Section: Obstetrics & Gynaecology

Original Research Article

ROLE OF SERUM LIPID PROFILE IN EARLY PREGNANCY AS A PREDICTOR OF PRE-ECLAMPSIA : A PROSPECTIVE OBSERVATIONAL STUDY

Diksha Chandrakar[1], Sangeeta Raman Jogi[2], Dipika Singh[3], Rachna Jain[4], Manisha Pradhani[5]

[1]PG Resident, Department of Obstetrics & Gynaecology, CIMS Bilaspur, India.
[2]Professor and Head, Department of Obstetrics & Gynaecology, CIMS Bilaspur, India.
[3]Associate Professor, Department of Obstetrics & Gynaecology, CIMS Bilaspur, India.
[4]Associate Professor, Department of Obstetrics & Gynaecology, CIMS Bilaspur, India.
[5]PG Resident, Department of Obstetrics & Gynaecology, CIMS, Bilaspur,India.

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Corresponding Author:
Dr. Diksha Chandrakar,
Email: docdiksha98@gmail.com

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ABSTRACT

Background: Preeclampsia is a major cause of maternal and perinatal morbidity and mortality worldwide. Dyslipidaemia during pregnancy has been implicated in the pathogenesis of pre-eclampsia through endothelial dysfunction and placental vascular abnormalities. The present study was conducted to evaluate the role of serum lipid profile in early pregnancy as a predictor of pre-eclampsia and its severity. **Materials and Methods:** This hospital-based prospective observational cohort study was conducted among 200 normotensive pregnant women between 14–20 weeks of gestation attending the Department of Obstetrics and Gynaecology at Chhattisgarh Institute of Medical Sciences. Serum lipid profile including total cholesterol (TC), triglycerides (TG), low-density lipoprotein (LDL), high-density lipoprotein (HDL), and very low-density lipoprotein (VLDL) was assessed. Participants were followed until delivery for the development and severity of pre-eclampsia and fetomaternal outcomes. Statistical analysis was performed using IBM SPSS Statistics. **Results:** The prevalence of pre-eclampsia was 27% (n = 54), of which 70.4% had mild and 29.6% had severe pre-eclampsia. Mean total cholesterol levels increased significantly from 158.3 ± 34.3 mg/dl in controls to 213.4 ± 26.0 mg/dl in mild and 254.3 ± 34.6 mg/dl in severe pre-eclampsia ($p = 0.001$). Similarly, triglyceride and LDL levels were significantly higher among pre-eclamptic women, while HDL levels showed a significant decline with increasing disease severity ($p = 0.001$). TC/HDL and LDL/HDL ratios were significantly elevated in pre-eclampsia. Severe pre-eclampsia was associated with significantly lower gestational age at delivery, higher caesarean section rates, low birth weight, NICU admission, neonatal mortality, ICU admission, and maternal mortality ($p = 0.001$). **Conclusion:** The study demonstrated a significant association between dyslipidaemia and the development as well as severity of pre-eclampsia. Elevated total cholesterol, triglycerides, LDL, VLDL, and lipid ratios with reduced HDL levels were associated with adverse fetomaternal outcomes. Early pregnancy lipid profile assessment may serve as a simple and cost-effective screening tool for identifying women at increased risk of severe pre-eclampsia.

INTRODUCTION

Preeclampsia is a pregnancy-specific multisystem hypertensive disorder characterized by the onset of hypertension (≥140/90 mmHg on two occasions at least four hours apart) after 20 weeks of gestation, accompanied by proteinuria (≥300 mg/24 hours) and/or maternal organ dysfunction such as thrombocytopenia, hepatic dysfunction, renal impairment, pulmonary edema, or neurological symptoms.[1,2] It affects nearly 2–8% of pregnancies worldwide and remains a major cause of maternal and perinatal morbidity and mortality.[3] Preeclampsia is primarily regarded as a placental disorder leading to widespread endothelial dysfunction. The widely accepted "two-stage" model proposes that abnormal trophoblastic invasion and inadequate spiral artery remodeling in early

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pregnancy result in placental hypoperfusion and ischemia. The ischemic placenta subsequently releases anti-angiogenic factors such as soluble fms-like tyrosine kinase-1 (sFlt-1) and soluble endoglin, while reducing placental growth factor (PlGF) and vascular endothelial growth factor (VEGF), thereby creating a systemic anti-angiogenic and inflammatory state.[4] Oxidative stress, immune activation, vasoconstriction, increased vascular permeability, and hypercoagulability ultimately produce the clinical manifestations of the disease.Preeclampsia is classified into early-onset (<34 weeks) and late-onset (≥34 weeks) disease. Early-onset preeclampsia is more commonly associated with defective placentation, fetal growth restriction, and adverse neonatal outcomes, whereas late-onset disease is often linked to maternal metabolic abnormalities such as obesity, insulin resistance, and dyslipidemia. Serious maternal complications include eclampsia, HELLP syndrome, acute kidney injury, pulmonary edema, disseminated intravascular coagulation, and stroke. Women with previous preeclampsia also have an increased long-term risk of chronic hypertension, ischemic heart disease, stroke, and chronic kidney disease, reflecting persistent endothelial and cardiometabolic dysfunction.[5] Since delivery of the placenta remains the only definitive treatment, current management focuses on blood pressure control, seizure prophylaxis with magnesium sulphate, maternal-fetal surveillance, and timely delivery. Consequently, considerable interest exists in identifying early predictive markers that may permit preventive interventions such as low-dose aspirin therapy.[5] Normal pregnancy is associated with progressive physiological hyperlipidemia characterized by increased total cholesterol, triglycerides, LDL-C, and VLDL levels, while HDL-C initially rises and may decline later in gestation. However, exaggerated lipid abnormalities resulting in an atherogenic lipid profile have been strongly linked with preeclampsia.[6] Women who subsequently develop preeclampsia often demonstrate elevated triglycerides, total cholesterol, LDL-C, and reduced HDL-C levels early in pregnancy, sometimes detectable during the first trimester itself.[7] Dyslipidemia contributes to disease pathogenesis through oxidation of LDL particles, endothelial injury, inflammation, thrombosis, and vasoconstriction. In uteroplacental vessels, lipid deposition and fibrinoid necrosis promote microatherosis and worsen placental ischemia.[8] Reduced nitric oxide bioavailability, increased endothelin-1 and thromboxane A2 activity, oxidative stress, obesity, and insulin resistance further aggravate endothelial dysfunction and hypertension.[9] Because of these mechanisms, maternal lipid profile has emerged as a potential predictive marker for preeclampsia. Elevated triglycerides, non-HDL cholesterol, remnant cholesterol, and LDL-C along with reduced HDL-C have shown significant associations with the occurrence and severity of preeclampsia.[10] Studies from India and other low- and middle-income countries have similarly demonstrated higher levels of total cholesterol, triglycerides, LDL-C, and VLDL with lower HDL-C among women who later developed pregnancy-induced hypertension or preeclampsia.[11] In addition, derived indices such as the atherogenic index of plasma (AIP), total cholesterol/HDL-C ratio, and LDL-C/HDL-C ratio may provide stronger predictive value by combining both harmful and protective lipid components. Novel hemato-lipid ratios such as monocyte-to-HDL-C ratio are also being explored as markers of combined inflammation and dyslipidemia.[12] Although lipid profile alone has moderate predictive accuracy, combining lipid parameters with maternal history, mean arterial pressure, uterine artery Doppler findings, and angiogenic markers may improve screening performance. Early identification of high-risk women allows closer antenatal surveillance, initiation of aspirin and calcium prophylaxis, lifestyle modification, and postpartum cardiometabolic follow-up. Despite limitations including heterogeneity among studies, confounding factors, and lack of standardized pregnancy-specific lipid cut-offs, growing evidence supports the important role of dysregulated lipid metabolism in preeclampsia.[12] Therefore, assessment of serum lipid profile in early pregnancy may serve as a simple and cost-effective adjunct in predicting preeclampsia.

MATERIALS AND METHODS

This hospital-based observational prospective cohort study was conducted in the Department of Obstetrics and Gynaecology in collaboration with the Department of Biochemistry at Chhattisgarh Institute of Medical Sciences. The study included antenatal women attending both the outpatient department (OPD) and inpatient department (IPD). The study duration was one year. The study population comprised antenatal women with singleton pregnancies between 14 and 20 weeks of gestation attending the Department of Obstetrics and Gynaecology during the study period. Gestational age was determined based on the last menstrual period (LMP) and/or ultrasonography findings.

Inclusion Criteria

Normotensive pregnant women with singleton pregnancy between 14 and 20 weeks of gestation were included in the study.

Exclusion Criteria

Women fulfilling any of the following criteria were excluded from the study:

- Age >35 years
- Obesity (BMI >25 kg/m²)
- Chronic hypertension
- Diabetes mellitus
- History of pregnancy-induced hypertension in previous pregnancy

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- Chronic medical disorders such as renal disease, cardiac disease, liver disorders, endocrine disorders, or any major systemic illness
- Patients receiving antihypertensive, hypoglycemic, hypolipidemic drugs, or insulin therapy
- Smokers
- Chronic alcoholics
- Multiple gestation pregnancy

Methodology

The study was initiated after obtaining approval from the Institutional Ethics Committee. Eligible antenatal women fulfilling the inclusion and exclusion criteria were enrolled after obtaining written informed consent. A predesigned and prestructured questionnaire was used for data collection. Detailed demographic and clinical information including age, occupation, socioeconomic status, presenting complaints, menstrual history, obstetric history, past medical history, personal history, family history, and treatment history was obtained. General physical examination and relevant systemic examination were performed in all participants. All routine antenatal investigations were carried out. In addition, serum lipid profile including total cholesterol (TC), triglycerides (TG), high-density lipoprotein cholesterol (HDL-C), low-density lipoprotein cholesterol (LDL-C), and very low-density lipoprotein cholesterol (VLDL-C) was assessed. All enrolled women were followed up during subsequent antenatal visits until delivery for the development of preeclampsia. Blood pressure measurements and urine albumin estimation by dipstick method were performed during follow-up visits. Based on the clinical course, participants were categorized into:

- Women who remained normotensive during pregnancy
- Women who developed preeclampsia

Women who developed preeclampsia were further subdivided into:

- Preeclampsia without severe features
- Preeclampsia with severe features

Participants were followed up monthly or more frequently whenever clinically indicated. Follow-up continued until delivery and up to discharge or seven days postpartum for assessment of fetomaternal outcomes.

Outcome Measures

Maternal and fetal outcomes assessed included:

- Gestational age at delivery
- Mode of delivery
- Intrapartum and postpartum complications
- Birth weight
- APGAR score at 1 minute and 5 minutes
- NICU admission
- Perinatal mortality

Statistical Analysis

Data were entered into Microsoft Excel and analysed using IBM SPSS. 25. Quantitative variables were expressed as mean ± standard deviation or median with interquartile range, depending on data distribution. Qualitative variables were expressed as frequency and percentage. Appropriate statistical tests were applied to assess the association between variables. A p-value <0.05 was considered statistically significant.

RESULTS

A total of 200 antenatal women fulfilling the inclusion and exclusion criteria were included in the study. The mean age of participants was 24.77 ± 4.01 years. Most women belonged to the age group of 18–25 years (57.5%), followed by 26–35 years (42.5%). Regarding parity, 108 women (54%) were primiparous and 92 women (46%) were multiparous. During follow-up, 54 women developed preeclampsia, giving a prevalence of 27%, while 146 women (73%) remained normotensive. Among the women who developed preeclampsia, 38 (70.4%) had preeclampsia without severe features, while 16 (29.6%) had preeclampsia with severe features.

Serum lipid parameters showed a significant association with preeclampsia severity. Mean total cholesterol increased progressively from 158.3 ± 34.3 mg/dl in the control group to 213.4 ± 26.0 mg/dl in mild preeclampsia and 254.3 ± 34.6 mg/dl in severe preeclampsia, with statistically significant differences between all groups (p=0.001). Similarly, triglyceride levels were significantly higher in mild and severe preeclampsia groups compared to controls, increasing from 145.2 ± 25.5 mg/dl in controls to 183.2 ± 27.7 mg/dl and 228.8 ± 36.9 mg/dl in mild and severe preeclampsia, respectively (p=0.001). LDL levels were also significantly raised in preeclampsia groups, with median values of 87.6 ± 24.1 mg/dl in controls, 134.4 ± 23.5 mg/dl in mild preeclampsia, and 155.8 ± 38.9 mg/dl in severe preeclampsia (overall p=0.001). However, the difference between mild and severe preeclampsia was not statistically significant (p=0.46). HDL levels showed a declining trend with increasing severity of disease. The mean HDL level was 43.2 ± 5.4 mg/dl in controls, 37.5 ± 4.7 mg/dl in mild preeclampsia, and 30.9 ± 4.6 mg/dl in severe preeclampsia, with significant differences between all groups (p=0.001). Mean VLDL levels were also higher in mild and severe preeclampsia groups compared to controls, being 35.1 ± 5.8 mg/dl, 40.2 ± 6.9 mg/dl, and 44.3 ± 8.4 mg/dl, respectively. The difference was significant between controls and both preeclampsia groups, but not between mild and severe preeclampsia (p=0.08). Atherogenic lipid ratios were significantly deranged among women with preeclampsia. The median TC/HDL ratio was 3.6 ± 1.3 in controls, 5.4 ± 2.0 in mild preeclampsia, and 8.6 ± 3.1 in severe preeclampsia (overall p=0.001). Similarly, the LDL/HDL ratio increased from 2.1 ± 0.6 in controls to 3.5 ± 0.9 in mild preeclampsia and 5.1 ± 1.3 in severe preeclampsia (overall p=0.001).

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However, differences between mild and severe preeclampsia were not statistically significant for both TC/HDL and LDL/HDL ratios. The mean gestational age at delivery was significantly lower in women with preeclampsia. It was 37.3 ± 1.2 weeks in controls, 36.3 ± 1.3 weeks in mild preeclampsia, and 33.6 ± 0.6 weeks in severe preeclampsia, with statistically significant differences among all groups. Caesarean section rates increased with disease severity. In the control group, 29.5% underwent caesarean section, compared to 34.2% in mild preeclampsia and 75% in severe preeclampsia (p=0.001). The commonest indication for caesarean section in controls and mild preeclampsia was non-progress of labour, whereas in severe preeclampsia, uncontrolled blood pressure, severe oligohydramnios, fetal distress, and IUGR with Doppler changes were the major indications. Neonatal outcomes were significantly poorer among women with preeclampsia. Normal birth weight babies were observed in 97.9% of controls, 44.8% of mild preeclampsia cases, and none of the severe preeclampsia cases. Low birth weight was seen in 50% of mild and 68.8% of severe preeclampsia cases, while very low and extremely low birth weight babies were more frequent in the severe group (p=0.001). APGAR scores at 1 and 5 minutes were significantly lower in preeclampsia groups compared to controls. NICU admission was required in 9.6% of controls, 28.9% of mild preeclampsia cases, and 62.5% of severe preeclampsia cases (p=0.001). The median duration of NICU stay was also higher in severe preeclampsia (8.5 days) compared to mild preeclampsia (4 days) and controls (2 days). Neonatal mortality was observed in 2.7% of controls, 7.9% of mild preeclampsia cases, and 25% of severe preeclampsia cases, showing a statistically significant difference across groups (p=0.001). The main causes of neonatal mortality were respiratory distress syndrome, birth asphyxia, extreme prematurity, neonatal sepsis, and congenital anomalies. Extreme prematurity was the leading cause of neonatal death in the severe preeclampsia group. Maternal morbidity was also higher among women with preeclampsia. ICU admission was required in 7.5% of controls, 23.7% of mild preeclampsia cases, and 62.5% of severe preeclampsia cases (p=0.001). The median duration of ICU stay increased from 3 days in controls to 5 days in mild preeclampsia and 7.5 days in severe preeclampsia. Maternal survival was 99.3% in controls, 100% in mild preeclampsia, and 87.5% in severe preeclampsia. Maternal mortality occurred in one control patient due to postpartum haemorrhage with haemorrhagic shock and in two severe preeclampsia patients due to pulmonary oedema and HELLP syndrome with DIC and MODS. Overall, altered lipid profile in early pregnancy was significantly associated with development and severity of preeclampsia as well as adverse fetomaternal outcomes.

Table 1: Baseline Characteristics of Study Participants (n = 200)

Variable	Frequency (n)	Percentage (%)
Age group (years)		
18–25 years	115	57.5
26–35 years	85	42.5
Parity		
Primiparous	108	54.0
Multiparous	92	46.0
Pre-eclampsia status		
Developed pre-eclampsia	54	27.0
Remained normotensive	146	73.0

Table 2: Severity of Pre-eclampsia among Study Participants (n = 54)

Severity of Pre-eclampsia	Frequency (n)	Percentage (%)
Mild pre-eclampsia	38	70.4
Severe pre-eclampsia	16	29.6
Total	54	100

Table 3: Comparison of Lipid Profile Parameters among Different Groups

Variable	Control	Mild Pre-eclampsia	Severe Pre-eclampsia	Overall p-value
Total Cholesterol (mg/dl)	158.3 ± 34.3	213.4 ± 26.0	254.3 ± 34.6	0.001
Triglycerides (mg/dl)	145.2 ± 25.5	183.2 ± 27.7	228.8 ± 36.9	0.001
LDL (mg/dl)*	87.6 ± 24.1	134.4 ± 23.5	155.8 ± 38.9	0.001
HDL (mg/dl)	43.2 ± 5.4	37.5 ± 4.7	30.9 ± 4.6	0.001
VLDL (mg/dl)	35.1 ± 5.8	40.2 ± 6.9	44.3 ± 8.4	0.001
TC/HDL ratio*	3.6 ± 1.3	5.4 ± 2.0	8.6 ± 3.1	0.001
LDL/HDL ratio*	2.1 ± 0.6	3.5 ± 0.9	5.1 ± 1.3	0.001

Table 4: Comparison of Fetomaternal Outcomes among Different Groups

Variable	Control n (%)	Mild Pre-eclampsia n (%)	Severe Pre-eclampsia n (%)	p-value
Caesarean section	43 (29.5)	13 (34.2)	12 (75.0)	0.001
Low birth weight (<2.5 kg)	3 (2.1)	19 (50.0)	11 (68.8)	0.001
NICU admission	14 (9.6)	11 (28.9)	10 (62.5)	0.001

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Neonatal mortality	4 (2.7)	3 (7.9)	4 (25.0)	0.001
ICU admission	11 (7.5)	9 (23.7)	10 (62.5)	0.001
Maternal mortality	1 (0.7)	0 (0.0)	2 (12.5)	0.001

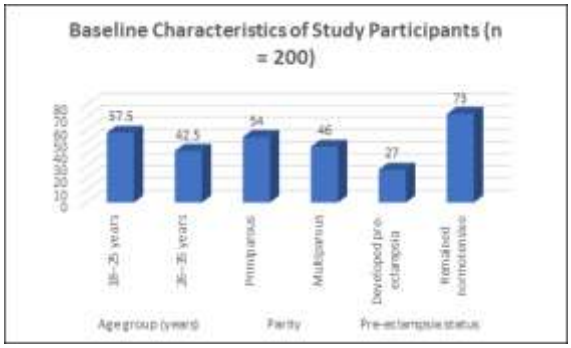

Figure 1: Baseline Characteristics of Study Participants (n = 200)

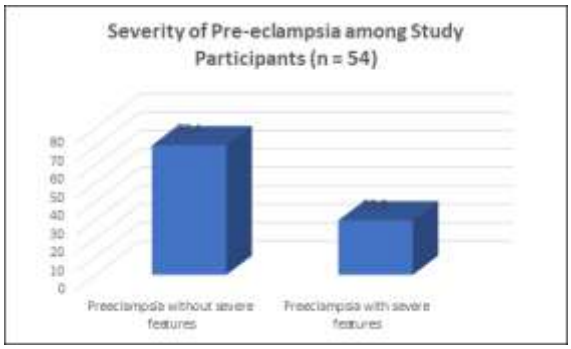

Figure 2: Severity of Pre-eclampsia among Study Participants (n = 54)

DISCUSSION

The present prospective observational study evaluated the role of maternal serum lipid profile during early pregnancy as a predictor of pre-eclampsia and its severity among 200 antenatal women. The study demonstrated a significant association between dyslipidaemia and the occurrence of pre-eclampsia, along with adverse fetomaternal outcomes. The mean age of participants in the present study was 24.77 ± 4.01 years, with the majority belonging to the 18–25 years age group. Similar findings were reported by Ahmed et al. (2018),[13] and Yadav et al. (2018),[14] who observed significantly elevated triglycerides, total cholesterol, LDL, and VLDL levels with reduced HDL among pre-eclamptic women in the reproductive age group. Li et al. (2021),[15] additionally identified advanced maternal age as a predictor of early-onset pre-eclampsia; however, the present study indicates that dyslipidaemia contributes significantly to disease development even among younger women. Primiparous women constituted 54% of the study population, supporting the known association between primigravidity and pre-eclampsia. Hassan et al. (2025),[16] similarly reported a higher prevalence of pre-eclampsia among primigravidae associated with elevated total cholesterol, LDL, VLDL, and triglycerides and reduced HDL levels. Siveska et al. (2020),[17] also documented higher proportions of severe pre-eclampsia among primiparous women. The prevalence of pre-eclampsia in the present study was 27%, with 70.4% mild and 29.6% severe cases. Gupta et al. (2022),[18] similarly observed a significantly higher incidence of pre-eclampsia among women with abnormal lipid profiles compared with women having normal lipid levels. Chughtai et al. (2024),[19] and Majhi et al. (2021),[20] reported lower prevalence rates, but both studies demonstrated significantly elevated lipid parameters among women who subsequently developed pre-eclampsia. A progressive rise in total cholesterol levels with increasing disease severity was observed in the present study, with mean values increasing from 158.3 ± 34.3 mg/dl in controls to 254.3 ± 34.6 mg/dl in severe pre-eclampsia (p = 0.001). Comparable findings were reported by Kumari P et al. (2023),[21] Majhi et al. (2021),[20] and El-Khouly et al. (2016),[22] who also demonstrated significantly elevated cholesterol levels among severe pre-eclamptic pregnancies. Triglyceride levels showed a statistically significant increase from 145.2 ± 25.5 mg/dl in controls to 228.8 ± 36.9 mg/dl in severe disease. Ahmed et al. (2018),[13] Faraji et al. (2022),[23] and Yadav et al. (2018),[14] similarly reported progressive hypertriglyceridemia with increasing severity of pre-eclampsia. Elevated triglycerides may contribute to endothelial dysfunction and placental vascular damage, thereby aggravating disease severity. LDL and VLDL levels also increased significantly with worsening disease severity, while HDL levels progressively declined. Similar observations were reported by Siveska et al. (2020),[17] Salma et al. (2022),[24] Kumari P et al. (2023),[21] and Ahmed et al. (2018).[13] Li et al. (2021),[15] further identified elevated LDL cholesterol as an independent predictor of early-onset pre-eclampsia with high diagnostic accuracy.The present study additionally demonstrated significantly elevated TC/HDL and LDL/HDL ratios among pre-eclamptic women, particularly in severe disease. Faraji et al. (2022),[23] reported that lipid ratios possess better predictive ability than individual lipid parameters alone, while Melekoğlu et al. (2022),[25] demonstrated significantly elevated inflammatory lipid ratios in severe pre-eclampsia. Adverse maternal and neonatal outcomes increased significantly with disease severity in the present study. Gestational age at delivery decreased progressively with increasing severity, consistent with findings by Li et al. (2021),[15] and Hassan et al. (2025),[16] who reported increased rates of preterm delivery among severe pre-eclampsia cases. Caesarean section rates were also markedly higher in severe disease, similar to observations by Ahmed et al. (2018),[13] Neonatal outcomes were significantly poorer among severe pre-eclampsia cases, with increased rates of low birth weight, very low birth

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weight, NICU admissions, prolonged NICU stay, lower APGAR scores, and neonatal mortality. Similar findings were reported by Siveska et al. (2020),[17] Li et al. (2021),[15] Kumari P et al. (2023),[21] and Hassan et al. (2025),[16] highlighting the adverse impact of severe maternal dyslipidaemia and placental insufficiency on fetal growth and neonatal survival. Maternal morbidity and mortality were also significantly higher among severe pre-eclampsia cases. ICU admissions, prolonged ICU stay, pulmonary oedema, HELLP syndrome, DIC, and MODS were more frequent in women with severe disease. Comparable findings were reported by Melekoğlu et al. (2022),[25] Ahmed et al. (2018),[13] and El-Khouly et al. (2016),[22] emphasizing the role of severe endothelial dysfunction and inflammatory vascular injury in dyslipidaemia-associated pre-eclampsia

CONCLUSION

The present study demonstrated a strong association between abnormal maternal lipid profile and the development as well as severity of pre-eclampsia. Women with pre-eclampsia showed significantly higher levels of total cholesterol, triglycerides, LDL, VLDL, TC/HDL ratio, and LDL/HDL ratio, along with significantly lower HDL levels compared to normotensive pregnant women. Increasing severity of dyslipidaemia was associated with worsening maternal and neonatal outcomes, including preterm delivery, higher caesarean section rates, low birth weight, NICU admission, ICU admission, and increased maternal and neonatal mortality. These findings suggest that serum lipid profile assessment during early pregnancy may serve as a simple, cost-effective, and useful screening tool for identifying women at higher risk of developing severe pre-eclampsia. Early detection of lipid abnormalities with timely antenatal surveillance and intervention may help reduce fetomaternal morbidity and mortality.

Limitations

The present study was conducted at a single tertiary care centre with a relatively limited sample size, which may restrict the generalisability of the findings to the wider population. Serum lipid profile was assessed only once during early pregnancy, and serial lipid measurements throughout gestation were not performed. Additionally, other important predictive biomarkers such as angiogenic and inflammatory markers were not evaluated, and long-term maternal cardiovascular outcomes were not assessed.

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