

## HYPOCALCAEMIA AMONG WOMEN WITH HYPERTENSIVE DISORDERS OF PREGNANCY IN A TERTIARY CARE HOSPITAL

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Received : 08/11/2022

Received in revised form : 11/12/2022

Accepted : 23/12/2022

**Keywords:**

Hypocalcaemia, Hypertensive, serumcalcium, Pregnancy, Hospital.

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DOI: 10.47009/jamp.2023.5.1.121

Source of Support: Nil,  
Conflict of Interest: Nonedeclared

*Int J Acad Med Pharm*  
2023; 5 (1); 586-592



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### Abstract

**Background:** The objective of the study were to estimate the proportion of hypocalcaemia among the women with preeclampsia and eclampsia of pregnancy and to use as a predictor for early diagnosis of HDP and its severity during antenatal screening. **Materials and Methods:** The cross sectional study was carried out in the Department of Obstetrics and gynecology in a tertiary care hospital in Paschim Medinipur, for 18 months from 1st April 2021 to 31st September 2022. A total of 200 women fulfilling eligibility criteria will be included in the study. **Result:** All the collected data was entered into an excel data sheet. After appropriate data filtration, the data sheet was transferred and analysed using SPSS software version 20.0. Appropriate descriptive statistics like rates, percentages, proportions, mean, and standard deviation were used to describe the data variables. The results were expressed as mean +/-standard deviation. **Conclusion:** Serum calcium levels in eclampsia and preeclampsia were found to be lower than normal reference range and suggest that serum calcium may be used as markers for PE and preeclampsia. Decrease in serum calcium in preeclampsia and eclampsia females could be due to either decreased intake or defective intestinal absorption or decreased renal tubular re-absorption.

## INTRODUCTION

Pregnancy is a physiological stress where many changes occur in the milieu interior of the body. Due to more stress being laid on biochemical changes in the blood, normal pregnancy turns into complicated pregnancy like hypertensive disorders of pregnancy (HDP) including preeclampsia and eclampsia.<sup>[1]</sup> Hypertensive disorders of pregnancy (HDP) are the leading cause of maternal, perinatal morbidity and mortality.<sup>[2-4]</sup> and affect around 2-10% of all pregnancies globally.<sup>[5]</sup> According to the World Health Organization (WHO), estimated incidence of HDP is seven times higher in developing countries as compared to developed countries and risk of maternal deaths due to it in low-income countries is 300 times that of high-income.<sup>[6,7]</sup> The first report on the relationship of hypertension in pregnancy with intake of calcium was made in 1980.<sup>[8]</sup> This was due to the finding that Mayan Indians that lived in Republic of

Guatemala, usually prepare their corn by dipping it in lime before cooking as part of their custom, were noticed to have a low incidence of preeclampsia (PE) and eclampsia and much consumption of calcium.

Absorption of calcium can vary, especially depending on calcium intake.<sup>[9]</sup> Calcium absorption appears to be greatest within the duodenum and ileum and occurs by both passive and active process.<sup>[10]</sup> Active reabsorption of calcium takes place in the loop of Henle in the proximal tubules and this is influenced by urinary loss and probably the acid-base balance. Excess calcium is eliminated by the kidneys.<sup>[11]</sup>

Hypocalcaemia has been shown to occur during pregnancy, reaching lowest level at the beginning of third trimester. This reduction may be due to factors such as higher nutritional demands in pregnancy, inadequate intake in the diet and volume expansion and reduction in concentration of plasma proteins (especially albumin) in pregnancy.<sup>[12]</sup> In addition,

increase in maternal oestrogen production blocks bone re-absorption and increases calcium urinary excretion. As a compensatory mechanism, parathyroid hormone (PTH) tends to increase at term. However parathyroid hormone may indirectly increase intestinal absorption of calcium as the only compensatory process during pregnancy because of the action of estrogen.<sup>[13]</sup>

Calcium supplementation during pregnancy is known to decrease incidence as well as severity of gestational hypertension, preeclampsia, eclampsia and also neonatal morbidity and mortality, as well as preterm births, especially in developing countries, although the impact varies according to the baseline calcium intake and other prevailing risk factors in the population. The underlying mechanism can be explained by reduction in parathyroid calcium release and intracellular calcium concentration, in woman taking calcium supplementation during pregnancy, thereby reducing smooth muscle contractility and promoting vasodilatation and hence, decreasing the risk and or severity of hypertensive disorder of pregnancy.

Hence, the purpose of the study was to estimate proportion of hypocalcemia among women with preeclampsia and eclampsia and impact of maternal serum calcium levels on severity of hypertensive disorder of pregnancy.

## MATERIALS AND METHODS

The study cross sectional study was carried out in the Department of Obstetrics and gynecology in a tertiary care hospital in Paschim Medinipur, for 18 months from 1st April 2021 to 31st September 2022. A total of 200 women fulfilling eligibility criteria will be included in the study. All pregnant women attending antenatal outpatient department and being admitted in Midnapore Medical College and Hospital under obstetrics and gynecology department considering inclusion and exclusion criteria.

### Inclusion Criteria

Diagnosis of pre-eclamptic and eclamptic women with gestational age of 28 weeks or more and blood pressure  $>140/90$  mm of Hg or more with proteinuria ( $>/ 1+$  dipstick) attending ANC OPD and admitted in our institute.

### Exclusion Criteria

Women having - Gestational hypertension, liver disease, renal disease, cardiovascular disease, severe anemia, diabetes, systemic or endocrine disorders, twin pregnancies, known hypertension, women who are taking medication or other pre-existing medical conditions which alter study parameters, pregnant women with a history of smoking and an illegal drug intake.

**Study Tool:** Proper history taking and physical examination of the patient, BHT of mothers, Antenatal OPD and labor room logbook record, Data collection tool (proforma), Serum calcium, Other relevant biochemical and hematological parameters like urea, creatinine,  $\text{Na}^+$ ,  $\text{K}^+$ , LFT, complete blood count including platelet count, urinary protein, Relevant radiological investigations (USG for FPP with AFI, NCCT brain in eclampsia).

### Methodology

Data will be collected regarding maternal age, gravida, residency, gestational age, socioeconomic status, BMI. Proper history will be taken regarding hypertensive disorders, past medical and surgical history, menstrual history, present and past obstetric history, family history and personal history. Detailed general examination including pulse, blood pressure and temperature, respiratory rate followed by systemic and obstetric examination will be done. Blood pressure of all participants was then measured using manual mercury sphygmomanometer. Blood pressure was carefully recorded, with woman in sitting position with feet flat on floor and back well supported and with arm at level of heart using an appropriately sized cuff, such that the inflatable bladder covered 75-100% of circumference of upper arm of the patient. Systolic blood pressure is first assessed by palpation of radial pulse after inflating the cuff. In auscultation technique, the diaphragm of the stethoscope is placed over the brachial pulse over antecubital fossa. Kotorkoff sounds phase I and V will be used to record systolic and diastolic respectively (14).

### Diagnostic Criteria of Pre-Eclampsia

Preeclampsia is a multisystem disorder of pregnancy. According to ACOG, it is defined as new-onset hypertension  $\geq 140/\geq 90$  mmHg on two occasions at least 4 hours apart but not more than 7 days after 20 weeks of gestation (10) with one of the following:

- Proteinuria ( $\geq 1+$  dipstick or more than 300 mg/24 hr)
- Renal insufficiency (serum Cr  $> 1.1$  mg/dL or doubling from baseline)
- Thrombocytopenia ( $< 100 \times 10^9$  /L)
- Impaired liver function (transaminases greater than twice normal)
- Pulmonary edema
- New-onset headache or visual symptoms.

## RESULTS

All the collected data was entered into an excel data sheet. After appropriate data filtration, the data sheet was transferred and analysed using SPSS software version 20.0. Appropriate descriptive statistics like rates, percentages, proportions, mean, and standard deviation were used to describe the data variables. The results were expressed as mean  $\pm$  standard deviation. Regression analysis and student t test (two tailed, independent) has been used to find the

significance of study parameters. Pearson's correlation coefficient(r) was calculated to assess the correlation between biochemical parameters and

the blood pressure. 'P' value of less than 0.05 was considered significant.

**Table 1: Distribution of Cases According to Socioeconomic Status**

Socioeconomic status	Eclampsia (54)		Preeclampsia (146)		P value	t test
	Count	Percentage (%)	count	Percentage (%)		
Lower	32	59.26	110	75.34	0.363186	5.065087
Upper lower	12	22.22	18	12.33		
Lower middle	10	18.52	10	6.85		
Upper middle	0	0	8	5.48		
Upper	0	0	0	0		

[Table 1] shows 59.26%, 22.22%, 18.52%,0% of eclamptic group and 75.34%,12.33%,6.85%,5.48% of pre-eclamptic group were from lower, upper lower, lower middle and upper middle respectively. There was no statistically significant difference between the two groups (P value- 0.36).

**Table 2: Distribution of Cases According to Gravida**

	Eclampsia (54)		Preeclampsia (146)		P value
	Count	Percentage(%)	Count	Percentage(%)	
Primigravida	44	81.48	90	61.64	0.226936
Multigravida	10	18.52	56	38.36	
Mean	1.259259		1.695364		
SD	0.619957		1.032753		

[Table 2] shows mean gravida in eclampsia is  $1.259259 \pm 0.619957$  and in preeclampsia is  $1.695364 \pm 1.032753$  which is statistically insignificant (P value- 0.226936).

**Table 3: The Mean Serum Calcium Level in Early Onset and Late Onset Eclampsia as well as Early Onset and Late Onset Preeclampsia**

	Study groups	Early onset (GA at	Late onset (GA at	P value
		Onset<34 weeks)	Onset≥34 weeks)	
Mean corrected serum calciumlevel (mg/dl)	Eclampsia	$7.4615385 \pm 0.9008871$ (n=13)	$7.839534884 \pm 0.837751569$ (n=41)	0.209481
	Preeclampsia	$7.49 \pm 0.553342857$ (n=8)	$7.849058 \pm 0.739103$ (n=138)	0.2248616

[Table 3] shows mean serum calcium level in eclampsia was  $7.4615385 \pm 0.9008871$  in early onset and  $7.839534884 \pm 0.837751569$  in late onset and in pre-eclampsia, it was  $7.49 \pm 0.553342857$  in early onset and  $7.849058 \pm 0.739103$  in late onset. Across the groups revealed non-significant statistical difference in the mean serum calcium levels among women with eclampsia and preeclampsia with p value 0.209 and 0.22 respectively.

**Table 4: Serum Calcium Level in Both Groups**

Serumcalciumlevel (mg/dl)	Eclampsia (54)		Preeclampsia(146)	
	Frequency	Percentage (%)	Frequency	Percentage (%)
9-11	0	0	19	13.01
8-9	22	40.74	45	30.82
7-8	29	53.70	54	37.00
<7	3	5.56	28	19.17

Among eclamptic patients, 22(40.74%) have serum calcium level between 8-9 mg/dl, 29(53.70%) have serum calcium level between 7-8 mg/dl, 3(5.56%) have serum calcium level below7 mg/dl. Among preeclamptic patients, majority (36.99 %) has serum calcium level between 7- 8 mg/dl, 13.01% have serum calcium level between 9-11mg/dl, 30.82% have serum calcium level between 8-9 mg/dl, and 19.17% have serum calcium level below 7mg/dl.

**Table 5: Correlation of Serum Calcium Level in Both Groups**

Serum Ca	Eclampsia	Preeclampsia	P value	T test
Mean	7.455714286	7.825882353	0.037155	9.266675
SD	0.518054	0.876575		

[Table 5] shows mean serum calcium in eclampsia was  $7.455714286 \pm 0.518054$  which is lower than that of preeclampsia (mean± SD-  $7.825882353 \pm 0.876575$ ) with P value 0.037 which is statistically significant.

**Table 6: Association of Severity of Preeclampsia with Serum Calcium**

Parameter	Mild Preeclampsia (n=86)	Severe Preeclampsia (n=60)	P value
Serum calcium	8.03093 ±0.833153	7.435167 ±0.828063	0.027458

[Table 6] shows mean serum calcium in mild and severe preeclampsia was  $8.03 \pm 0.83$  and  $7.43 \pm 0.82$  respectively with significant p value (0.0274).

**Table 7: Distribution of Cases According to Diastolic Blood Pressure**

DBP	Eclampsia(54)		Preeclampsia(146)	
	Frequency	Percentage (%)	Frequency	Percentage (%)
<100	32	59.26	55	37.67
101-110	12	22	81	55.48
111-120	10	10	8	5.48
>120	0	0	2	1.37

[Table 7] shows 59.26% of eclampsia and 37.67% of preeclampsia had DBP <100 mm of Hg, 22% of eclampsia and 55.48% of preeclampsia had DBP 101-110 mm of Hg, 10% of eclampsia and 5.48% of preeclampsia had DBP 111-120 mm of Hg and 1.37% of preeclampsia had DBP >120 mm of Hg. There was no eclampsia above 120 mm of Hg DBP.

**Table 8: Comparison of Mean Diastolic Blood Pressure between two Groups**

DBP	ECLAMPSIA(54)	PREECLAMPSIA(146)	P VALUE
Mean ± SD	99.48148 ± 7.795395	99.28814 ± 9.310043	0.965393

[Table 8] shows mean ± SD DBP in eclampsia and preeclampsia were  $99.48148 \pm 7.795395$  and  $99.28814 \pm 9.310043$  respectively. There was no statistically significant difference of DBP between two groups (p value=0.965).

**Table 9: Correlation of Serum Calcium Level with Diastolic Blood Pressure**

Diastolic blood pressure(mmHg)	Mean calcium (mg/dl)	SD	R	R square	Equation	P value
<100	7.942078	0.773906				
101-110	7.77205377	0.85227532				
111-120	6.97875	0.560266199				
>120	6.45	0.494975				
Mean ± SD - 99.27 ± 8.667589	Mean ± SD -7.8021 ± 0.860326		-0.21744355	0.047281697	Y= -0.0216x + 9.9446	0.00198188

[Table 9] shows correlation of serum calcium level with diastolic blood pressure. Mean serum calcium level in diastolic blood pressure >120 mm of Hg is lower ( $6.45 \pm 0.49$ ) than mean serum calcium in diastolic blood pressure <100 mm of Hg ( $7.94 \pm 0.77$ ). It also shows Pearson correlation of diastolic blood pressure with serum Ca levels. Serum Ca had a significant moderate negative correlation with diastolic BP (R= -0.217, p value=0.00198).

**Table 10: Distribution of Cases According to Systolic Blood Pressure**

SBP	Eclampsia (54)		Preeclampsia (146)	
	Frequency	Percentage (%)	Frequency	Percentage (%)
<150	14	26	46	31.50
150-160	25	46	69	47.26
161-170	12	22	14	9.59
171-180	1	1.85	8	5.48
>180	2	3.70	9	6.16

[Table 10] shows 26%, 46%, 22%, 1.85%, 3.70% of eclampsia had SBP of <150 mm of Hg, 150-160 mm of Hg, 161-170 mm of Hg, 171-180 mm of Hg and >180 mm of Hg respectively. Similarly, 31.50%, 47.26%, 9.59%, 5.48% and 6.16% of preeclampsia had SBP of <150 mm of Hg, 150-160 mm of Hg, 161-170 mm of Hg, 171-180 mm of Hg and >180 mm of Hg respectively.

**Table 11: Distribution of Serum Calcium Level with Systolic Blood Pressure**

SBP (mm of Hg)	Mean serum calcium level (mg/dl)	SD	R	R square	Equation	P value
<150	8.208571	0.832536				
150-160	7.792234	0.68909				
161-170	7.129286	0.71119				
171-180	6.792727	0.629191				
>180	6.738182	0.556309				

Mean ± SD 155.7822±14.33379	Mean ± SD 7.775347±0.854629	-0.474164	0.224831	y = -0.0283x + 12.18	1.02E-12
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[Table 11] shows correlation of serum calcium level with systolic blood pressure. Mean serum calcium level in systolic blood pressure >180 mm of Hg is lower (6.73±0.55) than mean serum calcium in systolic blood pressure <150 mm of Hg (8.20±0.83). It also shows Pearson correlation of systolic blood pressure with serum Ca levels. Serum Ca had a significant negative correlation with systolic BP (R= -0.474, p value= 1.02E-12).

**Table 12: Proteinuria in Preeclampsia and Eclampsia**

PROTEINURIA	ECLAMPSIA (54)		PREECLAMPSIA (146)	
	Frequency	Percentage (%)	Frequency	Percentage (%)
1+	35	64.81	129	88.36
2+	13	24.07	11	7.53
3+	4	7	5	3.42
4+	2	3.70	1	0.68

[Table 12] shows 64.81% of eclampsia and 88.36% of preeclampsia has been found 1+ in dipstick method.

**Table 13: Correlation of Serum Calcium Level with Proteinuria (By Dipstick Method)**

PROTEINURIA	Mean serum calcium(mg/dl)	SD
1+	7.94939	0.816348
2+	7.176429	0.736708
3+	6.713333	0.81306
4+	6.6	0.282843

Mean calcium level in proteinuria +1 was 7.94 ± 0.81 mg/dl, in proteinuria +2 mean calcium level was 7.17 ± 0.73 mg/dl, in proteinuria >+3 group mean calcium level was 6.71 ± 0.81 mg/dl and in proteinuria 4+ mean serum calcium was 6.6 ± 0.28 mg/dl. It shows inverse relationship between proteinuria and serum calcium level.

## DISCUSSION

In the present study, 200 cases were incorporated. Out of which 54(27%) were eclampsia and 146(73%) were preeclampsia. In my study, majority (65.06%) of preeclampsia were between 20-35 years and majority (66.67%) of eclampsia were below 20 years(teenage pregnancies). There was no statistically significant difference of age between the study groups (p value=0.74819). Kundu et al,<sup>[15]</sup> shows similar findings where mean age in preeclampsia is 23.7±0.65 and mean age in eclampsia is 21.87±0.75 and there was no significant difference between study groups. In our study women with PE were older which tally with observations of other authors, who have shown that PE is more likely to occur in women of advanced maternal age compared to younger women.<sup>[16]</sup> The findings correlates with the study done by Sethi S et al.<sup>[17]</sup> Mean Body mass Index of eclampsia was 21.17407 ±3.385328 which is significantly lower than that of preeclampsia (24.32603 ±5.067232) with p value 0.01775. Majority of patients enrolled in the study were booked for antenatal care. Mean gravida in eclampsia is 1.259259 ± 0.619957 and in preeclampsia is 1.695364 ± 1.032753 which is statistically insignificant (P value- 0.226936). Poonia le et al. also found insignificant difference (p>0.05). Furthermore, in this study it was found that both eclampsia and preeclampsia were more

common in primigravida (81.48% and 61.64% respectively) as compared to multigravida (18.52% and 38.36% respectively). Similar results were observed by a study done by Halimi et al.

Mean serum calcium level in eclampsia was 7.4615385 ± 0.9008871 in early onset and 7.839534884 ± 0.837751569 in late onset and in pre-eclampsia, it was 7.49 ± 0.553342857 in early onset and 7.849058 ± 0.739103 in late onset. Across the groups revealed non-significant statistical difference in the mean serum calcium levels among women with eclampsia and preeclampsia with p value 0.209 and 0.22 respectively. also study done by Chukwunyere et al,<sup>[18]</sup> showed significant difference of mean serum calcium in preeclampsia (p value=0.064) and gestational hypertension in early and late onset (p value=0.954).

Among eclamptic patients, 22(40.74%) have serum calcium level between 8-9 mg/dl, 29(53.70%) have serum calcium level between 7-8 mg/dl, 3(5.56%) have serum calcium level below 7 mg/dl. Among preeclamptic patients, majority (36.99 %) have serum calcium level between 7-8 mg/dl, 13.01% have serum calcium level between 9-11mg/dl, 30.82% have serum calcium level between 8-9 mg/dl, 19.17% have serum calcium level below 7mg/dl. Mean serum calcium in eclampsia was 7.4557± 0.51 which is lower than that of preeclampsia which was 7.8258 ± 0.87 with P value 0.037 which is statistically significant. My study also shows that mean serum calcium in mild and severe preeclampsia was 8.03 ± 0.83 and 7.43 ± 0.82 respectively with statistically significant p value (0.0274). The results were comparable with that observed by Gupta et al,<sup>[19]</sup> where severity of preeclampsia is inversely proportional to the levels of serum calcium while Vafaei et al,<sup>[20]</sup> in their study observed that serum Ca levels in PE pregnant

women had no significant differences with normotensive subjects and also severity of this disorder could not influenced the serum levels of calcium.

Koley et al,<sup>[21]</sup> also found that the serum calcium level in eclampsia and severe pre-eclampsia were significantly less than normal pregnant woman ( $7.06 \pm 0.16$  mg/dl and  $7.22 \pm 0.41$  mg/dl vs  $8.81 \pm 0.59$  mg/dl respectively ( $p$  value  $<0.05$ ). Manjareekaet al.<sup>[22]</sup> This difference with our result may be attributed to the different socio- demographic characteristics of the population and also to the different dietary habits of the population. Mohieldein AH et al.<sup>[23]</sup> stated in the study that low level of maternal total calcium may have a roll in the development of hypertension disorders of pregnancy. Serum calcium is very important for metabolism at the cellular level and are vital for muscle contraction, cell death and neuronal activity, making it very essential in pregnancy. Therefore, calcium consumption in pregnancy should be encouraged and recommended calcium supplement for women who live in places of low socio-economic status as well as for women who prefer to skip milk and milk products due to personal preferences.

Majority of eclampsia (59.26%) had DBP  $<100$  mm of Hg and 55.48% Of preeclampsia had DBP 101-110 mm of Hg. The study shows mean  $\pm$  SD DBP in eclampsia and preeclampsia were  $99.48148 \pm 7.795395$  and  $99.28814 \pm 9.310043$  respectively. There was no statistically significant difference of DBP between two groups ( $p$  value- 0.965).

Majority of eclampsia (46%) and preeclampsia (47.26%) had SBP 150-160 mm of Hg. Study shows mean  $\pm$  SD SBP in eclampsia and preeclampsia were  $156.9434 \pm 14.263241$  and  $155.890411 \pm 14.263241$  respectively. There was no statistically significant difference of DBP between two groups ( $p$  value- 0.677).

Serum calcium had a negative correlation ( $R = -0.474164$ ) with SBP and DBP ( $R = -0.217$ ). The relation of Serum calcium with SBP and DBP was statistically significant ( $p < 0.005$ ). The results were in agreement with the results of Agu and Okeudo,<sup>[24]</sup> who observed there was an inverse relationship between serum calcium and systolic blood pressure ( $R = -0.684$ ,  $p < 0.001$ ) as well as a negative correlation between serum calcium and diastolic blood pressure ( $R = -0.633$ ,  $p < 0.001$ ). Sethi s et al,<sup>[17]</sup> also found that Serum ionic calcium had a moderate negative correlation ( $R = -0.538$ ) with SBP and DBP ( $R = -0.5137$ ). The relation of S. ionic calcium with SBP and DBP was statistically significant ( $p < 0.0001$ ).

Thus, serum calcium appears to play an important role in the development of preeclampsia and it can evolve as a sensitive test for early detection of this disorder. Majority (64.81%) of eclampsia and (88.36%) preeclampsia has been found 1+ in dipstick method. It was observed that with increasing severity of preeclampsia measured in

terms of increasing diastolic blood pressure and increasing proteinuria, the serum calcium levels were gradually decreasing.

## CONCLUSION

Serum calcium levels in eclampsia and preeclampsia were found to be lower than normal reference range and suggest that serum calcium may be used as markers for PE and preeclampsia. Decrease in serum calcium in preeclampsia and eclampsia females could be due to either decreased intake or defective intestinal absorption or decreased renal tubular reabsorption. It may be concluded that deficiency of calcium in Pregnancy Induced Hypertension women may be related to their inadequate dietary intake and this macronutrient deficiency may be a risk factor for development of high blood pressure and hypertensive disorders of pregnancy. Therefore, based on this study, serial measurements of serum calcium among women who are at risk of HDPs, early identification and supplementation of calcium (dietary intake of 1200mg/day of calcium for pregnant women) may be used to predict the onset and severity of PE and eclampsia.

## REFERENCES

1. Kashinakunti SV, Sunitha H, Gurupadappa K, Shankarprasad DS, Suryaprakash G, Ingin JB. Lipid peroxidation and antioxidant status in pre-eclampsia. *Al Ameen J Med Sci* 2010;3(1):38-41.
2. Khan KS, Wojdyla D, Say L, Gülmezoglu AM, Van Look PF. WHO analysis of causes of maternal death: a systematic review. *Lancet*. 2006 Apr 1; 367(9516):1066-74.
3. Ugwuja EI, Famurewa AC, Ikaroaha CI. Comparison of serum calcium and magnesium between preeclamptic and normotensive pregnant Nigerian women in Abakaliki, Nigeria. *Ann Med Health Sci Res*. 2016; 6: 33-7.
4. Centre for Maternal and Child Enquiries. Saving mothers' lives: reviewing maternal deaths to make motherhood safer: 2006-08. The eighth report on confidential enquiries into maternal deaths in the United Kingdom. *BJOG*. 2011; 118(Suppl 1): 1-203.
5. Duley L. The global impact of preeclampsia and eclampsia. *Semin Perinatol*. 2009;33(3):130-7.
6. World Health Organization. World health report. 2005. Geneva: WHO; 2005. Make every mother and child count, [www.who.int/whr/2005/whr2005\\_en.pdf](http://www.who.int/whr/2005/whr2005_en.pdf).
7. Engender Health. Balancing the scales: expanding treatment for pregnant women with life-threatening hypertensive conditions in developing countries. A report on barriers and solutions to treat pre-eclampsia and eclampsia. New York: Engender Health; 2007.
8. Belizan JM, Villar J. The relationship between calcium intake and edema, proteinuria, and hypertension-gestosis: An hypothesis. *Am J Clin Nutr* 1980;33:2202-10.67
9. Young G, Jewell D. Interventions for leg cramps in pregnancy. *Cochrane Database Sys Rev*. 2002. CD000121.
10. Belzan JM, Zalazar A. A preliminary evidence of effects of calcium supplementation on blood pressure in normal pregnant women. *AMJ ObstetGynecol* 1983; 140:175-180.
11. Walter F. Plasma Calcium levels are regulated by hormonal and non-hormonal mechanisms, *Medical Physiology, A Cellular and Molecular Approach* (2003, revised 2009): Elsevier/ Saunders p. 1094-300. ISBN 1-14160-2328-3.
12. Fairweather-Tait S, Prentice A, Heumann K. Effects of calcium supplements and stage of lactation on the calcium absorption efficiency of lactating women accustomed to low calcium intake. *Am J Clin* 1995; 62:1188-92.

13. Heaney RP, Skillman T G. Calcium metabolism in normal human pregnancy. *J Clinical Endocrinol Metab* 1971; 33: 66-170.
14. WhitehouseAJ, Robinson M, Newnham JP, Pennell CE. Do hypertensive diseases of pregnancy disrupt neurocognitive development in offspring? *PaediatrPerinatEpidemiol*2012;26:101 8.
15. Kundu et al. ESTIMATION OF SERUM CALCIUM IN NORMAL PREGNANCY, PREECLAMPSIA AND ECLAMPSIA *Pharmacologyonline*.2009; 1: 1194-1199.
16. Ephraim RKD, Derick NMO, Seth WD, Henrietta E, Samuel A, Enoch OA. Serum calcium and magnesium levels in women presenting with preeclampsia and pregnancy-induced hypertension: a case-control study in the Cape Coast metropolis, Ghana. *BMC Pregnancy and Childbirth*. 2014;14:390.
17. SaloniSethi, Ankita Chaudhary, PriyaSonkhya, PremlataMital\*, Aditi Arora, Vikash K. Kasana, Ishita Agarwal, A comparative study of serum calcium and magnesium levels in women with pre-eclampsia and normotensive women *Int J ReprodContraceptObstet Gynecol*. 2021 Jun;10(6):2420-2426.
18. Chukwunyerere CF, Awonuga DO, Olunuga TO, Udenze IC. Comparison of Serum Calcium Level in Hypertensive and Normotensive Pregnant Women. *Nigerian Journal of Medicine* 2020;Volume 29: Issue 4.
19. Gupta P. A study of maternal serum calcium and serum magnesium levels in pre-eclamptic and normotensive pregnancies. *Int J ReprodContraceptObstet Gynecol*. 2020;9(8):3129-33.
20. Vafaei H, Dalili M, Hashemi SA. Serum concentration of calcium, magnesium and zinc in normotensive versus pre-eclampsia pregnant women: A descriptive study in women of Kerman province of Iran. *Iran J Reprod Med*. 2015;13:23-6.
21. Koley A, Das S, Sarkar S, Char D, Saha TK. Association of serum calcium and uric acid level with hypertensive disorders of pregnancy [pre eclampsia and eclampsia] and their correlation with disease severity. *IOSR-JDMS* 2013;9(5): 32e5.
22. Manjareeka M, Nanda S; Serum Electrolyte Levels in Preeclamptic women: A Comparative Study. *International Journal of Pharma and Bio Sciences* 2012; 3 (2):572-8.
23. Moheildeen AH, Doken AA, Oman YH, Idris HM. Serum calcium level as marker of pregnancy induced hypertension. *Sudan JMS* 2007;4:245-248
24. Agu CT, Okeudo C. A Comparative Study of Serum Calcium Levels between Pre-eclamptic and Normotensive Singleton Pregnancies in Federal Medical Centre, Owerri. *J Adv Med Medical Res*. 2018;27(11):1-8.