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Original Research Article

An observational study of serum vitamin D levels in preeclamptic and eclamptic pregnant women in labour

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ABSTRACT

Background: Hypertensive disorders of pregnancy (HDP), particularly preeclampsia and eclampsia, are major causes of maternal and perinatal morbidity and mortality. Emerging evidence suggests that vitamin D deficiency may contribute to the pathogenesis of these disorders through its effects on placental function, immune regulation, and vascular health.
Methods: This hospital-based observational cross-sectional study was conducted at Fakhruddin Ali Ahmed Medical College and Hospital over one year. A total of 112 pregnant women in labor were included, comprising 56 cases (preeclampsia/eclampsia) and 56 healthy normotensive controls. Serum 25-hydroxy vitamin D [25(OH)D] levels were measured using chemiluminescent immunoassay (CLIA). Serum calcium levels and relevant clinical and laboratory parameters were also assessed. Statistical analysis was performed using PSPP version 2.0.1.
Results: Vitamin D deficiency and insufficiency were significantly more common among cases compared to controls ($p=0.021$), while sufficient vitamin D levels predominated among controls. Vitamin D deficiency was more frequently observed in women with eclampsia, indicating an association with increasing disease severity. Serum calcium deficiency was also significantly higher among cases than controls ($p<0.001$). Additionally, systolic and diastolic blood pressures were significantly elevated among cases ($p<0.001$).
Conclusions: Vitamin D deficiency and low serum calcium levels were significantly associated with preeclampsia and eclampsia. Lower vitamin D levels were linked with greater disease severity, suggesting a potential role of vitamin D in HDP. Further studies are required to evaluate the role of routine screening and supplementation during pregnancy.

Keywords: Vitamin D deficiency, Preeclampsia, Eclampsia, Pregnancy-induced hypertension

INTRODUCTION

Pregnancy is a unique physiological state characterized by complex adaptations in the maternal immune, cardiovascular, endocrine, and metabolic systems that support fetal development.[1] When these adaptations become dysregulated, complications such as HDP can arise. Among these, preeclampsia and eclampsia are major contributors to maternal and perinatal morbidity and mortality worldwide.[2] Preeclampsia is a multisystem disorder typically presenting after 20 weeks of gestation with new-onset hypertension and evidence of organ dysfunction, while eclampsia represents its severe form, characterized by seizures.[3,4]

The pathogenesis of preeclampsia is complex and not fully understood, but abnormal placentation and impaired spiral artery remodelling are considered central mechanisms.[5] This leads to placental ischemia and the release of inflammatory mediators, anti-angiogenic factors, and oxidative stress markers, resulting in widespread endothelial dysfunction and systemic manifestations.[3] Globally, HDP complicates 2-8% of pregnancies and accounts for approximately 10-15% of maternal deaths, with a particularly high burden in low- and middle-income countries like India.[6]

Vitamin D, traditionally known for its role in calcium homeostasis and bone metabolism, has emerged as an important modulator of immune function, inflammation,

and vascular health. The active form, 1,25-dihydroxyvitamin D, acts through the vitamin D receptor (VDR), which is widely expressed in reproductive tissues, including the placenta. Adequate vitamin D levels are essential for proper placental development, immune tolerance, and vascular adaptation during pregnancy.[5]

Vitamin D deficiency is highly prevalent among pregnant women, especially in developing countries, despite adequate sunlight exposure. In India, more than 70% of pregnant women are estimated to have suboptimal Vitamin D levels due to factors such as limited sun exposure, darker skin pigmentation, and inadequate dietary intake.[7] Emerging evidence suggests that vitamin D deficiency may contribute to development of preeclampsia through multiple mechanisms, including dysregulation of renin-angiotensin system, impaired placental invasion, increased inflammatory response, and altered calcium metabolism.

Given the high burden of hypertensive disorders and the modifiable nature of vitamin D deficiency, evaluating its role in preeclampsia is of significant clinical importance. Identifying this association may aid in early risk stratification and open avenues for preventive strategies such as screening and supplementation during pregnancy.

Aims and objectives

Aim and objectives were to compare and contrast the serum vitamin D levels among pre-eclamptic, eclamptic pregnant women and healthy pregnant women in labour.

METHODS

This hospital-based observational cross-sectional study was conducted in the Department of Obstetrics and Gynaecology in collaboration with the Department of Biochemistry at Fakhruddin Ali Ahmed Medical College and Hospital over a period of one year, from 1st December 2024 to 30th November 2025. Ethical approval was obtained from the institutional ethics committee prior to commencement of the study, and written informed consent was obtained from all participants.

The study included pregnant women aged 18-40 years with singleton pregnancies who were admitted in labour. Participants were categorized into cases and controls. Cases included women diagnosed with preeclampsia or eclampsia according to ACOG criteria, while healthy normotensive pregnant women in labour served as controls. Women with chronic hypertension, diabetes mellitus, renal or hepatic disorders, thyroid disease, multiple pregnancies, malabsorption disorders, or those on medications affecting vitamin D metabolism were excluded from the study.

The sample size was calculated using the standard prevalence formula, taking the expected prevalence of Vitamin D deficiency among preeclamptic women as 82.8%, with 95% confidence interval and 7% absolute precision.[8] The calculated sample size was 112 participants, comprising 56 cases (28 preeclamptic and 28 eclamptic women) and 56 healthy controls.

Data were collected using a structured case record form. Sociodemographic details, obstetric history, antenatal records, supplement intake, and symptoms related to hypertensive disorders were recorded. All participants underwent detailed general and obstetric examinations, including BP measurement and urine protein assessment.

Approximately 5 mL of venous blood was collected aseptically from each participant prior to delivery. Serum was separated and analysed for 25-hydroxy vitamin D [25(OH)D] levels using CLIA with the VITROS 5600 Integrated System Analyser in the Department of Biochemistry. Additional investigations included complete blood count, liver and renal function tests, serum electrolytes, urine protein, random blood sugar, LDH, blood grouping, and infectious disease screening.

Data were entered into Microsoft excel and analysed using PSPP version 2.0.1. Descriptive statistics were expressed as mean±standard deviation, frequencies, and percentages. Comparison between groups was performed using t test, ANOVA, Mann-Whitney U test, or Kruskal-Wallis test as appropriate. Correlation analysis was performed using Pearson's or Spearman's correlation coefficient. A $p<0.05$ was considered statistically significant.

RESULTS

Study participants were from young age group and majority in gestational week of 37-40 weeks. Distribution of age and gestation age is provided in Table 1.

Nulliparity was more frequently observed among controls, whereas cases were more evenly distributed across higher parity groups. Nevertheless, nulliparous women constituted the largest parity category overall. The difference in parity distribution between cases and controls was statistically significant ($\chi^2=9.006$, $p=0.041$)

The mean SBP was significantly higher among cases compared to controls (155.04±12.67 mmHg vs. 117.89±11.33 mmHg; $t=16.348$, $df=110$, $p<0.001$). Similarly, mean DBP was significantly elevated in cases compared to controls (101.82±6.18 mmHg vs. 72.54±6.96 mmHg; $t=23.522$, $df=110$, $p<0.001$). Proteinuria was observed in all cases and none of the controls.

The distribution of vitamin D status showed a significant difference between cases and controls (Table 2). In addition, the blood calcium level also showed a significant difference among the cases and controls (Table 3).

On subgroup analysis that is on comparing the grades of pre-eclampsia and pre-eclampsia, we observed significant differences between the vitamin D levels as shown in Table 4.

Table 1: Distribution of age and gestational age.

Variables	Category	Cases, N (%)	Controls, N (%)	P value
Age group (in years)	18-23	25 (44.6)	34 (60.7)	0.07
	23-28	16 (28.6)	12 (21.4)	
	28-33	9 (16.1)	10 (17.9)	
	>33	6 (10.7)	0 (0.0)	
Gestational age (in weeks)	31-34	5 (8.9)	5 (8.9)	0.35
	34-37	13 (23.2)	14 (25.0)	
	37-40	32 (57.1)	26 (46.4)	
	>40	6 (10.7)	11 (19.6)	

Table 2: Distribution of vitamin D level among cases and controls.

Vitamin D status	Cases, (n=56), N (%)	Controls, n=56), N (%)	χ^2 value	Df	P value
Deficiency (<20 ng/ml)	12 (21.4)	3 (5.4)	70.26	2	0.021
Insufficiency (20-30 ng/ml)	41 (73.2)	14 (25.0)			
Sufficiency (>30 ng/ml)	3 (5.4)	39 (69.6)			
Total	56 (100.0)	56 (100.0)			

Table 3: Distribution of calcium levels among cases and controls.

Calcium level	Cases (n=56), N (%)	Controls (n=56), N (%)	χ^2 value	Df	P value
Deficiency	42 (75.0)	6 (10.7)	51.277	2	<0.001
Normal	13 (23.2)	29 (51.8)			
Excess	1 (1.8)	21 (37.5)			
Total	56 (100.0)	56 (100.0)			

Table 4: Distribution of vitamin D levels among grades of pre-eclamsia and eclampsia.

Vitamin D status	Mild preeclampsia, N (%)	Severe preeclampsia, N (%)	Eclampsia, N (%)	χ^2 value	Df	P value
Deficiency (<20 ng/ml)	1 (6.7)	1 (7.7)	13 (46.4)	11.018	3	0.04
Insufficiency (20-30 ng/ml)	14 (93.3)	12 (92.3)	15 (53.6)			
Total	15 (100.0)	13 (100.0)	28 (100.0)			

DISCUSSION

In the study the participants belonged to the younger age group and the difference in age distribution between cases and controls was not statistically significant (p=0.07), suggesting comparable maternal age profiles between groups. A small proportion of women above 33 years was observed among cases, indicating a possible trend toward higher age in hypertensive pregnancies which is in congruence with the studies by Liu et al and Lamminpää et al.[9,10] In studies by Gupta et al and Tyagi et al it was observed that most preeclamptic and normotensive women were near term at delivery, with no major difference in gestational age distribution between groups which is similar to the finding in our study comparable gestational age at delivery among the study groups.[7,11] In the present study, nulliparous women constituted the largest proportion of participants, and higher parity (≥3) was observed more frequently among cases. The difference in parity distribution between cases and controls was statistically significant, suggesting an association between parity and hypertensive disorders in pregnancy. The finding is consistent with published literature that nulliparity is well-established risk factor for preeclampsia, likely due to immunological maladaptation during the first pregnancy.[12] While, grand multiparity may also increase the risk of hypertensive disorders, especially in low-resource settings, which may explain the higher parity observed among cases in present study.[13]

The American College of Obstetricians and Gynecologists (ACOG) defines preeclampsia as new-onset hypertension with systolic blood pressure ≥140 mmHg or diastolic ≥90 mmHg after 20 weeks of gestation, which supports the elevated values of blood pressure and proteinurea observed in the cases present study.[14] We observed vitamin D deficiency and insufficiency were significantly more common among cases compared to controls, while most controls had sufficient vitamin D levels (p=0.021), indicating a strong association between low vitamin D levels and HDP. Further subgroup analysis among cases showed that vitamin D deficiency was more frequently observed in women with eclampsia, whereas vitamin D insufficiency predominated among preeclampsia cases,

suggesting that progressively lower vitamin D levels may be associated with increasing disease severity. These findings are consistent with findings by Gupta et al and Sadin et al which show an association between low maternal vitamin D and preeclampsia.[7,15]

Also, a systematic review and meta-analysis by Tabesh et al further concluded that maternal vitamin D deficiency significantly increases the risk of preeclampsia across observational studies.[16] In our study difference in calcium distribution between cases and controls was highly statistically significant ($p<0.001$), suggesting a strong association between low serum calcium and preeclampsia/eclampsia. This finding is in congruence with studies by Hofmeyr et al and Khaing et al.[17,18] Low calcium intake and reduced serum calcium are associated with an increased risk of preeclampsia, possibly due to enhanced vascular smooth muscle contractility and increased blood pressure.

CONCLUSION

The present study demonstrated that vitamin D deficiency and insufficiency were significantly more common among women with preeclampsia and eclampsia compared to normotensive controls, with lower vitamin D levels being associated with increasing disease severity. Serum calcium levels were also significantly lower among cases, supporting the role of altered calcium metabolism in hypertensive disorders of pregnancy. Further, interventional studies are needed to understand the molecular mechanism and to observe if vitamin D supplementation can reduce the occurrence of hypertensive disorders among women at risk of the same.

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