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Indian Journal of Obstetrics and Gynecology Research

Journal homepage: www.ijogr.org

Original Research Article

Early prediction of gestational hypertension using β-hCG Levels: A cross-sectional study in a tertiary care hospital of Maharashtra, India

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ARTICLE INFO

Article history:
Received 19-07-2024
Accepted 3-09-2024
Available online 15-02-2025

Keywords:
Prenatal care
Predictive marker
Maternal health
β- hCG
Pregnancy- induced hypertension

ABSTRACT

Background: Pregnancy-Induced Hypertension (PIH) is a significant complication affecting pregnant women, with potential severe outcomes for both mother and fetus. This study investigates the relationship between serum β-hCG levels and the risk of PIH, aiming to determine if elevated β-hCG can serve as an early indicator for PIH.

Materials and Methods: A cross-sectional study was conducted on 100 pregnant women aged 20 to 40 years at 14 to 19 weeks of gestation. Participants were categorized based on age, socioeconomic status, and occupation. Blood pressure measurements and β-hCG levels were recorded and analyzed.

Results: The mean age was 27.6 years. Gestational age at delivery ranged from 14 to 19 weeks, with 53% at 18 weeks. Normal blood pressure was observed in 61% of participants, while 39% were at risk for pregnancy-induced hypertension (PIH), categorized into mild, moderate, and severe PIH. Higher serum β-hCG levels correlated with PIH severity. Pedal edema and proteinuria were significant among PIH patients, affecting blood pressure and β-hCG levels.

Conclusion: Elevated β-hCG levels can potentially serve as a predictive marker for PIH, enabling early interventions. Incorporating β-hCG monitoring into routine prenatal care could improve maternal and fetal outcomes.

1. Introduction

Pregnancy-induced hypertension (PIH) represents a significant obstetric complication characterized by elevated blood pressure after 20 weeks of gestation. PIH encompasses various conditions, from gestational hypertension to severe manifestations like preeclampsia and eclampsia. These conditions pose substantial risks to both maternal and fetal health, necessitating a comprehensive understanding of their underlying mechanisms and contributing factors.[1]

Hypertensive disorders contribute to 14% of global maternal mortality rates, with nearly 95% of these deaths occurring in low- and lower-middle-income countries.[2,3] In India, PIH-related maternal mortality ranges from 5% to 15%, underscoring the need for early detection and management strategies to mitigate these risks.[4,5]

Emerging evidence suggests a potential association between elevated levels of β-human chorionic Gonadotropin (β-hCG) hormone and the development of PIH, particularly preeclampsia. β-hCG is a glycoprotein hormone primarily secreted by the syncytiotrophoblast cells of the placenta during early pregnancy. It plays a crucial role in supporting the maintenance of pregnancy by promoting the development and function of the corpus luteum, which in

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https://doi.org/10.18231/j.ijogr.2025.003

turn produces progesterone to sustain the uterine lining and support fetal growth.[6]

The levels of β-hCG in maternal serum and urine serve as essential markers for pregnancy detection and monitoring, with concentrations typically increasing rapidly during the first trimester before reaching a plateau and declining towards term. Research has suggested that β-hCG may influence the balance between pro-angiogenic and anti-angiogenic factors, thereby contributing to the pathogenesis of PIH.[7] This study aims to investigate this relationship, focusing on whether elevated β-hCG levels can serve as an early indicator of PIH, thereby facilitating timely interventions.

PIH is a significant concern due to its association with various maternal and fetal complications. Women with PIH are at greater risk of placental abruption, cerebrovascular events, organ failure, and disseminated intravascular coagulation. The fetuses of these mothers face significant risks of intrauterine growth restriction, prematurity, and intrauterine death.[8] Identifying early markers for PIH is crucial for implementing timely interventions that can mitigate these risks.

Previous studies have indicated that elevated β-hCG levels are associated with increased PIH severity. However, the focus has often been on the presence of elevated β-hCG rather than its correlation with the severity of PIH. This study aims to fill this gap by examining the relationship between β-hCG levels and the grade of PIH, providing insights that could improve the early detection and management of this condition.[9–15]

2. Materials and Methods

This study was a cross-sectional study designed to investigate the association between elevated β-hCG levels and the risk of Pregnancy-Induced Hypertension (PIH) among pregnant women. The study was conducted over a period of September 2022 to September 2024 at DY Patil Medical College and Hospital, Pune. We included pregnant women aged 20 to 40 years, at 14 to 19 weeks of gestation, attending the outpatient department. Women with pre-existing hypertension, chronic health conditions affecting blood pressure, multiple pregnancies, and those unable to provide informed consent were excluded from the study.

A sample size of 100 women was calculated (50 in each group), assuming a prevalence rate of 30% for elevated β-hCG levels, with a power of 80% and a 5% significance level. Group A comprised of participants with normal β-hCG levels (0.60 to 2 Multiples of Median or MoM) and group B comprised of participants with β-hCG levels higher than that of the sent standard (more than 2.1-2.2 MoM). Participants were recruited systematically, with every third eligible pregnant woman visiting the clinic during the study period invited to participate. This ensured a representative sample of women attending the hospital.

Data were collected through structured interviews and blood sample analyses. The structured interview included a pre-tested questionnaire designed to gather detailed information on participants' demographic information, medical history, and pregnancy-related details. The questionnaire was validated through a pilot study involving 20 participants, ensuring the clarity and relevance of the questions. Patients included in this study were followed up by every three weeks till delivery date. At every visit the patient's blood pressure was measured on two occasions 4 hours apart. Serum β-hCG levels were determined using a chemiluminescent immunometric assay (CLIA) or chemiluminescent microparticle immune assay (CMIA).

The study was approved by the Institutional Ethics Committee of DY Patil Medical College and Hospital, Pune. Participation was voluntary, and informed consent was obtained from all women. Anonymity and confidentiality were maintained by removing personal identifiers from the data.

Data were entered into an Excel spreadsheet and analyzed using statistical software. Descriptive statistics were used to summarize the data, with results presented as means, standard deviations, and percentages. Subgroup analyses were conducted to explore differences between various demographic groups. The analysis between group A and group B was done on percentage and grade of PIH. The PIH standard grade classification given in Table 1 was considered.

Table 1: PIH grade classification considered for participants in the study

PIH Grade	Systolic BP (mmHg)	Dystolic BP (mmHg)
Mild	140 – 149	90 – 99
Moderate	150 – 159	100 – 109
Severe	> 160	> 110

Inferential statistics included chi-square tests to determine associations between categorical variables. Statistical significance was set at a p-value of <0.05. All analyses were conducted using statistical software SPSS version 21.0.

3. Results

A total of 100 pregnant patients who met the inclusion criteria participated in the study. The participants' ages ranged from 20 to 40 years, with an average age of 27.6 years. The majority of participants (38%, n=38) were between 21 and 25 years old, followed by 36% (n=36) aged 26 to 30 years, and 23% aged 31 to 35 years. Only 3% of participants were older than 35 years, falling between 36 and 38 years. Regarding occupation, 64% of the women were housewives, while the remaining 36% were

working professionals, predominantly in IT and engineering sectors. Socio-economically, participants were categorized into five groups based on family income: lower class, lower-middle class, middle class, upper-middle class, and upper class, with the lower-middle class constituting 28% of the participants. The gestational age of participants ranged from 14 to 19 weeks, with most participants (53%) at 18 weeks of gestation, followed by 21% at 14 weeks. These results are summarised in Table 2.

Table 2: Demographic and baseline characteristics of the study participants (N=100)

Variable	Number (n)	Percentage (%)
Age Group		
21-25 years	38	38%
26-30 years	36	36%
31-35 years	23	23%
36-38 years	3	3%
Occupation		
Housewife	64	64%
Working Professionals	36	36%
Socio-Economic Status		
Lower Class	11	11%
Lower-Middle Class	28	28%
Middle Class	26	26%
Upper-Middle Class	22	22%
Upper Class	13	13%
Gestational Age		
14 weeks	21	21%
15 weeks	8	8%
16 weeks	2	2%
17 weeks	10	10%
18 weeks	53	53%
19 weeks	5	5%

Out of 100 women, 61 (61%) maintained normal blood pressure (average SBP 110 mmHg and DBP 76 mmHg) and were considered not at risk for pregnancy-induced hypertension (PIH). Conversely, 39% of participants were at probable risk of PIH, with an average blood pressure of 153/101 mmHg. These participants were further categorized into mild, moderate, and severe PIH grades based on blood pressure. Mild PIH was observed in 33% (13 participants) of women, with a mean SBP of 142 mmHg and DBP of 93 mmHg. Moderate PIH was found in 44% of women, with an average BP of 153/103 mmHg. Severe PIH was present in 23% of participants, with a mean BP of 169/111 mmHg.

Additionally, among these 39 participants at risk for PIH, blood pressure varied by age group, as shown in Table 3. The differences between the mean SBP and DBP of various age groups was statistically significantly different by ANOVA ($p = 0.03$).

Women with normal BP had an average serum β-hCG level of 1.17 MoM (SD ±0.46). Those with mild PIH had elevated β-hCG levels (Mean = 2.10 MoM, SD ± 0.66). Participants with moderate PIH had a mean β-hCG level of 3.60 MoM (SD ± 0.84), while those with severe PIH had a mean level of 4.40 MoM (SD ± 0.39). The β-hCG levels among all the participant groups by BP were statistically significant by ANOVA test, as shown in Table 4.

Pedal edema was observed in 40 participants. Women without edema had an average SBP of 110 mmHg and DBP of 76 mmHg, whereas those with edema had an average SBP of 153 mmHg and DBP of 101 mmHg. Serum β-hCG levels were higher in women with edema (Mean = 3.27 MoM) compared to those without (Mean = 1.17 MoM). The mean β-hCG levels were statistically significantly different in the two groups by independent t-test ($p < 0.001$).

Proteinuria was noted in patients with mild, moderate, and severe PIH. The differences between mean β-hCG levels and mean BP among participants groups by proteinuria grade at 20 weeks is detailed in Table 5. As clear from the table, the mean β-hCG levels among the groups by proteinuria were statistically significantly different by ANOVA test ($p<0.01$).

4. Discussion

This study examined the relationship between serum β-hCG levels and the risk of Pregnancy-Induced Hypertension (PIH), revealing significant associations that underscore the potential of β-hCG as an early predictive marker for PIH. Our findings align with previous research suggesting that elevated β-hCG levels are linked with hypertensive disorders in pregnancy, particularly preeclampsia.[6]

The results indicated that women with elevated β-hCG levels were at a higher risk of developing PIH, with a notable increase in the severity of the condition. Specifically, women with severe PIH exhibited the highest mean β-hCG levels (4.40 MoM), significantly higher than those with mild or moderate PIH. This gradient suggests a dose-response relationship, where increasing β-hCG levels correlate with worsening blood pressure profiles.[7] These findings are consistent with the hypothesis that β-hCG influences the balance between pro-angiogenic and anti-angiogenic factors, contributing to the pathophysiology of PIH.[8]

Our study's demographic analysis showed that younger women (under 25 years) had relatively lower mean SBP and DBP compared to older age groups, though the risk of PIH was still present across all age categories. This observation aligns with existing literature indicating that while age is a factor, β-hCG levels are a more critical predictor of PIH risk.[9]

The observed association between elevated β-hCG levels and PIH severity highlights the potential utility of β-hCG measurements in prenatal care. Early detection of elevated β-hCG levels can prompt closer monitoring and early intervention, potentially mitigating the adverse outcomes associated with PIH. Women identified at higher risk

Table 3: Age group wise mean SBP and DBP of study participants with risk of PIH (n=39)

Age Group	Number (%)	Mean SBP (mmHg)	Mean DBP (mmHg)	ANOVA p-value
< 25 years	13 (33%)	126	86	0.03
26-30 years	10 (26%)	147	97	
31-35 years	14 (36%)	153	102	
> 35 years	2 (5%)	160	101	

Table 4: Mean blood pressurereadings and β-hCG levels among study participant groups by PIH grade

PIH Grade	Number (n)	Mean SBP (mm Hg)	Mean DBP (mmHg)	Mean β-hCG (MoM)	β-hCG SD (MoM)	Anova p-value
Normal BP	61	110	76	1.17	±0.46	<0.001
Mild PIH	13	142	93	2.1	±0.66	
Moderate PIH	17	153	103	3.6	±0.84	
Severe PIH	9	169	111	4.4	±0.39	

Table 5: Association between blood pressure, serum β-hCG Levels, and proteinuria

Proteinuria after 20 Weeks	Mean SBP (mmHg)	SD (SBP)	Mean DBP (mmHg)	SD (DBP)	Mean β-hCG (MoM)	SD (β-hCG)	Anova p Value
1+	141.33	1.41	93.11	1.76	2.21	0.71	<0.001
2+	153.18	2.92	102.82	4.13	3.6	0.84	
3+	168.89	2.85	111.33	1.73	4.4	0.39	
Negative	109.04	6.98	74.36	6.97	1.11	0.38	
Trace (n=18)	122.67	14.67	84.93	7	1.54	0.66	

could benefit from more frequent prenatal visits, lifestyle modifications, and timely medical interventions to manage blood pressure and prevent complications.[10]

Furthermore, the study found a significant correlation between elevated β-hCG levels and the presence of edema and proteinuria among participants. Women with edema had significantly higher mean β-hCG levels (3.27 MoM) compared to those without edema (1.17 MoM), suggesting that elevated β-hCG may contribute to fluid retention and the development of edema in pregnant women.[11] Proteinuria, a key indicator of kidney function and PIH severity, also showed a positive association with elevated β-hCG levels, with the highest β-hCG levels observed in women with severe proteinuria (4.4 MoM).[12]

This study had several limitations. The sample size was relatively small and confined to a single institution, which may limit the generalizability of the findings. Additionally, the cross-sectional design precludes establishing causality between elevated β-hCG levels and PIH. Further longitudinal studies are needed to confirm these associations.

5. Conclusions and Recommendations

In conclusion, we found significant association between elevated serum β-hCG levels and the risk of PIH. Therefore, This study's findings support the incorporation of β-hCG level monitoring into routine prenatal screenings, particularly for women at higher risk of PIH. Incorporating β-hCG monitoring into routine prenatal care could improve the early detection and management of PIH, ultimately enhancing maternal and fetal health outcomes. Further research with larger sample sizes and diverse populations is warranted to validate these findings and expand our understanding of the underlying mechanisms.

6. Source of Funding

None.

7. Conflict of Interest

None.

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Cite this article: Sansare S, Kulkarni MM, Kulkarni J, Kathpalia S. Early prediction of gestational hypertension using β-hCG Levels: A cross-sectional study in a tertiary care hospital of Maharashtra, India. *Indian J Obstet Gynecol Res* 2025;12(1):16-20.