OPEN ACCESS

Scholars International Journal of Obstetrics and Gynecology

Abbreviated Key Title: Sch Int J Obstet Gynec
ISSN 2616-8235 (Print) | ISSN 2617-3492 (Online)
Scholars Middle East Publishers, Dubai, United Arab Emirates
Journal homepage: https://saudijournals.com

Original Research Article

Mid-Trimester (13-20 Weeks) Maternal Serum β HCG As a Predictor of Hypertensive Disorders of Pregnancy

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DOI: 10.36348/sijog.2024.v07i02.007 | **Received:** 01.01.2024 | **Accepted:** 05.02.2024 | **Published:** 26.02.2024

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Abstract

Background: Hypertensive disorders of pregnancy are a significant contributor to maternal mortality, with early identification of risk factors being crucial for proactive management. This study explores the potential of mid-trimester maternal serum β HCG levels as a predictive marker for hypertensive disorders during pregnancy. ***Objective:*** The primary objective of this prospective study was to evaluate the clinical utility of second-trimester serum β HCG levels in predicting the development of hypertensive disorders during pregnancy. ***Methods:*** The study, conducted from June 2020 to July 2021, recruited pregnant women aged 13-20 weeks who were normotensive and non-proteinuric. Data from 100 respondents were collected, with 50 in each group (Group A with β HCG > 35000 m IU/ml and Group B with β HCG < 35000 m IU/ml). Statistical analysis was performed using SPSS 24.0, and the significance level was set at $p < 0.05$. ***Results:*** Group A had a significantly higher proportion of hypertensive disorders compared to Group B (38% vs. 10%, $p < 0.001$), with Group A being more than five times as likely to develop hypertensive disorders (cOR = 5.5, 95% CI: 1.862, 16.344). Serum β HCG levels in respondents with hypertensive disorders (Mean = 60626.88 m IU/ml) were significantly higher than those who were normotensive (Mean = 32812.18 m IU/ml, $p < 0.001$). Sensitivity was 79.17%, specificity was 59.21%, and positive and negative predictive values were 38% and 90%, respectively. ***Conclusions:*** Mid-trimester serum β HCG levels are an efficient non-invasive predictor of hypertensive disorders during pregnancy. With its high sensitivity and negative predictive value, this cost-effective test can aid in the early identification and proactive management of at-risk pregnancies.

Keywords: Hypertensive disorders, β HCG, pregnancy, Predictive marker, Maternal serum.

INTRODUCTION

Hypertensive disorders during pregnancy represent a significant health challenge, affecting 5-10% of pregnancies globally [1]. These disorders are particularly concerning because they are the second leading cause of maternal mortality worldwide, following hemorrhage, according to a WHO systematic analysis [2]. Pregnancy-induced hypertension (PIH) is a condition unique to pregnancy, impacting 12–15% of pregnant women and posing a persistent threat to maternal and neonatal health [3]. Obstetricians continuously strive to identify pregnancy-related risks and, if possible, predict them, as early prediction can lead to effective prevention [4].

Hypertension during pregnancy is defined by a blood pressure reading of 140/90 mm Hg or higher on at least two occasions within 7 days, along with proteinuria, characterized by elevated urinary protein levels [5]. These disorders are further classified, such as gestational hypertension, preeclampsia, eclampsia, chronic hypertension, and superimposed preeclampsia on chronic hypertension. While the exact cause of preeclampsia remains unclear, it is evident that the placenta plays a pivotal role, and endothelial cell dysfunction is believed to be at its core [6].

One intriguing aspect of this condition is the potential role of mid-trimester maternal serum beta HCG levels in predicting hypertensive disorders during pregnancy [7]. Some researchers propose that immunological changes in trophoblasts during mid-trimester result in elevated beta HCG levels [8]. Elevated second-trimester serum beta HCG levels have been observed in patients who later develop hypertensive disorders during pregnancy, sparking interest in their predictive potential [9]. A study conducted in Bihar found a statistically significant difference in the development of hypertensive disorders based on beta HCG levels, further highlighting its potential.

Additional studies have reported a promising correlation between elevated second-trimester serum beta HCG levels and the development of hypertensive disorders in pregnancy [10]. These findings suggest that beta HCG levels could be an efficient and cost-effective predictor for identifying at-risk pregnancies early in the gestational period. This research aims to evaluate this non-invasive test's clinical utility, potentially revolutionizing hypertensive disorders' management during pregnancy.

OBJECTIVES

General Objectives

- To evaluate the mid-trimester (13-20 weeks) maternal serum Beta HCG levels as a predictor of development of the hypertensive disorders of pregnancy.

Specific Objectives

- To measure the Beta HCG level of pregnant women during the second trimester (13-20 weeks) of pregnancy.
- To assess the development of hypertensive disorders during pregnancy among pregnant women whose Beta HCG level is equal to or above 35000 mIU/ml.
- To assess the development of hypertensive disorders during pregnancy among pregnant women whose Beta HCG level is below 35000 mIU/ml.
- To determine the socio-demographic characteristics of the respondents.
- To compare factors associated with the development of hypertensive disorders of pregnancy between the two groups.

MATERIAL AND METHODS

Study Design

This study employed a prospective design to investigate the clinical utility of mid-trimester maternal serum β HCG levels in predicting hypertensive disorders during pregnancy. Pregnant women between 13-20 weeks of gestation, meeting specific inclusion and exclusion criteria, were purposively recruited from the Department of Gynaecology & Obstetrics at Rajshahi Medical College, Rajshahi. Data collection included detailed participant information, serum β HCG estimation, and regular follow-ups. Statistical analyses were conducted using SPSS software, with diagnostic validity tests to assess β HCG's predictive value. Ethical clearance was obtained, and participants provided informed consent.

Inclusion Criteria

- Pregnant women with gestational age between 13-20 weeks, confirmed by first-trimester ultrasound (USG) or reliable menstrual history.
- Singleton's pregnancy was confirmed by ultrasound.
- Normotensive, with blood pressure within the normal range.
- Non-proteinuric, with no significant protein in the urine.
- Absence of antenatal complications.

Exclusion Criteria

- Multiple pregnancies, such as twins or triplets.
- Presence of congenital abnormalities in the pregnancy.
- Pre-existing essential hypertension is diagnosed before pregnancy.
- Diabetes Mellitus diagnosed before pregnancy.
- Molar pregnancy is a rare and abnormal pregnancy condition.

Data Collection

Data collection involved recruiting pregnant women in their second trimester after obtaining ethical clearance. Detailed participant information was collected, including medical and family histories and physical measurements such as height, weight, and blood pressure. Serum beta HCG levels were estimated, and gestational age was determined using ultrasound and menstrual history. Participants were grouped based on beta HCG levels. Blood pressure measurements followed gold-standard protocols. Regular follow-ups occurred throughout pregnancy and postpartum, including blood pressure checks, urine analysis, weight measurements, and antenatal examinations, facilitating comprehensive data collection for subsequent analysis.

Data Analysis

Data was analyzed using Statistical Package for the Social Sciences (SPSS, version 23). Qualitative variables were described using frequency distributions, while quantitative variables were presented as mean ± standard deviation. Unpaired t-tests were used to assess differences in means between the hypertensive disorders in the pregnancy and normotensive groups. Chi-square tests were applied for categorical data. Diagnostic validity tests evaluated the predictive value of serum beta HCG for hypertensive disorders in pregnancy. A significance level of $p < 0.05$ was considered statistically significant in the analysis.

Ethical Considerations

Ethical approval was of the utmost importance throughout this study. Prior approval was obtained from the Ethical Committee of Rajshahi Medical College, Rajshahi. Participants provided voluntary informed consent after receiving verbal explanations about the study's design, purpose, potential benefits, and risks. They were assured of their right to withdraw from the study for any reason. The study adhered to the Helsinki Declaration for Medical Research Involving Human Subjects, 1964, revised in 2008 and last amended in 2013, ensuring ethical principles were followed rigorously in all participant recruitment and data collection aspects.

RESULT

Table 1: Distribution of Respondents Based on Demographic Characteristics

Characteristic	Category	Frequency	Percent
			Age
	< 20	20	20.0
	20-34	78	78.0
	> 35	2	2.0
			Place of Residence
	Urban	47	47.0
	Rural	53	53.0
			Educational Status
	PSC to SSC	87	87.0
	HSC & above	13	13.0
			Monthly Family Income (BDT)
	<15,000	25	25.0
	15,000-25,000	42	42.0
	>25,000	33	33.0
			BMI Category
	Normal	58	58.0
	Overweight	30	30.0
	Underweight	12	12.0

Most respondents, 78%, fall within the age range of 20-34, while only 2% are above 35. A nearly equal split exists between urban and rural residents, with 53% and 47%, respectively. Educationally, 87% have completed education up to SSC level. Monthly family income is divided, with 25% earning less than 15,000 BDT, 42% between 15,000 and 25,000 BDT, and 33% above 25,000 BDT. Regarding BMI, 58% are in the normal range, 30% are overweight, and 12% are underweight.

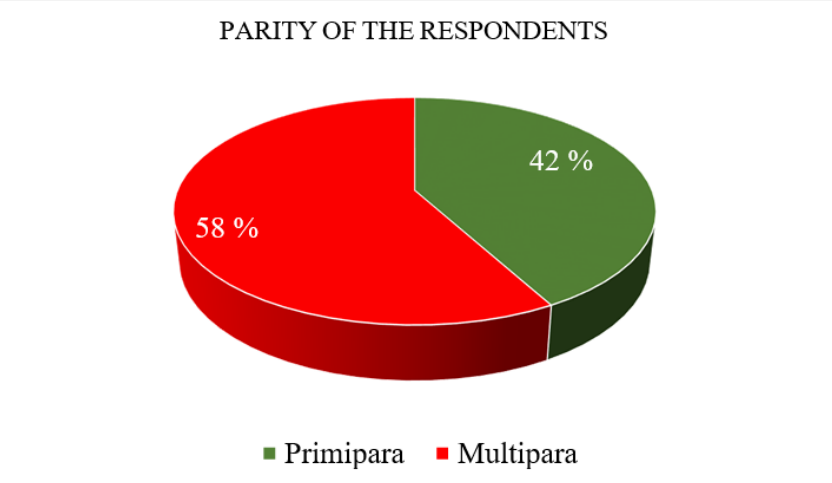

Figure 1: Distribution of the respondents according to their parity (n=100)

Distribution of the respondents according to their parity. It reveals that more than half (58%) of the respondents were multiparous and just above 2/5th (42%) of them were primipara.

Table 2: Distribution of the respondents according to their past obstetric history (n=100)

Past obstetric history	Frequency	Percent
Abortions	27	27.0
Preeclampsia in previous pregnancies	1	1.0
Neonatal deaths in previous pregnancies	10	10.0
Absent of any significant past obstetric history	62	62.0

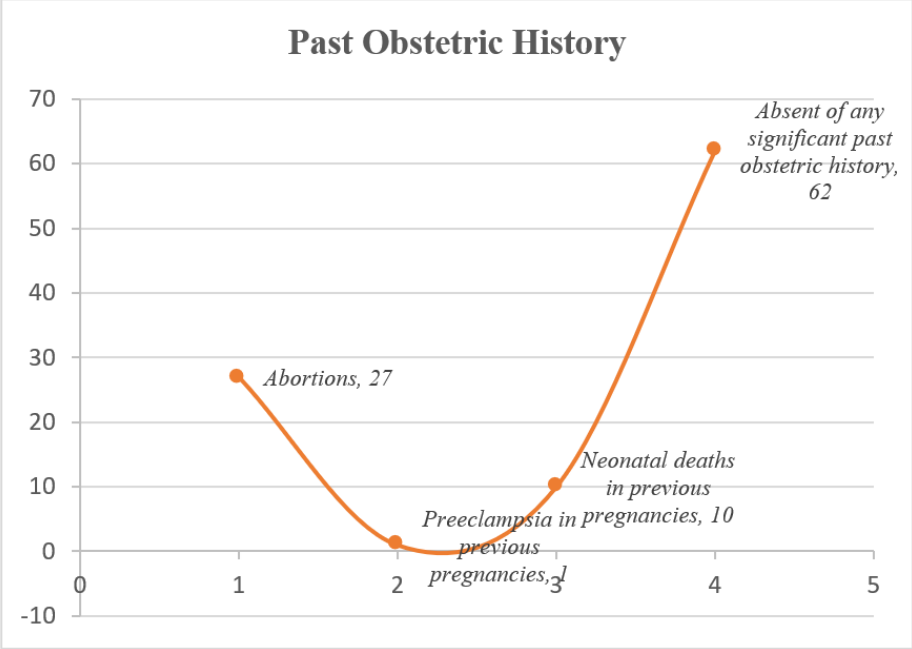

Figure 2: Participants by Previous Obstetric Record

The distribution of the respondents according to their past obstetric history. It reveals that about 3/5th (62%) of the respondents had no significant history. More than one-quarter (27%) of respondents had an abortion history in their previous pregnancy, and only some (10%) of them had a history of neonatal death.

Table 3: Relationship between Beta HCG Levels in 2nd Trimester (13-20 Weeks) and Pregnancy Blood Pressure Status in Two Groups of Respondents (n=100)

Group based on Beta HCG level at 2nd trimester of pregnancy (13-20weeks)	BP status of pregnancy		Total
	Hypertensive disorders of pregnancy	Normotensive	
Group A (> 35000 m IU /ml)	19 (38.0%)	31(62.0%)	50 (100.0%)
Group B(< 35000 m IU /ml)	5 (10.0%)	45 (90.0%)	50 (100.0%)
Total	**24 (24.0%)**	**76 (76.0%)**	**100(100.0%)**

The analysis explored the connection between Beta HCG levels during the 2nd trimester of pregnancy (13-20 weeks) and the blood pressure status of pregnant respondents (n=100). Group A (Beta HCG > 35000 m IU/ml) had a significantly higher rate of hypertensive disorders (38%) compared to Group B (Beta HCG < 35000 m IU/ml, 10%). A chi-square test revealed a significant relationship ($\chi^2 = 10.75$, df = 1, P < .001), with Group A more than five times likely to develop hypertensive disorders (cOR = 5.5, 95% CI: 1.862-16.344).

Table 4: Sensitivity and Specificity of 2nd Trimester Beta HCG Levels (13-20 Weeks) at 35000 mIU/ml Cutoff for Hypertensive Disorders in Pregnancy (n=100)

On the basis of mid-trimester Beta HCG level (13-20weeks)	BP status of pregnancy		Total
	Hypertensive disorders of pregnancy (Disease)	Normotensive (No disease)	
Group A (> 35000 m IU /ml)	*TP= 19 (38.0%)	**FP = 31(62.0%)	50 (100%)
Group B (< 35000 m IU /ml)	****FN= 5 (10.0%)	***TN= 45 (90.0%)	50 (100%)
Total	**24 (24 %)**	**76 (76 %)**	**100 (100%)**

The sensitivity and specificity of the Beta HCG test with a cutoff of 35000 mIU/ml in predicting hypertensive disorders during the 2nd trimester of pregnancy (13-20 weeks). It shows that the test correctly identified 38% of true positives (sensitivity) but also had 62% false positives. On the other hand, it accurately identified 90% of true negatives (specificity) with 10% false negatives. These values provide insights into the test's ability to detect hypertensive disorders in pregnant individuals.

Table 5: Summarizes Beta HCG level differences in the 2nd trimester between hypertensive and normotensive pregnant individuals

Variable	BP Status of Pregnancy	N	Mean (m IU/ml)	Std. Deviation	t-Value	p-Value
Beta_HCG_level	Hypertensive disorders of pregnancy	24	60626.88	23565.50	5.53	< .001
	Normotensive	76	32812.18	12917.35		

The independent samples t-test compared Beta HCG levels during the 2nd trimester in respondents with hypertensive disorders (n=24) and normotensive (n=76) individuals. Normality (Shapiro-Wilk) was confirmed, but variances differed (Levene's test). The t-test revealed a significant difference, with hypertensive respondents having higher levels (M=60626.88 m IU/ml, SD=23565.50) than normotensive (M=32812.18 m IU/ml, SD=12917.35), Mean Difference 27814.70 m IU/ml (95% CI 17495.87, 38133.52), t(100)=5.53, p<.001 (two-tailed).

Table 6: Distribution of Respondents Based on Gestational Age and Beta HCG Level (13-20 Weeks)

Gestational Age of Respondents	Group A (> 35000 m IU/ml)	Group B (< 35000 m IU/ml)	Total
13 (n=2)	0 (0.0%)	2 (100.0%)	2 (100.0%)
14 (n=12)	10 (83.3%)	2 (16.7%)	12 (100.0%)
15 (n=20)	16 (80.0%)	4 (20.0%)	20 (100.0%)
16 (n=17)	12 (70.6%)	5 (29.4%)	17 (100.0%)
17 (n=8)	0 (0.0%)	8 (100.0%)	8 (100.0%)
18 (n=17)	6 (35.3%)	11 (64.7%)	17 (100.0%)
19 (n=21)	6 (28.6%)	15 (71.4%)	21 (100.0%)
20 (n=3)	0 (0.0%)	3 (100.0%)	3 (100.0%)
Total	**50 (50.0%)**	**50 (50.0%)**	**100 (100.0%)**

The distribution of respondents based on gestational age during Beta HCG testing and the associated Beta HCG level groups. Most respondents were tested at 19 and 15 weeks of gestation, with notably higher percentages in Group A (> 35000 m IU/ml) at 14 and 15 weeks—no Group A respondents tested at 13 weeks, while all at 20 weeks were in Group B.

DISCUSSION

The present prospective study aimed to assess the clinical utility of second-trimester serum beta HCG levels as a predictive marker for the development of hypertensive disorders during pregnancy [11]. The study was conducted over one year in the Department of Gynaecology & Obstetrics, Rajshahi Medical College, Rajshahi. Pregnant women between 13-20 weeks of gestation, who were normotensive and non-proteinuric, were purposively recruited, irrespective of their parity. The study's demographic findings indicated that a significant proportion of respondents fell into the 20 to 34 age group (78%) [12]. While there was a slightly higher incidence of hypertensive disorders among this age group, the differences observed across age categories were not statistically significant. This aligns with previous studies that have found age alone may not be a robust predictor of hypertensive disorders during pregnancy.

The respondents' distribution based on their residence showed that more than half resided in rural areas (53%), with the remainder in urban areas [13]. Interestingly, urban respondents exhibited a slightly higher proportion of hypertensive disorders compared to rural respondents. While this difference was not statistically significant, it suggests that place of residence may play a role in the development of hypertensive disorders during pregnancy. Further research may provide valuable insights into the environmental and lifestyle factors contributing to these differences. Regarding educational status, a large majority of respondents had completed education up to the PSC to SSC levels (87%), while a smaller proportion had education up to HSC and above (13%) [14]. Interestingly, respondents with higher education levels (HSC & above) exhibited a slightly higher proportion of hypertensive disorders during pregnancy. However, this difference was not statistically significant. These findings suggest that educational status alone may not be a strong predictor of hypertensive disorders during pregnancy.

The study also examined the distribution of respondents based on their monthly family income [15]. Those with monthly family incomes between 15000-

25000 BDT had a proportionately higher incidence of hypertensive disorders compared to other income categories. This finding was statistically significant, indicating a potential relationship between income level and the development of hypertensive disorders. However, further research is needed to explore the underlying factors contributing to this association. The study categorized respondents based on their BMI, revealing that a majority had a normal BMI (58%), while a significant proportion were overweight [16]. Overweight respondents exhibited a slightly higher incidence of hypertensive disorders, but this difference was not statistically significant. This suggests that BMI alone may not be a strong predictor of hypertensive disorders during pregnancy, in line with previous studies. Parity played a significant role in the study, with primipara respondents exhibiting a significantly higher incidence of hypertensive disorders compared to multiparous respondents [17]. This finding aligns with prior research and underscores the importance of primiparity as a potential risk factor for hypertensive disorders during pregnancy. Additionally, respondents with a history of neonatal death in previous pregnancies also had a higher incidence of hypertensive disorders, although this was not statistically significant.

Serum Beta HCG Levels

The study investigated the relationship between medical history, particularly a history of hypertension and diabetes, and the development of hypertensive disorders. While those with a history of hypertension showed a slightly higher incidence of hypertensive disorders, this difference was not statistically significant. This suggests that medical history alone may not be a strong predictor. The key variable of interest, second-trimester serum beta HCG levels, was found to be significantly associated with the development of hypertensive disorders during pregnancy [18]. Respondents with high beta HCG levels exhibited a significantly higher incidence of hypertensive disorders compared to those with normal or low levels. This finding suggests that elevated beta HCG levels in the second trimester may serve as a predictive marker for hypertensive disorders during pregnancy, aligning with previous research.

Comparison with Previous Studies

The study's findings were compared with previous research in the field. While some studies showed similar trends, such as the association between primiparity and hypertensive disorders, others reported variations in findings related to age, monthly family income, and BMI. These discrepancies highlight the complex nature of hypertensive disorders during pregnancy and the potential influence of various factors. The study evaluated the sensitivity and specificity of beta HCG levels in predicting hypertensive disorders during pregnancy [19]. Using a cutoff point of 35000 mIU/ml, the sensitivity was found to be 79.17%, indicating the test's ability to identify hypertensive disorder cases correctly. The specificity was 59.21%, suggesting the test's ability to identify cases without hypertensive disorders correctly. The positive predictive value (PPV) was 38%, indicating the likelihood that a positive test result accurately predicts hypertensive disorders. The negative predictive value (NPV) was 90%, indicating the likelihood that a negative test result accurately predicts the absence of hypertensive disorders.

Gestational Age and Beta HCG Testing

The study also examined the timing of beta HCG testing during pregnancy. Respondents who tested their beta HCG levels at 14 and 15 weeks had proportionately higher levels in Group A (>35000 m IU/ml) than in Group B (<35000 m IU/ml). This suggests that early testing of beta HCG levels may provide valuable information for predicting hypertensive disorders [20].

CONCLUSION

Measuring serum Beta HCG levels during the mid-trimester (13-20 weeks) represents a significant advancement in obstetrics. This non-invasive approach provides the ability to predict the development of hypertensive disorders in pregnancy (HDP). The study demonstrated that respondents with Beta HCG levels exceeding 35000 m IU/ml had a significantly higher incidence of HDP (38% vs. 10%) compared to those with lower levels. Group A (Beta HCG > 35000 m IU/ml) was over five times more likely to develop HDP than Group B (Beta HCG < 35000 m IU/ml). Using a cutoff of 35000 mIU/ml, the test exhibited a sensitivity of 79.17% and specificity of 59.21%. This predictive marker holds the potential to prevent severe complications associated with HDP, reducing maternal and fetal morbidity and mortality while offering a cost-effective, outpatient-friendly screening tool in modern obstetrics.

RECOMMENDATION

- Firstly, Health professionals should suspect the development of hypertensive disorders of pregnancy if the maternal serum level of β-hCG goes beyond the normal level.
- Secondly, further studies should be done on more patients to confirm the significance of β HCG in the screening of hypertensive disorders of pregnancy.

ACKNOWLEDGMENT

I would like to express my gratitude to Allah for His guidance and blessings in completing this thesis. I thank Professor Dr. Shahela Jesmin, my research supervisor, and Associate Professor Dr. Rokeya Khatun for their support. Special thanks to my family and colleagues for their encouragement and the respondents' valuable data.

Funding: No funding sources.

Conflict of Interest: None declared.

REFERENCES

1. Hauth, J. C., Clifton, R. G., Roberts, J. M., Myatt, L., Spong, C. Y., Leveno, K. J., ... & Eunice Kennedy Shriver National Institute of Child Health and Human Development Maternal-Fetal Medicine Units Network. (2011). Maternal insulin resistance and preeclampsia. *American journal of obstetrics and gynecology*, *204*(4), 327-e1.
2. Say, L., Chou, D., Gemmill, A., Tunçalp, Ö., Moller, A. B., Daniels, J., ... & Alkema, L. (2014). Global causes of maternal death: a WHO systematic analysis. *The Lancet global health*, *2*(6), e323-e333.
3. Redman, C. W., Sargent, I. L., & Taylor, R. N. (2015). Immunology of normal pregnancy and preeclampsia. In *Chesley's hypertensive disorders in pregnancy* (pp. 161-179). Academic Press.
4. Victor, S. R., & Jayalakshmi, D. (2019). Serum β HCG as a predictor and potent marker for pregnancy induced hypertension. *IAIM*, *6*(3), 38-43.
5. Program, N. H. B. P. E. (2000). Report of the national high blood pressure education program working group on high blood pressure in pregnancy. *American journal of obstetrics and gynecology*, *183*(1), s1-s22.
6. Gathiram, P., & Moodley, J. J. C. J. O. A. (2016). Preeclampsia: its pathogenesis and pathophysiolgy: review articles. *Cardiovascular journal of Africa*, *27*(2), 71-78.
7. Kaur, G., Jain, V., Mehta, S., & Himani, S. (2012). Prediction of PIH by maternal serum beta HCG levels in the second trimester (13–20 weeks) of pregnancy. *The Journal of Obstetrics and Gynecology of India*, *62*, 32-34.
8. Gratacos, E. (2000). Lipid-mediated endothelial dysfunction: a common factor to preeclampsia and chronic vascular disease. *European journal of obstetrics & gynecology and Reproductive biology*, *92*(1), 63-66.
9. Mazhari, F., & Code, Q. R. (2018). Prediction of hypertensive disorders in pregnancy by estimation of maternal serum beta HCG levels in the mid-trimester (13-20 weeks) of pregnancy. *International Journal of Biomedical Research*, *9*(10), 354-357.
10. Vidyabati, R. K., Hijam, D., Singh, N. K., & Singh, W. G. (2010). Serum ßhCG and lipid profile in early second trimester as predictors of pregnancy induced hypertension. *The Journal of Obstetrics and Gynecology of India*, *60*, 44-50.
11. Bhalerao, A. V., & Dawle, S. S. (2017). Prediction of pregnancy-induced hypertension by maternal serum beta human chorionic gonadotropin levels in early second trimester of pregnancy. *Journal of South Asian Federation of Obstetrics and Gynaecology*, *10*(2), 104-109.
12. Perveen, A., Parmar, S., & Goyal, S. (2019). A Study of Relationship Between Second Trimester Maternal Serum Beta Human Chorionic Gonadotropin and Hypertensive Disorder of Pregnancy. *Indian Journal of Obstetrics and Gynecology*, *8500*(8000), 135.
13. Revankar, V. M., & Narmada, L. (2017). Assessment of serum β-hCG and lipid profile in early second trimester as predictors of hypertensive disorders of pregnancy. *International Journal of Gynecology & Obstetrics*, *138*(3), 331-334.
14. KIM, H. S., OH, M. J., & KIM, H. J. (1999). The value of elevated second trimester human chorionic gonadotropin levels in predicting development of pregnancy-induced hypertension. *Korean Journal of Obstetrics and Gynecology*, 85-89.
15. Sharma, V., Sharma, P., & Firdous, N. (2016). Beta hCG in mid trimester as a predictor of pregnancy induced hypertension. *Int J Sci Res*, *5*(9), 303-05.
16. Roiz-Hernández, J., Cabello-Martínez, J. D. J., & Fernández-Mejía, M. (2006). Human chorionic gonadotropin levels between 16 and 21 weeks of pregnancy and prediction of preeclampsia. *International Journal Of Gynecology & Obstetrics*, *92*(2), 101-105.
17. Muthulakshmi, D., Sasirekha, R., & Medha, R. (2017). Serum β-hCG levels between 12 to 20 weeks of gestation in prediction of hypertensive disordrers of pregnancy. *Int J Reprod Contracept Obstet Gynecol*, *6*, 3347-51.
18. Soundararajan, P., Muthuramu, P., Veerapandi, M., & Mariyappan, R. (2016). Serum beta human chorionic gonadotropin and lipid profile in early second trimester (14-20 weeks) is a predictor of pregnancy-induced hypertension. *International Journal of Reproduction, Contraception, Obstetrics and Gynecology*, *5*(9), 3011-3017.
19. Yadav, K., Aggarwal, S., & Verma, K. (2014). Serum βhCG and lipid profile in early second trimester as predictors of pregnancy-induced hypertension. *The Journal of Obstetrics and Gynecology of India*, *64*, 169-174.
20. Murmu, S., & Dwivedi, J. (2020). Second-trimester maternal serum beta-human chorionic gonadotropin and lipid profile as a predictor of gestational hypertension, preeclampsia, and eclampsia: a prospective observational study. *International Journal of Applied and Basic Medical Research*, *10*(1), 49.