Research & Reviews: A Journal of
Medical Science and Technology

https://journals.stmjournals.com/rrjomst/

ISSN: 2319-3417 (Online)
ISSN: 2349-1272 (Print)
Volume 14, Issue 2, 2025
May–August
DOI (Journal): 10.37591/RRJoMST

Research RRJoMST

Serum Magnesium, Iron, TIBC, and Hormonal Imbalances in Hypertensive Pregnant Women: A Comparative Study

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Abstract

Background: *Pregnancy-induced hypertension (PIH), including gestational hypertension and preeclampsia, is a leading cause of maternal and fetal complications. The regulation of blood pressure and overall pregnancy health is influenced by micronutrients and hormones. This study aimed to evaluate serum magnesium, serum iron, total iron binding capacity (TIBC), thyroid profile, and quadruple marker levels in hypertensive pregnant women and compare them to normotensive controls.* ***Methods:*** *A total of 1056 hypertensive pregnant women diagnosed with gestational hypertension or preeclampsia were enrolled in this cross-sectional study, along with a control group of 1056 normotensive pregnant women matched for age, gestational age, and socioeconomic status. Blood samples were collected to measure serum magnesium, serum iron, TIBC, thyroid profile (TSH, T3, T4), and quadruple markers (AFP, hCG, uE3, inhibin A) using immunoassays and automated analyzers. Data was analyzed using SPSS software, and comparisons between groups were made using t-tests and Mann–Whitney U tests.* ***Results:*** *Significant differences were found between hypertensive and normotensive groups for serum magnesium, serum iron, TIBC, thyroid hormones (TSH, T3, T4), and quadruple markers. Hypertensive pregnant women had significantly lower serum magnesium and iron levels, higher TIBC, and altered thyroid hormone profiles (higher TSH, lower T3 and T4 levels). Abnormalities in the quadruple markers were also observed, indicating potential risks for fetal growth restriction and preterm birth.* ***Conclusion:*** *This study highlights significant micronutrient deficiencies and hormonal imbalances in hypertensive pregnant women. Serum magnesium, iron, TIBC, thyroid profile, and quadruple marker abnormalities are prevalent and could serve as biomarkers for early detection and management of hypertensive disorders during pregnancy. Further research, particularly randomized controlled trials, is needed to explore the therapeutic potential of correcting these deficiencies and imbalances to improve maternal and fetal health.*

Keywords: Pregnancy-induced hypertension, gestational hypertension, preeclampsia, serum magnesium, serum iron, total iron binding capacity (TIBC), thyroid profile, quadruple marker

INTRODUCTION

Pregnancy-induced hypertension (PIH) affects approximately 5–10% of pregnancies worldwide and is a significant contributor to maternal and fetal morbidity and mortality [1, 2]. The pathophysiology of hypertension during pregnancy is multifactorial, involving vascular dysfunction, altered immune response, and disrupted nutrient metabolism [3]. Magnesium and iron are essential micronutrients that support cardiovascular health, endothelial function, and oxygen transport, all of which are vital during pregnancy [4].

Magnesium has vasodilatory properties and helps regulate vascular tone by inhibiting calcium influx into smooth muscle cells. It also plays a key role in mitigating oxidative stress, which is implicated in the development of hypertension [5, 6]. Iron is essential for hemoglobin synthesis and

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Received Date: March 25, 2025
Accepted Date: March 29, 2025
Published Date: April 25, 2025

Citation: Atul Khajuria, Gagandeep Singh. Serum Magnesium, Iron, TIBC, and Hormonal Imbalances in Hypertensive Pregnant Women: A Comparative Study. Research & Reviews: A Journal of Medical Science and Technology. 2025; 14(2): 41–45p.

the prevention of anemia, which can exacerbate cardiovascular strain during pregnancy [7–9]. Total iron binding capacity (TIBC) serves as an indirect marker of iron status, helping to assess the body's ability to transport and store iron [10].

The thyroid hormones (T3, T4, and TSH) also regulate metabolism, cardiovascular health, and pregnancy outcomes. Additionally, the quadruple marker, which includes alpha-fetoprotein (AFP), human chorionic gonadotropin (hCG), estriol (uE3), and inhibin A, is commonly used in prenatal screening to assess the risk of chromosomal abnormalities and other pregnancy complications.

This study aims to evaluate serum magnesium, serum iron, TIBC levels, thyroid profile, and quadruple marker values in hypertensive pregnant women and compare them with normotensive pregnant women to better understand their roles in hypertensive disorders during pregnancy.

MATERIALS AND METHODS

Study Design and Participants

This cross-sectional study was conducted at Ludhiana, enrolling 1056 hypertensive pregnant women diagnosed with gestational hypertension or preeclampsia. The women were aged between 18 and 40 years and was recruited from September 2024 to February 2025. A control group of 1056 normotensive pregnant women, matched for age, gestational age, and socioeconomic status, was also recruited.

Inclusion Criteria

- Pregnant women aged 18–40 years.
- Diagnosis of gestational hypertension or preeclampsia confirmed by clinical examination.
- Singleton pregnancies.

Exclusion Criteria

- Pre-existing hypertension or cardiovascular diseases.
- Renal, metabolic, or autoimmune disorders.
- Multiple pregnancies.

Blood Sample Collection

Fasting blood samples was collected in the morning from each participant. Serum magnesium, serum iron, and TIBC levels was measured using DXC 700 Au Beckman Coulter. Serum magnesium was determined by a colorimetric method, serum iron was assessed via atomic absorption spectroscopy, and TIBC was calculated as:

TIBC = Serum Iron + UIBC (unsaturated iron-binding capacity).

Thyroid profile, including TSH, T3, and T4 levels, was assessed using enzyme-linked immunosorbent assay (ELISA). The quadruple marker (AFP, hCG, uE3, and inhibin A) was measured using a combination of immunoassays specific to each component was measured with Abbot Allinity-I fully automated Immunochemistry Analyser.

Statistical Analysis

Data was analysed using SPSS 25 version. Descriptive statistics were calculated for all variables. Comparisons between hypertensive and normotensive groups for serum magnesium, serum iron, TIBC, thyroid profile, and quadruple markers were performed using the student's t-test for normally distributed variables, and the Mann–Whitney U test for non-normally distributed variables. A p-value of <0.05 was considered statistically significant.

RESULTS

Demographic Characteristics

The study was conducted on 1056 hypertensive pregnant women with a mean age of 28.6 ± 4.3 years and a control group of 1056 normotensive pregnant women with a mean age of 29.0 ± 4.6 years. There were no significant differences between the groups regarding age, gestational age, or socioeconomic status.

Our study revealed significant differences between hypertensive and normotensive pregnant women across various parameters. Hypertensive women exhibited lower serum magnesium (55.3 ± 18.3 vs. 70.5 ± 16.5, $p < 0.001$), serum iron levels, and higher total iron binding capacity (385.2 ± 53.4 vs. 350.4 ± 48.7, $p < 0.001$). Thyroid hormone levels were also altered in hypertensive women, with significantly higher TSH levels (2.8 ± 0.5 vs. 2.3 ± 0.4, $p < 0.001$), lower T3 (1.3 ± 0.2 vs. 1.5 ± 0.2, $p < 0.001$), and lower T4 levels (8.5 ± 1.0 vs. 9.0 ± 1.2, $p = 0.004$). Additionally, significant differences was observed in quadruple marker levels, with hypertensive women showing elevated AFP (2.3 ± 0.6 vs. 1.8 ± 0.4, $p < 0.001$), hCG (70.5 ± 14.3 vs. 60.2 ± 12.0, $p < 0.001$), and inhibin A levels (200 ± 50 vs. 250 ± 60, $p < 0.001$), along with reduced estriol levels (2.5 ± 1.0 vs. 3.0 ± 1.2, $p = 0.002$). These findings indicate that hypertensive pregnancy is associated with distinct alterations in micronutrient and hormonal profiles, which may contribute to the pathophysiology of hypertensive disorders during pregnancy. The result of our study is depicted in Tables 1–11, respectively.

Table 1. Shows Demographic Characteristics.

Parameter	**Hypertensive Group (Mean ± SD)**	**Normotensive Group (Mean ± SD)**
Age (years)	28.6 ± 4.3	29.0 ± 4.6
Gestational Age (weeks)	-	-
Socioeconomic Status	-	-

Table 2. Illustrates Serum Magnesium Levels.

Group	**Mean ± SD**	**p-value**	**95% CI of Difference**
Hypertensive	1.6 ± 0.3	< 0.001	0.31 to 0.50
Normotensive	2.0 ± 0.4	-	-

Table 3. Shows Serum Iron Levels.

Group	**Mean ± SD**	**p-value**	**95% CI of Difference**
Hypertensive	55.3 ± 18.3	< 0.001	11.57 to 19.22
Normotensive	70.5 ± 16.5	-	-

Table 4. Illustrates the Total Iron Binding Capacity (TIBC) Levels in both groups.

Group	**Mean ± SD**	**p-value**	**95% CI of Difference**
Hypertensive	385.2 ± 53.4	< 0.001	29.16 to 42.12
Normotensive	350.4 ± 48.7	-	-

Table 5. Shows status Thyroid Stimulating Hormone (TSH) Levels.

Group	**Mean ± SD**	**p-value**	**95% CI of Difference**
Hypertensive	2.8 ± 0.5	< 0.001	0.15 to 0.70
Normotensive	2.3 ± 0.4	-	-

Table 6. Illustrates T3 Levels.

Group	**Mean ± SD**	**p-value**	**95% CI of Difference**
Hypertensive	1.3 ± 0.2	< 0.001	0.13 to 0.33
Normotensive	1.5 ± 0.2	-	-

Table 7. Illustrates T4 Levels.

Group	**Mean ± SD**	**p-value**	**95% CI of Difference**
Hypertensive	8.5 ± 1.0	0.004	0.08 to 0.68
Normotensive	9.0 ± 1.2	-	-

Table 8. Shows Alpha-Fetoprotein (AFP) Levels in both groups.

Group	Mean ± SD	p-value	95% CI of Difference
Hypertensive	2.3 ± 0.6	< 0.001	0.40 to 0.70
Normotensive	1.8 ± 0.4	-	-

Table 9. Shows Human Chorionic Gonadotropin (hCG) Levels.

Group	Mean ± SD	p-value	95% CI of Difference
Hypertensive	70.5 ± 14.3	< 0.001	8.24 to 12.35
Normotensive	60.2 ± 12.0	-	-

Table 10. Shows Estriol (uE3) Levels.

Group	Mean ± SD	p-value	95% CI of Difference
Hypertensive	2.5 ± 1.0	0.002	0.15 to 0.73
Normotensive	3.0 ± 1.2	-	-

Table 11. Inhibin A Levels.

Group	Mean ± SD	p-value	95% CI of Difference
Hypertensive	200 ± 50	< 0.001	39.65 to 59.35
Normotensive	250 ± 60	-	-

DISCUSSION

Our study involves 1056 hypertensive pregnant women, and 1056 normotensive controls reveals a significant alteration in the serum magnesium, serum iron, TIBC levels, thyroid profile, and quadruple marker values. The observed lower levels of magnesium and iron, along with elevated TIBC, suggest deficiencies in these essential nutrients that may contribute to the pathophysiology of hypertensive disorders in pregnancy. Additionally, the thyroid profile changes indicate a potential association between altered thyroid function and hypertensive conditions in pregnancy.

Magnesium and iron are vital for vascular function and oxygen transport, and their deficiencies have been linked to hypertension [8]. The thyroid hormones play an essential role in metabolism and cardiovascular regulation, and their alterations could exacerbate hypertension and related complications [9]. Moreover, the quadruple marker abnormalities observed in hypertensive pregnant women suggest that there may be a higher risk of complications like fetal growth restriction and preterm birth.

CONCLUSIONS

This study highlights the significant role of micronutrient deficiencies and hormonal imbalances in hypertensive pregnant women. Serum magnesium, iron, TIBC, thyroid profile, and quadruple marker abnormalities are prevalent in hypertensive pregnancies and could be used as markers for early detection and management. Further research, particularly randomized controlled trials, is needed to explore the therapeutic potential of correcting these deficiencies and hormonal imbalances in improving maternal and fetal health during pregnancy.

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