

## Impact of maternal anaemia in different trimesters on newborn weight: A hospital-based observational study

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**Abstract:** Anaemia is an extremely significant nutritional disorder throughout the world. Anemia in pregnancy is widely reported in India. The majority of the studies have highlighted a poor pregnancy result linked to anaemia. Other than that, the timing of the haemoglobin taken into consideration for analysis lacked consistency. As a result, we designed this hospital-based observational research to investigate these factors. **Methods:** The study was carried out at Maharaja Krushna Chandra Gajapati Medical College and Hospital Brahmapur, Ganjam, Odisha where 1000 pregnant women were selected, and their haemoglobin levels were assessed. It was observed in their antenatal record that the haemoglobin levels in earlier trimesters. We monitored these mothers till the babies were born and assessed the gestation and birth weight of the infants. For the baseline characteristics, descriptive statistics were employed. **Results:** In our study, 56.4% of mothers were anaemic. The second trimester showed a higher percentage of anaemia, while the third trimester showed the lowest percentage. Through all three trimesters, 394 (39.4%) mothers remained anaemic. The second trimester showed a higher percentage of anaemia (65.4%), while the third trimester showed the lowest rate (44.8%). Only 23 mothers were classified as having severe anaemia (Haemoglobin less than 7 gm/dl), out of which 15 were in 1<sup>st</sup> trimester, 6 were in 2<sup>nd</sup> trimester and only 2 were in the 3<sup>rd</sup> trimester. **Conclusions:** Mothers who were anaemic in the third trimester had a considerably higher prevalence of low birth weight infants. Mothers who were anaemic in their second and third trimesters had a higher rate of preterm births. In our investigation, higher haemoglobin levels had no impact on either birth weight or gestation.

**Keywords:** Anaemia, Birth Weight, Gestation Age, Haemoglobin, pregnancy.

### INTRODUCTION

Anaemia is a significant nutritional disorder in the world. India has a large portion of the population suffering from anaemia. India has reported a high prevalence of anaemia in pregnancy. In one of the studies conducted on a large population, it was estimated that 87% of Indian pregnant women are anaemic. This number is the highest among neighbouring Southeast Asian countries <sup>1</sup>. Interestingly, anaemia in

pregnant women has multiple implications for pregnancy and fetal growth. It is well-established that there is a physiological drop in haemoglobin (Hb) in the mid-trimester. This physiological drop is attributed to the increase in plasma volume and, thus, the decrease in blood viscosity. This helps improve blood flow to the placenta. The nadir of this drop is variable, and there was a need for criteria to define anaemia in pregnancy. The World Health Organisation has defined a Haemoglobin level of less than 110 g/l as anaemia in pregnant mothers <sup>2</sup>.

Previously, anaemia in pregnant women was considered detrimental to fetal growth and pregnancy outcome. Low birth weight and preterm birth have been consistently associated with anaemia in pregnancies <sup>1-4</sup>. The role of anaemia in pregnancy and iron on the developing fetus has been studied over the last several decades. The outcome of these studies is either inconclusive or, at most supports the widely held beliefs that have been born about pregnancy outcomes and anaemia <sup>2-6</sup>. Therefore, most countries have supplemented pregnant women with iron and folic acid because of the beneficial effects of increasing Hb levels <sup>1</sup>.

In the modern era of research methodology, researchers have tried to reconsider this basic idea of increasing Hb in pregnancy with iron supplementation in order to achieve a better pregnancy outcome. Several randomized controlled trials (RCTs) and meta-analyses have shown that routine iron supplementation does not do much <sup>7,8</sup>. Few studies have also demonstrated that increasing Hb beyond a certain level could have negative consequences <sup>9-19</sup>. This has prompted clinicians and researchers to search for the optimal Hb level to produce the best outcome. Although there are defined criteria for anaemia in pregnancy, it is still unclear which trimester Hb should be taken as the assessment standard. Previous studies have not examined this aspect in detail. Fetal growth occurs in different phases; most problems related to micronutrients appear in the third trimester. Therefore, examining the impact of anemia in different trimesters on the fetal outcome would be more meaningful. We aimed to compare the pregnancy and birth weight of babies born to mothers with and without anaemia in different trimesters.

## MATERIAL AND METHOD

This was a hospital-based observational study. The study was carried out at Maharaja Krushna Chandra Gajapati Medical College and Hospital Brahmapur, Ganjam, Odisha. The mothers were recruited as they arrived to give birth. The required information was obtained from interviews and prenatal records. After the birth of the baby, the remaining data were collected. The sample size was calculated based on the following formula –

$$\text{Sample size } n = \frac{[DEFF * Np(1-p)]}{[(d^2/Z^2_{1-\alpha/2} * (N-1) + p * (1-p))]}$$

The validity of the study was assumed to be 80%. The design effect was considered 2, as in anaemia surveys. The required sample size was 960 after adding to the 20% non-response rate. The sample size was rounded off to 1000. We have included all the pregnant women who came to the hospital to give birth.

Pregnant women with any of the following characteristics at the time of booking were excluded: Diabetes mellitus, Hypertension, chronic kidney disease, heart problems, Toxoplasmosis, rubella, cytomegalovirus, herpes infection, Haemoglobinopathies (including thalassemia), Multiple gestation. After obtaining written informed consent, pregnant mothers were enrolled in the study. The details of the study were explained to the pregnant mothers. They were first interviewed and their prenatal record was reviewed. If they met any of the exclusion criteria, they were excluded. The Hb measurement was carried

out using the cyanmethemoglobin method (Analyzer-Coulter). The measure was taken in all three trimesters when they came for the antenatal check-up. The rest of the management conformed to the standards practised in prenatal care. Birth weights were measured in kilograms using a digital scale. A pregnancy assessment was performed using the first-trimester dating scan. Obstetric and postnatal checks supplemented this by modified Ballard scoring. Statistical analysis was performed using Microsoft Excel.

## RESULT

In our study, 56.4% of mothers were anaemic. The second trimester showed a higher percentage of anaemia, while the third trimester showed the lowest percentage. Through all three trimesters, 394 (39.4%) mothers remained anaemic. The second trimester showed a higher percentage of anaemia (65.4%), while the third trimester showed the lowest rate (44.8%). Of the study participants, 28.3% (283) were non-anaemic throughout the study period. Only 23 mothers were classified as having severe anaemia (Haemoglobin less than 7 gm/dl), out of which 15 were in 1<sup>st</sup> trimester, 6 were in 2<sup>nd</sup> trimester and only 2 were in the 3<sup>rd</sup> trimester. The results are provided in table 1, which shows the number of anaemic mothers and their haemoglobin in three trimesters.

**Table 1 Number of anaemic mothers and mean haemoglobin**

Mean Haemoglobin	10.4 gm/dl
Mean Birth weight (Kg)	2.84 Kg
Mean Gestation	37.9 weeks
Anaemic mothers 1st Trimester	564 (56.4%)
Mean Hb of anaemic mothers 1st Trimester	9.34 gm /dl
Anaemic mothers 2nd Trimester	654 (65.4%)
Mean Hb of anaemic mothers 2nd Trimester	9.73 gm/dl
Anaemic mothers 3rd Trimester	448 (44.8%)
Mean Hb of anaemic mothers 3rd Trimester	10.04 gm/dl
Number of mothers remained anaemic (throughout)	404 (40.4%)
Number of mothers remained non-anaemic (throughout)	283 (28.3%)
Severe anaemia (<7 gm/dl)	23

Mother's haemoglobin levels improved over the subsequent two trimesters after being anaemic in the first trimester. In comparison to the anaemia group, the mean Hb in the group with no anaemia remained high

during all three trimesters. The mothers who were not anaemic experienced a mid-trimester decline. In all three trimesters, Haemoglobin levels in anaemic mothers generally increased. As the pregnancy continued, there was less of a difference in the mean Hb values in the two groups.

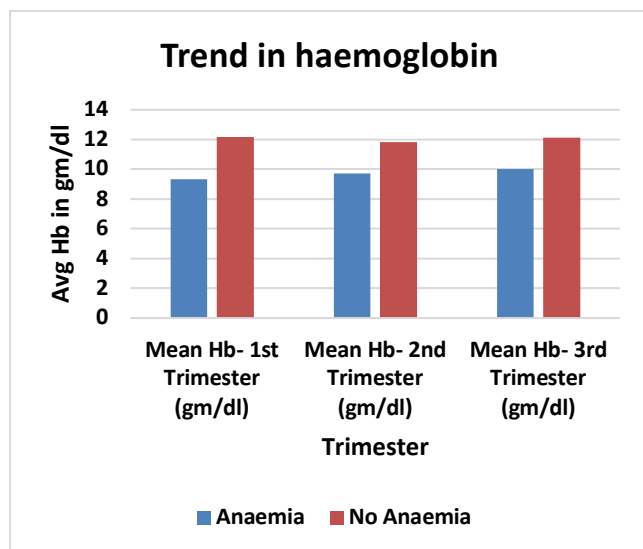


Figure 1 Trend in haemoglobin over three trimesters

Regardless of trimester, the babies' mean birth weight and gestation fell within the clinical normal range in both anaemic and nonanaemic women groups. Compared to their other group, babies delivered to anaemic moms remained lighter. The difference became more pronounced when babies of anaemic moms were compared to babies of nonanaemic mothers. The mean birth weight of babies in both groups is provided in table-2.

Table 2 Mean birth weight and gestation at various trimesters		
Parameter	Anaemia	No Anaemia
Mean Hb- 1st Trimester (gm/dl)	9.34	12.16
Mean Hb- 2nd Trimester (gm/dl)	9.73	11.81
Mean Hb- 3rd Trimester (gm/dl)	10.04	12.15
Mean birth weight (All trimesters, Kg)	2.81	3.01
Mean birth weight in 1st trimester (Kg)	2.84	2.96
Mean birth weight in 2nd trimester (Kg)	2.82	2.98
Mean birth weight in 3rd trimester (Kg)	2.81	2.97
Mean Gestation in 1st trimester (Weeks)	37.8	38.1
Mean Gestation in 2nd trimester (Weeks)	37.8	38.2

Mean Gestation in 3rd trimester (Weeks)	37.6	38.3
Mean Gestation in all trimesters (Weeks)	37.7	38.2

The mean gestation of babies born to anaemic mothers was shorter than newborns born to nonanaemic mothers. In the third trimester, this distinction was very noticeable. The difference persisted even when the all-trimester anaemia group was contrasted with the all-trimester no anaemia group.

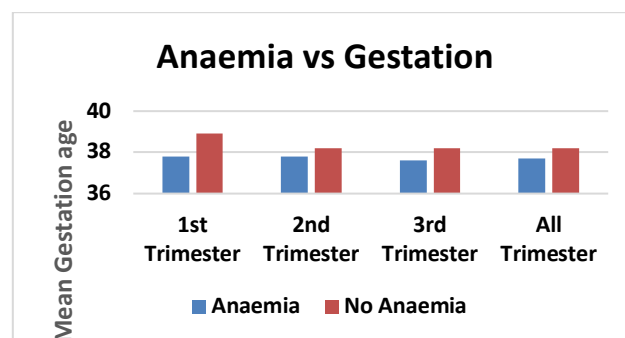


Figure 2 The average gestation trends in two groups at different trimesters

In mothers with anaemia, the percentage of underweight babies was slightly higher. With the exception of third-trimester anaemia, the difference was not particularly noteworthy. The difference favouring the no anaemia group in the current study was 6.42 percent. The overall difference between two groups was 4.02%. [Table 3].

Table-3 Low birth weight babies between anaemic and non anaemic groups.			
LBW	Anaemia (%)	No anaemia (%)	Difference
First trimester	10.58	10.71	0.12%
Second trimester	11.57	9.01	2.56%
Third trimester	14.28	7.86	6.42%
All trimester	13.41	9.37	4.02%

Except in the first trimester, anaemic mothers had a considerably higher frequency of preterm births than nonanaemic mothers. Overall, there was a difference of more than 8%, with the third trimester showing the greatest variation of 11.53%. The variation was lowest in 1<sup>st</sup> trimesters of 1.66%. The details of the difference is provided in table 4.

Table-4 Preterm deliveries difference between anaemic and non-anaemic groups			
Preterm	Anaemia (%)	No anaemia (%)	Difference
First trimester	19.86	18.32	1.54

Second trimester	21.54	16.08	5.46
Third trimester	26.08	14.39	11.69
All trimester	24.18	15.38	8.8

High Hb (for both >12.5 gm/dl) had no negative effects on the result in terms of mean birth weight and mean gestation. As fewer mothers in these groups, their numbers could not be compared to those in the anaemia group. Overall mean birth weight and mean gestation

was higher in the mother's group where the haemoglobin was high (More than 12.5 gm/dl). Table no. 5 provides the details of the comparison between both the groups.

## DISCUSSION

Anaemia is fairly common among pregnant women <sup>1,2</sup>. According to our study, more than 50% of the mothers had anaemia, to begin with; other research studies have also found similar findings <sup>1,20</sup>. The Hb level trend is highly intriguing.

**Table 5 Comparison between mean birth weight and gestation age in high haemoglobin and anaemic mothers**

	Hb gm/dl	Count (n)	Mean Birth weight (Kg)	Mean Gestation (Weeks)	Hb gm/dl	Count (n)	Mean Birth weight (Kg)	Mean Gestation (Weeks)
1st Trimester	>12.5	28	3.24	38.9	<11	564	2.84	37.8
2nd Trimester	>12.5	49	3.19	38.2	<11	654	2.82	37.8
3rd Trimester	>12.5	168	3.14	38.2	<11	448	2.81	37.6

Anaemic mothers did not experience the mid-trimester decline that non-anaemic mothers did. This implies that a necessary physiological arrangement is a decrease in haemoglobin during the middle of the third trimester. As opposed to non-anaemic mothers, whose mean haemoglobin was higher in the middle of the third trimester, no decreased values were observed in anaemic mothers. This shows that the haemoglobin may need to fall within a specific range in order to provide a positive outcome. The range is between 10.4 and 12.2 g/dl. The two groups' mean birth weights and gestations were compared, and it became clear that the anaemic group had lower values for both than the nonanaemic group. Given that both groups' average birth weight and gestation are well within the safe normal clinical range, the modest difference between the two groups remains solely of statistical interest. This difference's clinical implications are rarely significant.

According to Swain et al., the second-trimester haemoglobin and birth weight have an antagonistic relationship <sup>16</sup>. Our research study of qualitative characteristics produced several remarkable, therapeutically applicable findings. There was no statistical significance in the first two trimesters, and the incidence of low birth weight infants in the two groups remained about identical. The difference became noticeable when the mothers were anaemic in the third trimester. Research shows that maternal anaemia and low birth weight are significantly associated <sup>3,5,21-23</sup>. Retrospective research has found no link between anaemia in the first trimester and low birth weight <sup>24</sup>. The Hb levels at delivery or during the third trimester were

compared in the majority of these investigations <sup>3,5,21-23</sup>. This may indicate that Hb during the third trimester plays a significant role in determining birth weight. It is common knowledge that the third trimester is a time of high foetal growth. The same trimester also has the highest iron and other micronutrient accretion rates.

This physiology explains the connection between third trimester haemoglobin and low birth weight. In contrast to those mentioned above, the link between maternal anaemia and premature delivery is fairly strong. With the exception of the first trimester, anaemia has been associated with significantly higher premature birth rates. The third trimester is when this link seems to be strongest. Numerous research have found a similar correlation <sup>3,5,22,25</sup>. Such a relationship has only been reported in the study by Kumar et al. and Monika et al. when women had severe anaemia, or Haemoglobin less than 7.0 g/dl <sup>26,27</sup>. Similar to our study findings, another retrospective study found no association between first trimester anaemia and premature delivery of babies <sup>24</sup>. In contrast to our results, a study from China found a reverse trend in the association between anaemia in all three trimesters and premature delivery of babies <sup>28</sup>. The authors found first-trimester anaemia and third-trimester anaemia to be strongly correlated. Other studies also found comparable patterns similar to our study <sup>16,29</sup>. Further intense research is needed to determine whether maternal haemoglobin versus uterine dynamics or other feto-placental complex interactions can account for such a link.

One of the study found association between low birth weight and high hemoglobin levels <sup>30</sup>. Our study's sample size was insufficient to allow for the drawing of



relevant findings. High haemoglobin in the third trimester does not appear to increase the number of low birth weight infants. In their analysis of roughly 100 patients, Rusia et al. reached similar conclusions<sup>3</sup>. One study from Nepal with 1400 study participants reported no correlation between high hematocrit and either low birth weight or preterm births<sup>6</sup>. Maintaining appropriate Haemoglobin levels throughout the pregnancy would appear to produce the greatest neonatal results in terms of preterm and low birth weight.

## CONCLUSIONS

Anaemia during pregnancy is clearly associated with foetal outcome after pregnancy. If the mother is anaemic solely during the third trimester, there is a higher likelihood of low birth weight kids. If a mother is anaemic in her second and third trimesters, the likelihood of preterm births increases. Early iron supplementation and appropriate Hb (10–12 g/dl) during gestation have superior overall results in terms of preterm births and low birth weight infants. This raises the issue of whether the policy of providing women with iron supplements needs to be reviewed. We believe that a policy of earlier iron supplementation in the second and third trimesters needs to be taken into consideration in light of the aforesaid results

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