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Evaluation Of Serum Lipid Profile And C-Reactive Protein In Pre-Eclamptic Patients Attending Tertiary Health Institutions In Enugu State, Nigeria.

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Abstract
Pre-eclampsia is a hypertensive disorder of pregnancy characterized by systemic inflammation, endothelial dysfunction, and abnormal lipid metabolism, and it remains a major cause of maternal morbidity and mortality worldwide. This study evaluated serum lipid profile and C-reactive protein (CRP) levels in pre-eclamptic women compared with normotensive pregnant controls and examined their relationship with blood pressure indices. A total of 100 pregnant women aged 18–40 years were recruited from a tertiary hospital in Enugu, comprising 50 pre-eclamptic patients and 50 normotensive controls. Serum total cholesterol (TC), triglycerides (TG), high-density lipoprotein cholesterol (HDL-C), and low-density lipoprotein cholesterol (LDL-C) were determined using enzymatic colorimetric methods, while CRP was measured by turbidimetric immunoassay and ELISA kit. Data were analyzed using Student's t-test and Pearson's correlation, with significance set at $P < 0.05$. The results showed significantly higher levels of TC (4.66 ± 0.72 mmol/L), TG (1.89 ± 0.60 mmol/L), and CRP (3.59 ± 1.02 mg/L) in pre-eclamptic women compared with controls TC (4.01 ± 0.31mmol/L), TG (0.78 ± 0.14mmol/L), and CRP (1.42 ± 0.66mg/L) respectively; $P < 0.05$), while HDL-C was markedly lower (1.26 ± 0.15mmol/L versus. 1.86 ± 0.08 mmol/L, $P < 0.05$). Systolic and diastolic blood pressures correlated positively with TC, LDL-C, TG, and CRP but correlated. negatively with HDL-C. These findings indicate that dyslipidaemia and inflammation coexist in pre-eclampsia, suggesting a metabolic inflammatory interplay that contributes to vascular dysfunction and hypertension. Monitoring lipid and CRP levels in pregnancy may therefore aid early detection and prevention of pre-eclampsia.

Keywords: *Pre-eclampsia, Lipid profile, C-reactive protein, Dyslipidaemia, Hypertension, Inflammation, Pregnancy.*

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I. Introduction

Pre-eclampsia is a multisystem pregnancy-specific disorder characterised by new-onset hypertension and proteinuria after 20 weeks of gestation (Magee *et al.,* 2022). It affects approximately 5–8% of pregnancies globally and remains a major cause of maternal and perinatal morbidity and mortality, especially in developing countries such as Nigeria (Osungbade and Ige, 2011). The pathophysiology of pre-eclampsia is multifactorial and involves abnormal placentation, endothelial dysfunction, oxidative stress, and inflammatory activation (Steegers et al., 2010).

The liver plays a significant role in lipid metabolism and the synthesis of acute-phase proteins such as C-reactive protein (CRP) (Kushner *et al.,* 2021). During normal pregnancy, physiological changes occur in lipid metabolism to support fetal growth and energy needs. These include mild increases in total cholesterol, triglycerides, and lipoproteins, resulting from oestrogen-induced hepatic lipogenesis (Herrera and Desoye, 2016). However, in pre-eclampsia, these changes become exaggerated, leading to dyslipidaemia characterized by elevated total cholesterol (TC), triglycerides (TG), and low-density lipoprotein cholesterol (LDL-C), along with reduced high-density lipoprotein cholesterol (HDL-C) (Fahmy *et al.,* 2017). Dyslipidaemia contributes to endothelial injury and vascular inflammation, both central features of pre-eclampsia (Enquobahrie *et al*., 2004).

C-reactive protein (CRP) is a sensitive biomarker of systemic inflammation produced by the liver in response to interleukin-6 (IL-6) and other cytokines (Pepys and Hirschfield, 2003). Elevated CRP levels indicate an ongoing inflammatory process, and increasing evidence suggests that pre-eclampsia is associated with chronic low-grade inflammation (Udenze *et al.,* 2015). Studies have shown significantly higher serum CRP levels in women with pre-eclampsia than in normotensive pregnant women, implicating it as a marker of endothelial dysfunction and oxidative stress (Sproston and Ashworth, 2018).

Inflammation in pre-eclampsia contributes to vascular damage, increased vascular permeability, and abnormal lipid oxidation (Redman and Staff, 2015). Oxidized LDL stimulates macrophage activation and CRP synthesis, promoting further endothelial injury (Tjoa *et al.,* 2017). This CRP–lipid interplay creates a vicious cycle of vascular inflammation, contributing to elevated blood pressure and poor placental perfusion (Ghaffari *et al.,* 2020). The association between dyslipidaemia and high CRP levels therefore provides insight into the inflammatory and metabolic mechanisms underlying pre-eclampsia (Das *et al*., 2021).

Lipid profile alterations during pregnancy are normally adaptive; however, when these exceed physiological thresholds, they predispose to oxidative stress and inflammatory damage (Herrera and Desoye, 2016). Increased triglycerides and LDL-C in pre-eclampsia can accumulate in endothelial cells, promoting vasoconstriction and platelet aggregation (Mihailović *et al*., 2019). Conversely, HDL-C plays a protective role by facilitating reverse cholesterol transport and exerting antioxidant effects. Reduced HDL-C levels in pre-eclampsia therefore exacerbate vascular dysfunction and inflammation (Enquobahrie *et al*., 2004).

The liver's central role in both lipid metabolism and CRP synthesis highlights the biochemical link between inflammation and dyslipidaemia in pre-eclampsia. Evaluating both lipid profile and CRP together provides a more comprehensive understanding of disease severity and risk prediction. This study was designed to assess serum lipid profile and CRP concentrations in pre-eclamptic and normotensive pregnant women attending a tertiary institution in Enugu State, Nigeria, and to explore the relationship between these parameters and blood pressure indices.

II. Materials And Methods

Study Design and Population

This was a comparative cross-sectional study conducted at a tertiary healthcare institution in Enugu State, Nigeria. A total of 100 pregnant women aged 18–40 years participated, comprising 50 pre-eclamptic patients attending the antenatal clinic and 50 normotensive pregnant women serving as controls. Pre-eclampsia was diagnosed based on the criteria of blood pressure ≥140/90 mmHg on two separate occasions and the presence of proteinuria (≥1+ on dipstick) after 20 weeks of gestation (Magee *et al.,* 2022). Ethical approval and informed consent were obtained prior to sample collection

Determination of lipid profile

Serum total cholesterol (TC), high-density lipoprotein cholesterol (HDL-C), and triglycerides (TG) were determined using enzymatic colorimetric methods based on the procedures of (Allain *et al*., 1974; Friedewald *et al*., 1972). Low-density lipoprotein cholesterol (LDL-C) was calculated using the Friedewald formula:

LDL-C = TC - HDL-C – TG/5

Determination of C - reactive protein (CRP)

Serum C-reactive protein (CRP) concentration was measured using the turbidimetric immunoassay and ELISA kit method described by Pepys and Hirschfield (2003). CRP levels were expressed in milligrams per litre (mg/L).

Measurement of blood pressure and anthropometric parameters

Blood pressure was measured using a standard mercury sphygmomanometer with the participant in a sitting position. The systolic blood pressure (SBP) and diastolic blood pressure (DBP) were recorded as the first and fifth Korotkoff sounds respectively. Anthropometric parameters, including age and gestational weeks, were obtained from patients' records.

Statistical analysis

All data were expressed as mean ± standard deviation (SD). Comparisons between the pre-eclamptic and non-pre-eclamptic groups were made using Student's t-test, while associations between lipid parameters, CRP, and blood pressure were analyzed using Pearson's correlation coefficient (r). Statistical significance was set at $p < 0.05$. Data analysis was performed using SPSS version 25.0 (IBM Corporation, USA).

III. Results

Table 4.1: Anthropometric parameters of study participants (Serum Lipid Profile and CRP concentrations)

Characteristics	Pre-eclamptic	Non pre-eclamptic	T-value	p-value
Age (years)	32.54 ± 7.33	32.77 ± 7.33	0.100	0.921
Gestational weeks	32.31 ± 2.93	33.00 ± 2.82	0.613	0.545
Systolic BP (mmHg)	186.2 ± 33.80	110.8 ± 11.15	7.637	<0.001
Diastolic BP (mmHg)	115.4 ± 18.98	74. 23 ± 7.59	7.258	<0.001

In table 4.1 there was no significant difference in mean age or gestational weeks between the two groups ($p > 0.05$). However, both systolic and diastolic blood pressures were significantly higher in the pre-eclamptic group compared with the normotensive controls ($P < 0.05$).

Table 4.2: Lipid profile and CRP levels in pre-eclamptic and non-pre-eclamptic participants.

Characteristics	Pre-eclamptic	Non pre-eclamptic	T-value	P
TC (mmol/l)	4.66 ± 0.724	4.01 ± 0.31	2.944	<0.05
HDL-C (mmol/l)	1.26 ± 0.150	1.86 ± 0.08	12.59	<0.05
LDL-C (mmol/l)	2.98 ± 0.66	2.09 ± 0.45	0.309	>0.05
TG (mmol/l)	1.89 ± 0.604	0.78 ± 0.14	6.282	<0.05
CRP (mg/l)	3.59 ± 1.019	1.422 ± 0.66	6.436	<0.05

In table 4.2 Mean total cholesterol, triglycerides, and CRP levels were significantly higher in the pre-eclamptic group ($P < 0.05$), while HDL-C was markedly lower. LDL-C was slightly elevated but not statistically significant ($P > 0.05$)

Table 4.3: Correlation of systolic blood pressure with lipid profile parameters and CRP

Systolic BP	TC	HDL	LDL	TG
R	0.908	-0.853	0.871	0.813
P	0.007	0.0002	0.001	0.0007

In table 4.3 systolic blood pressure (SBP) exhibited strong positive correlations with total cholesterol ($r = 0.908$, $p = 0.007$), LDL-C ($r = 0.871$, $p = 0.001$), triglycerides ($r = 0.813$, $p = 0.0007$), and CRP, but correlated negatively with HDL-C ($r = –0.853$, $p = 0.0002$).

Table 4.4: Correlation of diastolic blood pressure with lipid profile parameters and CRP

diastolic BP	TC	HDL	LDL	TG
R	0.642	-0.733	0.740	0.651
P	0.018	0.0044	0.0038	0.016

In table 4.4 diastolic blood pressure (DBP) also correlated positively with total cholesterol ($r = 0.642$, $p = 0.018$), LDL-C ($r = 0.740$, $p = 0.0038$), triglycerides ($r = 0.651$, $p = 0.016$), and CRP, while showing a negative correlation with HDL-C ($r = –0.733$, $p = 0.0044$).

IV. Discussion

This study investigated serum lipid profile and C-reactive protein (CRP) levels in pre-eclamptic and normotensive pregnant women and examined their relationships with blood pressure indices. The findings revealed that total cholesterol (TC), triglycerides (TG), and CRP were significantly elevated in pre-eclamptic patients compared with the normotensive controls, whereas high-density lipoprotein cholesterol (HDL-C) was markedly reduced. These results corroborate the growing evidence that pre-eclampsia is associated with dyslipidaemia and systemic inflammation, both of which contribute to endothelial dysfunction and vascular complications (Udenze *et al*., 2015; Steegers *et al*., 2010).

The significant increase in serum total cholesterol and triglycerides observed among pre-eclamptic patients aligns with earlier studies by Enquobahrie *et al*. (2004) and Mihailović *et al.* (2019), who reported that abnormal lipid metabolism plays a key role in the pathogenesis of pre-eclampsia. During normal pregnancy, mild hyperlipidaemia is physiological and ensures adequate energy supply for the growing fetus (Herrera and Desoye, 2016). However, in pre-eclampsia, these changes are exaggerated, possibly due to impaired hepatic lipase activity and insulin resistance, leading to the accumulation of atherogenic lipoproteins. Elevated triglyceride levels can undergo oxidative modification, producing toxic lipid peroxides that damage vascular endothelium and promote vasoconstriction (Redman and Staff, 2015).

The observed reduction in HDL-C among pre-eclamptic women in this study agrees with reports by Das *et al*. (2021) and Ghaffari *et al*. (2020), which noted that decreased HDL-C compromises the antioxidant and anti-inflammatory roles of HDL, thereby predisposing patients to oxidative stress and endothelial injury.

HDL-C facilitates reverse cholesterol transport and inhibits LDL oxidation; hence, low HDL-C may aggravate vascular inflammation and elevate blood pressure.

C-reactive protein (CRP), an acute-phase reactant synthesised by hepatocytes in response to interleukin-6, was significantly increased in pre-eclamptic patients compared with controls. This finding confirms the role of systemic inflammation in the disease's pathophysiology, as reported by Sproston and Ashworth (2018) and Kushner *et al.* (2021). Elevated CRP reflects ongoing endothelial activation, oxidative stress, and placental ischemia, which are characteristic of pre-eclampsia (Tjoa *et al*., 2017). Furthermore, CRP itself can amplify inflammatory processes by binding to damaged cell membranes and activating complement pathways, thus perpetuating vascular injury.

The positive correlations observed between blood pressure (systolic and diastolic) and lipid parameters (TC, LDL-C, TG) as well as CRP indicate a close interplay between metabolic and inflammatory pathways in pre-eclampsia. This supports the hypothesis that dyslipidaemia and inflammation act synergistically to cause endothelial dysfunction and hypertension (Ghaffari *et al.,* 2020; Fahmy *et al*., 2017). In contrast, the inverse relationship between HDL-C and blood pressure highlights its protective effect against oxidative stress and vascular constriction.

These findings reinforce the concept that pre-eclampsia is not merely a hypertensive disorder of pregnancy but a systemic inflammatory and metabolic condition involving the liver and vascular endothelium (Magee *et al.,* 2022). The liver plays a dual role being both the site of lipid synthesis and CRP production. Abnormal hepatic response to inflammatory cytokines may therefore explain the simultaneous occurrence of dyslipidaemia and elevated CRP in pre-eclamptic women (Herrera and Desoye, 2016; Kushner *et al.,* 2021).

This study's results are consistent with those of Udenze *et al*. (2015) in Nigeria, who reported significantly higher triglycerides and CRP among pre-eclamptic women. The pattern observed in this study further underscores the CRP–lipid interplay in the progression of pre-eclampsia. High triglyceride and LDL-C concentrations can increase CRP production through oxidative stress and endothelial activation, while CRP can, in turn, promote lipid oxidation, forming a vicious cycle that exacerbates vascular injury and hypertension (Das *et al*., 2021).

The slight, non-significant increase in LDL-C seen in this study may reflect individual metabolic variability, dietary influence, or the relatively small sample size. Nonetheless, the consistent elevation of TC and TG alongside increased CRP suggests that lipid-driven inflammation contributes significantly to disease severity. Early screening of lipid profile and CRP levels in pregnant women could therefore help identify those at risk of developing pre-eclampsia, enabling preventive management strategies. Overall, this study reinforces that dyslipidaemia and inflammation are central biochemical features of pre-eclampsia. The strong positive correlations between CRP, lipid parameters, and blood pressure further highlight their potential as predictive biomarkers. Implementation of routine biochemical screening for lipid and inflammatory markers in antenatal care settings could improve early detection and management outcomes among high-risk women.

V. Conclusion

This study demonstrated that pre-eclampsia is associated with significant alterations in serum lipid profile and increased levels of C-reactive protein, reflecting underlying inflammation and metabolic dysfunction. Elevated total cholesterol, triglycerides, and CRP, along with reduced HDL-C, were strongly linked to increased blood pressure indices. These findings suggest that lipid dysregulation and systemic inflammation contribute synergistically to the pathogenesis of pre-eclampsia.

In resource-limited settings like Nigeria, integrating lipid profile and CRP testing into routine antenatal screening is **recommended** for early identification of high-risk pregnancies. Such preventive strategies could reduce maternal and perinatal complications associated with pre-eclampsia

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