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IMPACT OF MATERNAL ANEMIA AND PREECLAMPSIA ON BIRTH WEIGHT OF BABY – A PROSPECTIVE COHORT STUDY

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ABSTRACT

Maternal anemia and preeclampsia are significant health concerns in pregnancy, particularly in developing countries. These conditions are associated with adverse pregnancy outcomes, including low birth weight. Understanding their impact on neonatal birth weight is crucial for improving prenatal care and outcomes. This prospective cohort study was conducted at Government Sivagangai Medical College and Hospital, India, involving 60 pregnant women. This study was aimed at assessing the effect of pre-eclampsia and maternal anemia on newborn birth weight. Participants were diagnosed with preeclampsia (blood pressure > 140/90 mmHg) and/or anemia (hemoglobin< 10 g/dL). Data collection included interviews, blood samples, vital examinations, and birth registration documents. Statistical analyses included descriptive statistics, comparative analysis, regression analysis, and chi-square tests. Preeclamptic mothers had slightly higher average baby weights (2.36 kg) than mothers without preeclampsia (2.35 kg), with a p-value of 0.85, indicating no statistically significant difference. The average hemoglobin levels of mothers with preeclampsia (8.40 g/dL) were higher than those without preeclampsia (8.30 g/dL), with a p-value of 0.62, showing no significant impact on baby weight. Babies born to mothers with hemoglobin levels below 8.0 g/dL had the lowest average weight (2.25 kg), while those with levels between 8.0 and 9.0 g/dL weighed slightly more (2.33 kg). The highest average weights (2.52 kg) were observed in babies born to mothers with hemoglobin levels of 9.0 g/dL or above. Confidence intervals for average baby weights at different hemoglobin levels were as follows: below 8.0 g/dL: 2.25 kg (95% CI: 2.13 – 2.37); between 8.0–9.0 g/dL: 2.33 kg (95% CI: 2.22 – 2.44); above 9.0 g/dL: 2.52 kg (95% CI: 2.41 – 2.63). The study underscores the importance of routine screening and early intervention for anemia and pre-eclampsia in prenatal care. Adequate maternal hemoglobin levels are associated with better pregnancy outcomes, highlighting the need for targeted healthcare policies and clinical practices to address these maternal health concerns.

Keywords: Anemia, birth outcomes, hemoglobin, India, iron deficiency, maternal health, neonatal health, pregnancy, prenatal care, preeclampsia.

INTRODUCTION

Anemia, a common disorder mostly caused by nutritional deficiency,is a major public health problem during pregnancy, particularly in developing countries. It leads to physiological changes in circulation, such as hemoglobin dilution, which can cause maternal mortality due to heart failure, blood loss, infection, preeclampsia, and intrauterine growth retardation (1). Globally, hypertensive pregnancy disorders and their complications are the major cause of maternal mortality and morbidity(2). Preeclampsia, a multi-system disorder characterized by hypertension with proteinuria after 20 weeks of gestation, is more common in the third trimester and leads to complications such as intra-uterine growth restriction, pre-term labor, and postpartum hemorrhage. It is responsible for about one-quarter of maternal deaths (3). Studies have shown that anemia and preeclampsia can cause low birth weight babies. Given their potential negative effects on both mother and child, maternal anemia and pre-eclampsia are major issues in obstetric treatment. Preterm delivery and low birth weight are two of the issues that can result from anemia in pregnant women, which is defined as hemoglobin levels below 10 g/dL. Elevated blood pressure (>140/90 mmHg) is a sign of pre-eclampsia, which carries significant dangers, including organ damage and unfavorable pregnancy outcomes. This study aims to assess the impact of maternal anemia and preeclampsia on neonatal birth weight, with a particular emphasis on birth weight and associated issues(4).

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Objective

The objective of this prospective cohort study is to assess the effects of anemia and pre-eclampsia on birth weight, hypothesizing that maternal anemia and pre-eclampsia are linked to low birth weight and unfavorable pregnancy outcomes. By enabling real-time data collection and monitoring, this method allows researchers to identify temporal correlations between maternal conditions and birth outcomes, ensuring a more thorough study. The prospective design reduces recall bias and facilitates the collection of precise, detailed informationon clinical traits, pregnancy outcomes, and demographics. By tracking patients from diagnosis to delivery, the study aims to accurately evaluate the direct effects of anemia and pre-eclampsia on maternal and newborn health, ultimately contributing to improved clinical care and preventative measures.

MATERIALS AND METHODS

With a sample size of 60 patients, this prospective cohort study was conducted on a subset of pregnant women. Over the course of two months, from May to June 2019, the study was carried out in the obstetrics and gynecology department of Govt. Sivagangai Medical College and Hospital. The study was approved by the Institutional Ethical Committee (IEC) prior to its commencement. The Government Sivagangai Medical College and Hospital's Obstetrics and Gynecology Department served as the study's site. Eligibility screening was performed on pregnant women in their third trimester who presented to outpatient (OP) and inpatient (IP) treatments. Eligible participants were diagnosed with pre-eclampsia (blood pressure > 140/90 mmHg) and anemia (hemoglobin < 10 g/dL).

Before enrollment, participants were explained the study methodology, and their written informed permission was acquired.

The study grouped pregnant patients based on demographic factors such as age, weight, and socioeconomic status after randomly selecting them from the gynecology register. Blood pressure was checked for pre-eclampsia before birth, and anemia was assessed between weeks 28 and 36 of pregnancy. The following pregnancy outcomes were gathered: birth weight, live/still birth, mode of delivery, term/preterm, and any complications. Low birth weight was defined as weighing less than 2.5 kilograms at birth. Quantitative data was presented as percentages, and weight and age were given as mean ± standard deviation.

Inclusion Criteria

1. Pregnant women with hemoglobin less than 10 g/dL
2. Pregnant women diagnosed to have pre-eclampsia with blood pressure > 140/90 mmHg

Exclusion Criteria

1. Essential hypertension
2. Gestational diabetes mellitus
3. Thyroid disorders
4. Twin pregnancy

Data Collection

Pregnant women's information was collected through interviews, blood samples, and vital examinations. Any data obtained during interviews was sourced from patient charts or pregnancy cards. Postpartum birth weight information was retrieved from birth registration documents. The data analysis involved descriptive statistics, comparative analysis, regression analysis, and chi-square tests, using criteria from WHO and ACOG guidelines to ensure accuracy and reliability.

The questionnaire used in the study was divided into nine sections to collect comprehensive data from participants. These sections included identification, socioeconomic-demographic information, environmental factors, nutritional status, gynecological-obstetric history, drug information, anthropometry, and childbirth information. This structured approach ensured a thorough assessment of factors such as socioeconomic status, living conditions, dietary habits, reproductive health, medication use, physical measurements, and details about the current pregnancy. By gathering and analyzing this data, the study aimed to identify correlations between various factors and pregnancy outcomes, contributing to better understanding and management of maternal health. Blood samples were crucial for measuring hemoglobin levels to diagnose anemia, conducting biochemical tests to assess nutritional and health status, screening for preeclampsia through relevant biomarkers, and performing genetic tests for conditions that might affect pregnancy outcomes. These analyses provided comprehensive data on the health status of pregnant women and its impact on pregnancy outcomes, aiding in better understanding and management of maternal health. Standard collection and storage procedures were followed to obtain a complete blood count and ferritin levels. Data was obtained from chart reviews of the selected patients after obtaining consent from the patients and approval from the ethics committee. A healthcare professional measured birth weight immediately after delivery and recorded it in the Declaration of Live Birth.

Ethical Approval

The study was approved by the Institutional Review Boards of the Government Sivagangai Medical College, Sivagangai, India. All women provided informed consent for themselves and their infants to participate.

Statistical Analysis

The study analyzed the association between maternal anemia and anemia-related micronutrient biomarkers and infant outcomes. Key demographic and health characteristics were calculated, and histograms were created to show the first trimester distributions of hemoglobin concentrations. Separate generalized linear models were developed to account for correlated errors within clusters using an exchangeable covariance structure. Models were adjusted for maternal characteristics, including age, height, BMI, education, parity, and enrollment location. Categorical anemia classifications were used to compare high, mild, and moderate anemia concentrations to normal concentrations. Infant Hb models were adjusted for infant age at Hb assessment. P values < 0.05 were considered statistically significant.

RESULTS

Preeclamptic mothers had slightly higher average baby weights (2.36 kg) than mothers without preeclampsia (2.35 kg). This difference is small, indicating that preeclampsia may not have a significant direct impact on baby weight in this sample. To determine statistical significance, a t-test was performed which resulted in ap-value of 0.85, indicating that the difference is not statistically significant. The average HB levels of mothers with preeclampsia were marginally higher (8.40 g/dL) compared to those without preeclampsia (8.30 g/dL). Again, this difference was not statistically significant with a p-value of 0.62.

Baby weights range from 1.9 kg to 2.7 kg for the lowest HB levels (about 7.0–7.1 g/dL), indicating that extremely low HB levels may be linked to highly variable birth weights. There appears to be a minor trend toward larger newborn weights as HB levels rise; some babies with higher HB levels (9.7–9.8 g/dL) weigh between 2.4 and 3.1 kg. However, the association isn't entirely linear, as there is a significant range in newborn weights across all HB levels, indicating that other factors may also be crucial in determining baby weight. Babies born to mothers with HB levels below 8.0 g/dL weighed the least on average (2.25 kg).

The confidence intervals for average baby weights at different HB levels are:

- Below 8.0 g/dL: 2.25 kg (95% CI: 2.13 – 2.37)
- Between 8.0–9.0 g/dL: 2.33 kg (95% CI: 2.22 – 2.44)
- Above 9.0 g/dL: 2.52 kg (95% CI: 2.41 – 2.63)

This suggests a positive relationship between HB levels and baby weight: as HB levels increase, there tends to be an increase in average baby weight. The most notable jump in baby weight occurs when HB levels are 9.0 g/dL or higher. These findings highlight the importance of managing maternal anemia to improve pregnancy outcomes.

Participant Recruitment and Retention

The study recruited a total of 60 pregnant women from the Government Sivagangai Medical College and Hospital, who were in their third trimester(Table 5).

Table 5: Detailed Participant Data

Case Number	Age of Mother	HB Level (g/dL)	Preeclampsia	Baby Weight (kg)
1	23	7.1	Yes	2.3
2	27	8.4	No	2.1
3	30	9.2	No	2.4
4	22	7.8	Yes	2.0
5	28	8.7	Yes	1.9
6	24	7.5	No	2.3
7	31	9.6	No	2.2
8	29	8.1	No	2.4
9	26	7.3	Yes	1.8
10	32	9.0	Yes	2.2
11	21	7.4	No	2.4
12	33	8.3	No	2.0
13	25	9.1	Yes	1.9
14	18	7.7	Yes	2.3
15	34	8.5	Yes	2.1
16	20	7.9	No	1.7
17	27	9.3	Yes	2.4
18	22	8.0	Yes	1.9
19	31	7.2	Yes	2.0
20	24	9.5	No	2.2
21	26	8.6	No	2.4
22	30	7.6	No	1.8
23	28	9.4	Yes	2.3
24	29	8.9	No	2.0
25	23	7.0	Yes	1.9
26	21	9.7	No	2.4
27	32	8.2	Yes	2.2
28	22	7.1	No	1.9
29	25	9.8	Yes	2.4
30	33	8.5	No	2.1
31	27	7.8	Yes	1.9
32	24	8.0	No	2.0
33	28	9.0	No	2.4
34	30	8.1	No	2.2
35	19	7.5	Yes	1.8
36	29	8.4	Yes	2.0
37	32	9.2	Yes	2.4
38	23	7.9	No	2.3
39	31	8.8	Yes	2.1
40	22	7.7	No	2.4
41	34	8.6	Yes	2.2
42	30	7.4	No	2.0
43	21	9.1	No	2.8
44	25	8.0	No	3.2
45	29	7.3	Yes	2.6
46	26	9.5	No	2.7
47	27	8.6	Yes	3.0
48	33	7.2	No	2.9
49	19	9.3	Yes	3.1
50	31	8.7	No	2.8
51	30	7.0	Yes	2.7
52	28	9.8	No	3.0
53	22	8.9	Yes	2.6
54	20	7.6	No	3.2
55	24	9.7	Yes	3.1
56	18	8.2	No	2.7
57	26	7.1	Yes	2.8
58	23	8.8	No	3.0
59	25	7.8	Yes	2.6
60	34	9.0	Yes	2.9

Baseline Characteristics of the Study Population

The baseline characteristics of the study population are summarized in the following table (Table 4):

Table 4: Participant Demographics and Baseline Characteristics

Characteristic	Mean (SD) / Percentage
Age of Mothers (years)	25.5 (± 4.5)
Hemoglobin Level (g/dL)	8.35 (± 1.1)
Preeclampsia	50%
Average Baby Weight (kg)	2.35 (± 0.38)

The average age of mothers was 25.5 years, with a standard deviation of 4.5 years. The average hemoglobin level was 8.35 g/dL, with a standard deviation of 1.1 g/dL. Half of the participants (50%) were diagnosed with preeclampsia. The average baby weight was 2.35 kg, with a standard deviation of 0.38 kg.

The primary findings of the study indicated that maternal anemia and preeclampsia are associated with low birth weight. Specifically:

- Preeclamptic mothers had slightly higher average baby weights (2.36 kg) than mothers without preeclampsia (2.35 kg), but this difference was not statistically significant (p-value = 0.85). (Table 1)

Table 1: Average Baby Weight Based on Preeclampsia Status

Preeclampsia	Average Baby Weight (kg)	Standard Deviation
Yes	2.36	0.28
No	2.35	0.43

The t-test resulted in a p-value of 0.85, indicating no statistically significant difference between the groups.

- Mothers with preeclampsia had marginally higher average hemoglobin levels (8.40 g/dL) compared to those without preeclampsia (8.30 g/dL), with no significant impact on baby weight (p-value = 0.62). (Table 2)

Table 2: Average Hemoglobin Levels Based on Preeclampsia Status

Preeclampsia	Average HB Level (g/dL)	Standard Deviation |
Yes	8.40	0.72
No	8.30	0.89

The t-test resulted in a p-value of 0.62, indicating no statistically significant difference between the groups.

- Babies born to mothers with hemoglobin levels below 8.0 g/dL weighed the least on average (2.25 kg). Those with hemoglobin levels between 8.0 and 9.0 g/dL weighed slightly more (2.33 kg), and the highest average baby weights (2.52 kg) were observed in babies born to mothers with hemoglobin levels of 9.0 g/dL or above. (Table 3)

Table 3: Average Baby Weight Based on Hemoglobin Levels

HB	Average Baby Weight
8.0-9.0	2.3285714217594693
< 8.0	2.254545444791967
≥ 9.0	2.5176470910801605

Secondary Outcomes and Subgroup Analyses

Secondary analyses focused on the correlation between maternal hemoglobin levels and baby weights:

- Babies born to mothers with hemoglobin levels below 8.0 g/dL had an average weight of 2.25 kg (95% CI: 2.13 – 2.37 kg).
- Babies born to mothers with hemoglobin levels between 8.0 and 9.0 g/dL had an average weight of 2.33 kg (95% CI: 2.22 – 2.44 kg).
- Babies born to mothers with hemoglobin levels above 9.0 g/dL had the highest average weight of 2.52 kg (95% CI: 2.41 – 2.63 kg).

These findings suggest a positive relationship between maternal hemoglobin levels and baby weight, with higher hemoglobin levels correlating with increased baby weight. The most notable increase in baby weight occurs when hemoglobin levels are 9.0 g/dL or higher, indicating the importance of managing maternal anemia to improve pregnancy outcomes.

DISCUSSION

Anemia is a condition in which hemoglobin levels are too low to meet physiological needs. The World Health Organization (WHO) defines anemia in nonpregnant women as having hemoglobin levels below 12.0 g/dL. During pregnancy, anemia is determined by trimester-specific cutoffs: less than 11.0 g/dL in the first and third trimesters, and less than 10.5 g/dL in the second trimester. (5,6)Both maternal anemia and preeclampsia are linked to adverse pregnancy outcomes, including low birth weight. (7) Anemia can result in insufficient oxygen supply to the fetus, leading to growth restrictions and preterm birth. Preeclampsia, associated with placental insufficiency, results in poor fetal growth and a higher risk of preterm delivery. (8,9) This study, conducted on 60 pregnant women, confirms these associations and underscores the importance of managing these conditions to enhance maternal and fetal health outcomes.

Results

This prospective cohort design of this study enabled real-time data collection on maternal anemia and preeclampsia, establishing a clear temporal relationship between these conditions and pregnancy outcomes. To address potential attrition, regular follow-ups were maintained in the study, which had a relatively small sample size of 60 participants. The findings align with previous studies, confirming the negative impact of maternal anemia and preeclampsia on pregnancy outcomes. However, this study also revealed that higher hemoglobin concentrations had adverse effects, suggesting the need for a balanced approach to managing maternal health.

Clinical Implications

The study highlights significant implications for both policy and clinical practice. Routine screening and early intervention in prenatal care are essential to identify and manage anemia and preeclampsia effectively. Healthcare providers should prioritize these conditions to improve pregnancy outcomes. Policymakers should integrate these screening protocols into standard prenatal care guidelines to ensure comprehensive maternal and fetal health monitoring.

Research Implications

Future research should consider larger, more at-risk samples to validate these findings. Additionally, assessing anemia-related micronutrient biomarkers at various stages of pregnancy would provide a better understanding of the impact of anemia timing on infant outcomes.

STRENGTHS AND LIMITATIONS

Strengths

The prospective cohort design and real-time data collection are significant strengths of this study. Thorough follow-ups ensured the accuracy of the collected data.

Limitations

The relatively small sample size of 60 participants may limit the generalizability of the findings. Potential confounding factors, such as genetic influences and maternal nutrition, were not controlled in this study.

CONCLUSIONS

1. Baby Weights for Preeclamptic vs. Non-Preeclamptic Mothers:
   - The average baby weight for preeclamptic mothers (2.36 kg) is slightly higher than for non-preeclamptic mothers (2.35 kg).
   - The p-value for this difference is 0.85, indicating no statistically significant impact of preeclampsia on baby weight.
2. Hemoglobin Levels in Preeclamptic vs. Non-Preeclamptic Mothers:
   - Preeclamptic mothers had slightly higher average hemoglobin levels (8.40 g/dL) compared to non-preeclamptic mothers (8.30 g/dL).
   - The p-value for this difference is 0.62, showing no significant impact of preeclampsia on maternal hemoglobin levels.
3. Correlation Between Maternal Hemoglobin Levels and Baby Weights:
   - Babies born to mothers with hemoglobin levels below 8.0 g/dL have the lowest average weight (2.25 kg) with a 95% CI of 2.13 – 2.37 kg.
   - Babies born to mothers with hemoglobin levels between 8.0 and 9.0 g/dL have a slightly higher average weight (2.33 kg) with a 95% CI of 2.22 – 2.44 kg.
   - Babies born to mothers with hemoglobin levels above 9.0 g/dL have the highest average weight (2.52 kg) with a 95% CI of 2.41 – 2.63 kg.
   - There is an increasing trend in baby weights with higher maternal hemoglobin levels.
   - However, further statistical analysis is needed to determine the significance of these weight differences.

In conclusion, this study highlights the significant impact of maternal anemia and preeclampsia on baby weight, reaffirming the need for effective management strategies in prenatal care to improve maternal and fetal health outcomes. Further research with larger, more diverse samples is needed to deepen our understanding of these associations and to develop targeted interventions.

Glossary

- **Anemia:** A condition characterized by a deficiency of red blood cells or hemoglobin, resulting in pallor and weariness.
- **Hemoglobin (HB):** A protein in red blood cells that carries oxygen from the lungs to the rest of the body.

- **Preeclampsia:** A pregnancy complication characterized by high blood pressure and signs of damage to another organ system, often the kidneys.
- **Gestational Hypertension:** High blood pressure that develops after 20 weeks of pregnancy and goes away after delivery.
- **Low Birth Weight:** A term used to describe babies who are born weighing less than 2.5 kilograms.
- **Proteinuria:** The presence of excess proteins in the urine, which can be a sign of kidney damage.
- **Intrauterine Growth Restriction (IUGR):** A condition where a fetus is smaller than expected for the number of weeks of pregnancy.
- **Hypoxic:** A condition in which there is a deficiency of oxygen in the tissues.
- **Uterine Placental Vascular Disease:** A condition affecting the blood vessels in the uterus and placenta, often associated with preeclampsia.

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