (World Health Organization) guiding criteria as mild 10–11% g, moderate 7–9.9% g, and severe below 7% g [Table 2].

It was found that maternal hemoglobin concentration have a positive correlation (r > 0) with neonatal birth weight in all three trimesters in both cases and controls which is statistically significant ($P < 0.05$) [Table 3].

Maternal mean hemoglobin concentration in low birth weight babies was found to be persistently low compared to normal birth weight babies which is statistically significant ($P < 0.05$) [Table 4].

After adjusting for maternal age and period of gestation by multiple linear regression analysis, it was found that only third trimester maternal hemoglobin is directly related to neonatal low birth weight ($P < 0.05$) [Table 5].

Table 1: Demographic profile of the study group

Factors		Case (*n*=262)	Control (*n*=262)
Maternal age (years), Mean (±SD)		23.52(±4.59)	23.56 (±4.66)
Gravida	Primigravida	143 (49%)	149 (51%)
	Multigravida	119 (51.3%)	113 (48.7%)
Gestational Age	Preterm	102 (55.4%)	82 (44.6%)
	Term	160 (47.1%)	180 (52.9%)
Maternal Hb% Mean (±SD)	1st Trimester	11.298 (±1.1487)	12.715 (±0.9293)
	2nd Trimester	10.410 (±1.0883)	11.940 (±0.9622)
	3rd Trimester	9.608 (±1.0958)	11.202 (±1.0746)
Birth weight (kg), Mean (±SD)		2.151 (±0.2386)	3.047 (±0.3666)

Table 2: Classification of anemia in study group

Trimesters	Category	Case (*n*=262)	Controls (*n*=262)
1st Trimester	Normal	130 (49.6%)	251 (95.8%)
	Mild	113 (43.1%)	11 (4.2%)
	Moderate	19 (7.2%)	0
	Severe	0	0
2nd Trimester	Normal	56 (21.3%)	202 (77.1%)
	Mild	117 (44.6%)	56 (21.3%)
	Moderate	89 (33.9%)	4 (1.5%)
	Severe	0	0
3rd Trimester	Normal	28 (10.6%)	147 (56.1%)
	Mild	55 (20.9%)	72 (27.4%)
	Moderate	176 (67.1%)	43 (16.4%)
	Severe	03 (1.1%)	0

Table 3: Relation between hemoglobin and neonatal birth weight

Trimesters	Case (*n*=262)	Control (*n*=262)
1st Trimester	r=0.310	r=0.420
	P=0.000	*P*=0.000
2nd Trimester	r=0.325	r=0.437
	P=0.000	*P*=0.000
3rd Trimester	r=0.347	r=0.437
	P=0.000	*P*=0.000

DISCUSSION

From the present study, we found a positive correlation between maternal hemoglobin concentration and neonatal birth weight in both case and control. More preterm deliveries were seen in low birth weight babies. The mean hemoglobin concentration was low in all three trimesters in low birth weight babies in comparison to babies with normal birth weight. The frequency of anemic mother is more in third trimester and the severity of anemia in pregnant women increases from early to late trimester. Maternal anemia in third trimester is found to be more associated with the risk of low birth weight babies. The possible explanation regarding low birth weight in anemic mother is mostly due to iron deficiency. Iron deficiency anemia results in impaired transport of oxygen by hemoglobin to uterus, placenta, and fetus. It also causes dysfunction of the tissue enzymes. This mechanism causing impaired myometrial contractility results in atonic uterus as well as placental dysfunction causing various complications such as preterm birth, low birth weight babies, growth restricted babies, and perinatal deaths.[7] Moreover, maternal anemia influences placental vascularization by altering angiogenesis, decreased oxygen supply in latter part of pregnancy may affect the growth.[8] In severely anemic mother, there is increased level of stress hormones, nor epinephrine or cortisol leading to low birth weight neonates.[8] In addition to the common deficiencies of iron and folate, there are various factors essential for erythropoiesis which includes proteins (erythropoietin), minerals (iron), trace elements (zinc, cobalt, and copper) vitamins (folic acid, Vitamin B12, Vitamin C), and hormones (androgens and thyroxine) which were also implicated as major cause of nutritional anemia in pregnancy.[1]

Table 4: Mean Hb content during the three trimesters of pregnancy

Trimesters	Hb% in cases, Mean(±SD)	Hb% in Control, Mean (±SD)	Significance
1st Trimester	11.298 (±1.1487)	2.715 (±0.9293)	*P* = 0.000
2nd Trimester	10.410 (±1.0883)	11.940 (±0.9622)	*P* = 0.000
3rd Trimester	9.608 (±1.0958)	11.202 (±1.0746)	*P* = 0.000

Table 5: Hemoglobin adjustment to maternal age and period of gestation

Trimesters	Case (*n*=262)	Control (*n*=262)
1st Trimester	*P*=0.081	*P*=0.440
2nd Trimester	*P*=0.169	*P*=0.549
3rd Trimester	*P*=0.012(*P*<0.05)	*P*=0.357

Kalaivani associated maternal anemia with poor intrauterine growth, increased risk of preterm delivery and low birth weight rates in their study. Our study shows more number of preterm deliveries in low birth weight babies.[6] Koller *et al.* concluded that high maternal Hb% during pregnancy may increase risk of fetus and the uteroplacental circulation may be impeded by the high viscosity of the mothers blood thus causing placental infarction and growth retardation. Our study, however, did not show significant rise in hemoglobin level during pregnancy.[5] Bedi *et al.* conducted a hospital-based cross-sectional study. High magnitude of anemia was found in third trimester of pregnancy. The number of low birth weight babies was significantly more in babies born to anemic mothers as compared to non-anemic mothers which has a similarity to our study where we found increased severity of anemia in third trimester.[9] The results in our study are in accordance with the conclusions of the study by Jagadish *et al.* who observed that incidence of low birth weight babies was significantly more in mothers who were anemic in their third trimester.[10] The conclusions drawn by Yildiz *et al.* that low hemoglobin values at third trimester gestation were associated with low birth weight have a similarity to our study.[11] The findings in all these studies point out to a single fact that third trimester Hb% is an important factor in determining birth weight of the newborn. Final development and maturation of the fetus occur during third trimester. As a result, iron (>7.5 mg/day)[12] and other micronutrients required for the growth and development of fetus is highest in the third trimester as well. Bakacak *et al.* found a positive correlation only between fetal weight and increased first trimester maternal hemoglobin concentration. No association was found between fetal weights and second and third trimester hemoglobin concentration which is in contrast to our study.[13] Rao *et al.* observed that high prevalence of anemia in first trimester pregnant women whereas mean hemoglobin concentration in first trimester of both case and control was normal in our study.[1] Srinivas *et al.* conducted a retrospective study "The relationship between Maternal Anemia and Birth weight in New Born" in 2014 and concluded that no correlation was found between maternal anemia and low birth weight. He also concluded that a higher rate of operative delivery was observed in the anemic pregnant women.[14] However, no additional information regarding the possible mechanism for association was provided in the study. Further intensive research which could explain such an association between maternal Hb% versus uterine dynamics or other fetoplacental complex relations should be undertaken to completely comprehend the underlying mechanisms.

Limitations of the Study

1) Small sample Size
2) Short duration of the study.

Strength of the Study

Good compliance of the subjects in the study.

CONCLUSIONS

Maternal hemoglobin has a positive correlation (r > 0) with neonatal birth weight throughout the pregnancy. Hemoglobin level in mothers of low birth weight babies is persistently low compared to mothers having normal birth weight babies. Severity of anemia increases from early to late trimester. Third trimester maternal hemoglobin has got much impact on neonatal low birth weight. Although much focus is given on iron and folic acid supplementation to correct anemia in pregnancy, improving the dietary habits and improving the bioavailability of food rich in iron should be advocated. Repeated and closely spaced pregnancies should be avoided. Tests for detection of anemia during pregnancy and effective treatment for anemia should be made available to the pregnant mothers as early as possible during pregnancy. Encouraging pregnant women to have regular antenatal checkups should be done. However, most importantly, all women should be aware of the consequences related to anemia in pregnancy and this would be possible by spreading education among women. We found anemia in third trimester to be correlated with neonatal low birth weight that is an important public health problem. There should be proper instructions in health-care set up regarding adequate management of anemia during third trimester including diet and supplementary medicines. Proper orientation and training program for ASHA workers and community health guides should be undertaken at the sub-center level to spread awareness among masses.

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How to cite this article: Das D, Das RR, Singnarpi E, Dutta S. Maternal anemia in various trimesters of singleton pregnancies and its correlation with birth weight: An observational study. Natl J Physiol Pharm Pharmacol 2023;13(03):520-524.

Source of Support: Nil, **Conflicts of Interest:** None declared.