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Evaluating the Serum Electrolyte Status of Preeclampsia Women Cared for in Tertiary Hospitals in Enugu Metropolis: A Cross Sectional Study

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ABSTRACT

Preeclampsia is a pregnancy-specific multisystem disorder that typically begins at 20 weeks or later in pregnancy and occurs in 3-5% of pregnancies. This becomes necessary to evaluate the serum electrolyte status of preeclampsia women cared for in tertiary hospitals in Enugu metropolis. The study was conducted in University of Nigeria teaching hospital Enugu and Enugu state university of Science and technology teaching hospital all in Enugu metropolis. A cross sectional survey design was conducted on pregnant women from August to December 2023. Sociodemographic data was obtained from sixty pregnant women (thirty preeclampsia and thirty normotensives) within the age of 18-45 years. Five milliliters of venous blood sample was collected from the study participants for the analysis of serum levels of electrolytes (sodium, potassium, chloride and bicarbonate). Anthropometric measurements were done using standard procedures. The statistical package, graph pad prism version 7 was used to analyze data generated from this study. There was a notable increase ($p > 0.05$) was observed in the systolic (186.30±6.00) and diastolic(114.50±3.50) blood pressure, and potassium level(4.53±0.06) of the preeclampsia study participants in comparison to the systolic (106.2±1.90), diastolic (67.67±2.30) blood pressure, and potassium levels(4.13±0.05) normotensives. A noteworthy decrease ($p<0.05$) was observed in the sodium level (129.80±0.55) of the preeclampsia women in comparison to the normotensives (133.2±0.76). No significant difference ($p>0.05$) was observed in the serum levels of chloride and bicarbonate. This study demonstrated a notable decreased ($p<0.05$) in serum sodium and an increase in potassium levels in preeclampsia pregnant women in comparison to the normotensives. A well designed study regarding the impact of preeclampsia on the ion channels particularly Na^+/K^+ cotransporter is recommended.

Keywords: Sodium; Potassium; Chloride; Bicarbonate; Preeclampsia; Enugu State

INTRODUCTION

Preeclampsia is a pregnancy-specific multisystem disorder that typically begins at 20 weeks or later in pregnancy and occurs in 3-5% of pregnancies. (Charles *et al*., 2020; Chappelli *et al*., 2021; Arnanz *et al*., 2022; Magee *et al*., 2022). It can have various impacts on both the pregnant mother and the developing fetus, including the development of hypertension, proteinuria, liver dysfunction, placental abruption, and fetal growth restriction (Jin *et al*., 2022). It continues to be a prominent contributor to maternal and fetal mortality and morbidity, especially in low-income and middle-income countries (LMICs) (Jin *et al*., 2022; Magee *et al*., 2022).

The global prevalence of preeclampsia is estimated to be between 2% and 8 % (Aquino *et al*., 2022). This prevalence tends to be higher in first-time pregnancies, individuals of advanced maternal age, those with a history of previous preeclampsia, and individuals with preexisting medical conditions such as chronic hypertension, kidney disease, and diabetes mellitus (Aquino *et al*., 2022). The prevalence of preeclampsia in developing nations varies, ranging from 1.8% to 16.7% (Anto *et al*., 2023). In Nigeria, the prevalence of preeclampsia is reported to range from 2% to 16% and 3.3% in Enugu state (Ugwu et al., 2011; Akaba *et al*., 2021)

Preeclampsia is often referred to as the "disease of theories" due to the numerous hypotheses explaining its pathophysiology (Chang *et al*., 2023). The ultimate pathways in the pathogenesis of preeclampsia involve placental hypoxia and ischemia, releasing vasoactive factors into the maternal circulation (Qui *et al*., 2020; Poniedzialek-czajikowska *et al*., 2023). This process, coupled with endothelial cell dysfunction, ultimately leads to the signs and symptoms of preeclampsia (Khan *et al*., 2022; Rana *et al*., 2022). The sodium and potassium homeostasis plays a crucial role in endothelium-dependent vasodilatation, a process that is impaired in primary hypertension (Adewolu, 2013; Ekun *et al*., 2018). Numerous research studies highlight the detrimental effect of excess sodium on arterial pressure (Chapman *et al*., 2023). Furthermore, deficiency of potassium has been documented to plays a critical role in hypertension and its consequential cardiovascular outcomes (Ferreira *et al*., 2021).

A good knowledge of the serum electrolyte levels in preeclampsia patients can serve as a valuable index for the clinician in comprehending the physiological and pathological changes associated with preeclampsia. The findings concerning electrolyte changes in preeclampsia are intricate and contradictory. Some studies have reported no significant disparities, while others have observed noteworthy changes (Adewolu, 2013; Ekun *et al*., 2018; Jin *et al*., 2022. Furthermore, to the best of our knowledge, there is a paucity of documented data on the serum electrolyte (sodium, potassium, chloride and bicarbonate) levels among preeclampsia women attending tertiary institutions in the Enugu metropolis. In the wake of this, our study was birthed to evaluate the serum electrolyte status of pregnant women with preeclampsia undergoing treatment in tertiary healthcare institutions in the Enugu metropolis. The findings from this study will be a base line and further proffer the clinicians with reliable information to make evidence-based decisions for better preeclampsia management.

MATERIALS AND METHODS

Study area

The study adopted a cross sectional survey design and was carried out between August 2023 and December 2023 at the University of Nigeria Teaching Hospital and Enugu state University of Science and Technology Teaching Hospital in Enugu state, south east Nigeria.

Study population and design

A total number of sixty (60), age and sex matched pregnant women were used for the study. They consists of thirty (30) preeclampsia pregnant women (used as test) and thirty (30) normotensive pregnant women (used as control) receiving ante natal care at the previously mentioned tertiary hospitals. All study participants were notified and made to understand clearly, the aim of the study and the procedures that will be carried out. Informed consent was signed and questionnaires distributed by trained nurses. Trained phlebotomists collected blood samples from the study participants for the analysis of sodium, potassium, chloride and bicarbonate.

Sample size determination

The sample size for this study was determined using the formula for sample size determination in cross sectional study (Niang *et al*., 2022) and a prevalence rate of 3.3% (Ugwu *et al*., 2011) as reported among preeclampsia women in Enugu state. A 95% confidence interval and 0.05 precision was used. A 10% of no-response rate was employed to make up for non-response.

Ethical consideration

The Ethical Committee of the Enugu State University of Science and Technology Teaching Hospital (ESUTH), Enugu reviewed and approved the study (ESUTHP/C-MAC/RA/034/vol.4/96). All study procedures adhered to the principles enumerated in the 1964 Declaration of Helsinki. Participants' privacy was protected.

Inclusion criteria

Normotensive and preeclampsia pregnant women in their second and third trimester within the age of 20-45 years were recruited for the study. In addition, subjects who have no previous report of being hypertensive or a family history of hypertension were also recruited for the study

Exclusion criteria

Pregnant women who have any systemic disease, below the age of 18 years and above 45 years were excluded from the study

Blood sample collection

The skin around the antecubital fossa was thoroughly cleansed with methylated spirit. Five milliliters of venous blood was collected and was put in a plain test tube, without any anticoagulant. The blood samples were taken to the clinical laboratory, allowed to clot, thereafter centrifuged for 10 minutes at 1500 rpm. A clear serum obtained after centrifugation was transferred to an aliquot vial and kept in a -20°C freezer until analysis. All blood samples were analyzed after seven (7) days of collection.

Estimation of Serum electrolytes

The study participants blood sample was analyzed for serum electrolytes (sodium, potassium, chloride and bicarbonate) using the ST-200 plus Electrolyte Analyzer (Sensa Core, Sensa Core Medical Instrumentation Pvt. Ltd., Export Promotion Industrial park, Pashamylaram, Medak, Hyderabad, Telangana, India). The researchers adhered strictly to the manufacturers operational guidelines attached to the analyzer.

Statistical data analysis

Descriptive statistics such as frequency (percentage) was conducted for categorical variables (sex, age, highest level of education attained and occupation) while mean and standard deviation was conducted for continuous variables (age, gestational age, systolic/diastolic blood pressure and serum levels of sodium, potassium, bicarbonate and chloride). Pearson's correlation was used to association between serum electrolytes (sodium, potassium, chloride and bicarbonate) and hypertension (SBP and DBP). A p-value of <0.05 was used to assess statistical significance. The data was analyzed using GraphPad prism version 7 (Graphpad Software Inc., USA) at $P < 0.05$.

RESULTS

Table 1: Sociodemographic characteristics of the study participants

Variables	Preeclampsia N (%)	Normotensive N (%)
Sex		
Female	30(100.0)	30(100.0)
Total	30(100.0)	30(100.0)
Age(years)		
20-29	01(3.3)	10(33.3)
30-39	17(56.7)	10(33.3)
40-49	12(40.0)	10(33.3)
Total	30(100.0)	30(100)
Highest level of education attained		
Primary	0(0)	0(0,0)
Secondary	12(40.0)	16(53.3)
Tertiary	18(60.0)	14(46.7)
Total	30(100.0)	30(100)
Occupational status		
Employed	25(83.3)	20(66.7)
Unemployed	05(16.7)	10(33.3)
Total	30(100.0)	30(100.0)

A total of sixty (60) pregnant women were recruited for this study. The study participants were age and sex (females, 100%) matched. Out of the sixty, thirty (30) that presented with preeclampsia were used as test group, while thirty (30) normotensive were used as control group. The prevailing age range of the preeclampsia as observed in the study was 30-39 years 17/30 (56.7%).

The highest level of education attained by the preeclampsia was observed to be tertiary education 18/30 (60%), while for the normotensives, secondary school 16/30 (53.3%). Majority of the study participants were employed at the time of the study. Out of the thirty (30) preeclampsia, twenty five (25) were employed, 25/30 (83.3%). For the normotensives, twenty (20) 20/30 (66.7%) out of thirty (30) were employed at the time of the study.

Table 2: Mean comparison of the blood pressure, gestational age and age of the study participants

	Preeclampsia		Normotensive		
Variables	Mean	SD	Mean	SD	p-value
Age(years)	36.53	0.83	30.63	1.32	0.04
G. A.(weeks)	31.33	0.908	31.67	0.77	0.781
Systolic BP(mmHg)	186.30	6.00	106.20	1.90	0.001
Diastolic BP (mmHg)	114.50	3.50	67.67	3.30	<0.001

Key: G.A. Gestational age, BP = Blood Pressure

The mean age of the preeclampsia participants (36.53±0.83) was higher (p=0.04) in comparison to the control (30.63±1.32). The mean comparison of the systolic blood pressure (186.30±6.0) mmHg of the preeclampsia participants was observed to be higher (p=0.001) than the systolic blood pressure of the normotensive (106.20 mmHg). The mean comparison of the diastolic blood pressure (114.3±3.50) mmHg of the preeclampsia participants was observed to be higher (p<0.001) than the diastolic blood pressure of the normotensives (62.92±2.30). There was no significant difference (p>0.05) in the mean gestational age of the study participants.

Table 3: Serum electrolytes (Sodium, Potassium, Bicarbonate and Chloride) concentration of the study participants.

	Preeclampsia		Normotensive		
Variables	Mean	SD	Mean	SD	p-value
Sodium(mmol/l)	129.80	0.55	133.20	0.76	0.001
Potassium(mmol/l)	4.50	0.06	4.13	0.05	<0.001
Bicarbonate(mmol/L)	25.13	0.31	25.60	0.23	0.230
Chloride(mmol/l)	101.80	1.03	101.60	1.02	0.894

A noteworthy decrease (p=0.001) was observed in the mean level of sodium of the preeclampsia participants (129.80±0.55) mmol/l in comparison to the controls (133.20±0.76). The mean comparison of the serum potassium level of the preeclampsia (4.53±0.06)mmol/l was observed to be significantly higher (p<0.001) than the normotensive counterparts (4.13± 0.05) mmol/l. There was no observed statistical difference (p>0.05) in the mean level of chloride and bicarbonate of the study participants.

Table 4: Correlation between hypertension parameters (SBP and DBP) and Serum electrolytes (Sodium, Potassium, Chloride and bicarbonate) of the preeclampsia women.

Variables	Sodium	Potassium	Chloride	Bicarbonate
SBP(mmHg)				
R	-0.516	0.650	0.059	0.219
p-value	0.004	0.001	0.759	0.245
DBP(mmHg)				
R	-0.551	0.662	0.029	0.221
p-value	0.002	<0.001	0.881	0.242

A notable negative correlation (r= -0.516, p=0.004) was observed between systolic blood pressure and sodium level of the preeclampsia participants. The correlation between diastolic blood pressure and the sodium concentration of the study participants showed a notable negative correlation(r= -0.551, p=0.002). The systolic blood pressure of the preeclampsia study participants when correlated with potassium levels showed a positive relationship which was significant(r=0.650, p=0.001) while the correlation between diastolic blood pressure and potassium level (r=0.662, p<0.001) of the study participants showed a positive correlation. The correlation between the study participants systolic/ diastolic blood pressure and chloride and bicarbonate levels showed no significant difference (p>0.05).

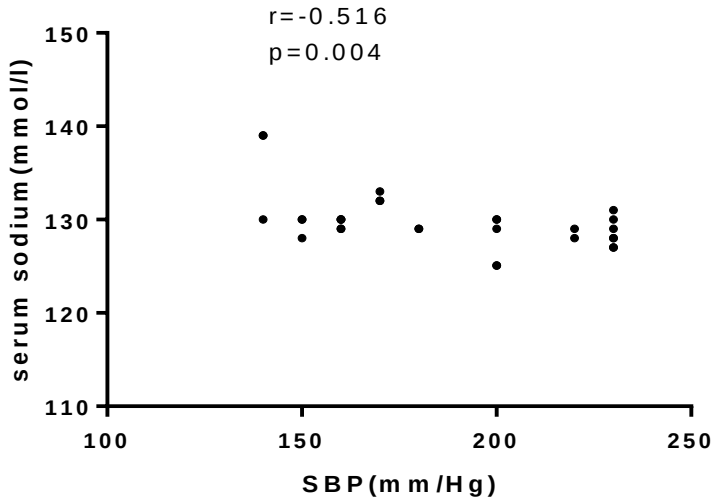

Figure 1: Correlation between systolic blood pressure and sodium level

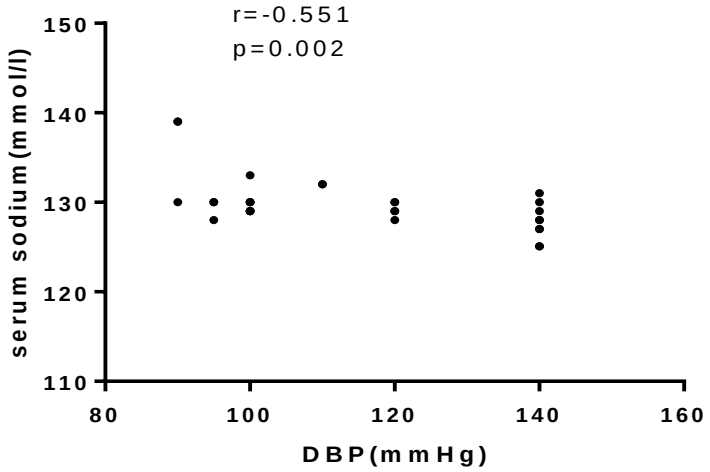

Figure 2: Correlation between diastolic blood pressure and sodium level

DISCUSSION

This current study evaluated the serum electrolyte (sodium, potassium, chloride and bicarbonate) levels of preeclampsia pregnant women cared for in tertiary hospitals in Enugu metropolis, south east Nigeria. The prevalence of preeclampsia at the time of this study was 3.1 % (30/968), this observation is in line with findings of Ugwu *et al*., (2011) who documented a prevalence of 3.3%. Furthermore, this findings falls within 2%-16%, documented prevalence of preeclampsia in Nigeria (Akaba *et al*., 2021).

This study observed a noteworthy decreased sodium levels in the preeclampsia pregnant women in comparison with the normotensives. This observations is in agreement with documented studies (Adewolu 2013, Dwiveli *et al*., 2016, Ekun *et al*., 2018). A negative correlation was observed between SBP and DBP versus sodium levels. In preeclampsia, hyponatremia is associated with severity and frequency of seizure and other complications (Pu *et al*., 2021).

Available literature proposed that syndrome of inappropriate antidiuretic hormone secretion (SIADH) and low effective plasma volume may lead to a non-osmotic release of ADH which, maybe a key player in the reduction of sodium levels in preeclampsia pregnant women (Ekun *et al*., 2018). However, Charles *et al*., (2022) documented no significant difference in the sodium levels of normotensive and preeclampsia pregnant women. Charles et al., (2022) used the flame photometric method to analyse electrolytes while in this study, ion selective electrode was used, hence, the observed difference observed maybe due to different methodologies.

This study observed a statistically significant increase in potassium levels of the preeclampsia participants in comparison with the normotensives. Dwiveli *et al*., (2016) and Ekun *et al*., (2022) documented a noteworthy increase in potassium levels in preclampsia women which is similar to the observation of this study (Dwiveli *et al*., 2016; Ekun *et al*., 2022). However, the findings of Adewolu *et al* (2013) observed an elevated potassium levels in the preeclampsia participants. Preeclampsia is characterized by the presence of placenta-derived endogenous digitalis-like factor(s) (EDLFs) which are similar to cardiotonic steroids; they inhibit the sodium potassium adenosine triphosphatase (Na/K ATPase) enzyme transport complex, which functions as the sodium pump, therefore just like the digitalis, they may result in inhibition of (Na/K ATPase) and consequentially, hyperkalemia (Khan *et al*., 2022).

Hudali and Takkar (2015), suggested that magnesium sulphate infusion used in the course of treatment of preeclampsia may potentially be attributed to the elevation in plasma potassium levels observed in preeclampsia (Ekun *et al*., 2018). The mechanism behind this relationship may be attributed to magnesium supplementation. Magnesium supplementation plays a role in lowering plasma renin activity which may lead to a decreased excretion of potassium by the kidneys resulting in the face of an elevated potassium levels (Elsa & Anita 2015). Magnesium infusion may enhance the excretion of sodium but inhibit potassium by the kidney leading to an increased potassium level in preeclampsia women.

This study observed no significant difference in the serum levels of chloride and bicarbonate in the blood samples of the preeclampsia and normotensive subjects. The report of Charles *et al* (2020) agrees with this current findings, however, Manjareeka and Nanda (2012), reported a significantly increased chloride and bicarbonate levels in preeclampsia. The correlation of chloride and bicarbonate with systolic and diastolic blood pressure in this study demonstrated no significant association. Alterations in sodium levels may be associated with an increased chloride levels, delayed renal excretion of sodium is closely associated with increased chloride (Charles *et al*., 2020).

CONCLUSION

This study demonstrated an increased sodium and a decreased potassium levels in preeclampsia pregnant women in comparison to the normotensives. No significant different was observed in the serum levels of bicarbonate and chloride in the preeclampsia and normotensives. A well designed study regarding the impact of preeclampsia on the ion channels particularly Na^+/K^+ cotransporter may proffer a good reason for these alterations and an evidence based insight to prevention and better management of preeclampsia.

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