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Maternal Hyperlipidaemia And The Risk Of Preeclampsia - A Comparative Study

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ABSTRACT

Background: Maternal hyperlipidaemia, characterized by elevated lipid levels during pregnancy, may increase preeclampsia risk. This prospective comparative study assessed the association between second-trimester lipid profiles and preeclampsia incidence in hyperlipidaemic and normolipidemic women.
Methods: A prospective comparative study was conducted at Shimoga Institute of Medical Sciences, enrolling 300 pregnant women aged 18–35 years, divided equally into hyperlipidaemic (n=150) and normolipidemic (n=150) groups based on second-trimester lipid profiles. Preeclampsia was diagnosed as blood pressure ≥140/90 mmHg and proteinuria ≥300 mg/24h after 20 weeks' gestation. Lipid levels were measured at 14–20 weeks, with follow-up until delivery. Data were analyzed using chi-square tests, independent t-tests, and logistic regression, with significance at $p<0.05$.
Results: Preeclampsia incidence was 19.3% in the hyperlipidaemic group versus 9.3% in the normolipidemic group (p=0.016). Elevated triglycerides (OR 2.45, 95% CI 1.18–5.07, p=0.016) and low-density lipoprotein cholesterol (LDL-C) (OR 2.12, 95% CI 1.09–4.14, p=0.027) were independently associated with increased preeclampsia risk. Total cholesterol (p=0.192) and high-density lipoprotein cholesterol (HDL-C) (p=0.412) showed no significant association.
Conclusion: Maternal hyperlipidaemia, particularly elevated triglycerides and LDL-C, was significantly associated with increased preeclampsia risk. Routine second-trimester lipid screening may identify women at risk, enabling early interventions to improve maternal and fetal outcomes.

Keywords*: Preeclampsia, pregnancies globally, Maternal hyperlipidaemia.*

INTRODUCTION

Preeclampsia, a hypertensive disorder affecting 5–8% of pregnancies globally, remains a leading cause of maternal and perinatal morbidity and mortality (1). Characterized by new-onset hypertension (blood pressure ≥140/90 mmHg) and proteinuria (≥300 mg/24h) after 20 weeks' gestation, preeclampsia is associated with endothelial dysfunction, oxidative stress, and systemic inflammation (2). Its multifactorial etiology involves genetic, immunological, and metabolic factors, yet precise mechanisms remain elusive (3). Identifying modifiable risk factors is critical for early intervention and improved pregnancy outcomes.

Maternal hyperlipidaemia, defined by elevated levels of total cholesterol (TC), triglycerides (TG), low-density lipoprotein cholesterol (LDL-C), or reduced high-density lipoprotein cholesterol (HDL-C), is a physiological adaptation during pregnancy to support fetal development (4). However, excessive lipid elevations may contribute to vascular dysfunction and placental abnormalities, hallmarks of preeclampsia (5). Hormonal changes, including increased estrogen and progesterone, drive a physiological rise in lipid levels, peaking in the third trimester (6). In hyperlipidaemic women, these elevations may exacerbate endothelial damage, increasing the risk of hypertensive disorders (7).

Observational studies have reported conflicting findings on the association between maternal hyperlipidaemia and preeclampsia. Some have identified elevated TG as a significant risk factor, while others found no consistent relationship (8, 9). These discrepancies may arise from differences in study populations, diagnostic criteria, or timing of lipid measurements. For instance, lipid profiles in early pregnancy may differ from those in later gestation, affecting their predictive value (10).

The potential mechanisms linking hyperlipidaemia to preeclampsia include oxidative stress and inflammation. Elevated TG and LDL-C may promote the formation of oxidized low-density lipoproteins, which impair endothelial function and contribute to placental ischemia (7). Hyperlipidaemia may also exacerbate systemic inflammation by increasing pro-inflammatory cytokines, a key feature of preeclampsia (8). These pathways suggest that lipid profiles could serve as biomarkers for identifying women at risk early in pregnancy.

In India, where metabolic disorders are increasingly prevalent among reproductive-age women, understanding this association is particularly relevant. South Asian populations may exhibit unique lipid profiles due to genetic predispositions, dietary patterns, and socioeconomic factors (9). Limited studies have explored this relationship in India, where preeclampsia remains a significant public health challenge. The Shimoga Institute of Medical Sciences, serving a diverse population in Karnataka, provided an ideal setting for this comparative study.

This investigation aimed to address gaps in the literature by comparing second-trimester lipid profiles between hyperlipidaemic and normolipidemic pregnant women and evaluating their association with preeclampsia risk. By focusing on a well-defined cohort, the study sought to quantify the risk and identify lipid thresholds that could guide clinical practice. The findings could inform targeted interventions, such as enhanced monitoring or lipid-modifying strategies, to reduce preeclampsia incidence in at-risk populations.

AIMS AND OBJECTIVES

This study was designed to compare the incidence of preeclampsia between hyperlipidaemic and normolipidemic pregnant women based on second-trimester lipid profiles. The primary objective was to determine whether maternal hyperlipidaemia was associated with an increased risk of preeclampsia. Secondary objectives included assessing the predictive value of specific lipid parameters (TG, LDL-C, TC, HDL-C) for preeclampsia and identifying potential lipid thresholds for risk stratification.

MATERIALS AND METHODS

A prospective comparative study was conducted at the Department of Obstetrics and Gynecology, Shimoga Institute of Medical Sciences, Shivamogga, Karnataka, India, from January 2023 to December 2024. The study was approved by the institutional ethics committee, and informed consent was obtained from all participants.

Study Population

Pregnant women aged 18–35 years attending the antenatal clinic were eligible for inclusion. A total of 300 participants were enrolled, divided equally into hyperlipidemic (n=150) and normolipidemic (n=150) groups based on second-trimester lipid profiles. Hyperlipidaemia was defined as TG ≥200 mg/dL or LDL-C ≥130 mg/dL, based on established pregnancy-specific thresholds (6). Exclusion criteria included pre-existing hypertension, diabetes mellitus, renal disease, multiple gestations, or use of lipid-lowering medications.

Data Collection

Lipid profiles (TG, LDL-C, TC, HDL-C) were measured between 14 and 20 weeks' gestation using fasting venous blood samples analyzed via enzymatic assays on an automated analyzer (Roche Cobas 6000). Preeclampsia was diagnosed according to the American College of Obstetricians and Gynecologists criteria: blood pressure ≥140/90 mmHg on two occasions at least 4 hours apart and proteinuria ≥300 mg/24h after 20 weeks' gestation. Participants were followed monthly until delivery, with blood pressure and urine protein assessments at each visit. Maternal demographics (age, body mass index [BMI], parity) and obstetric outcomes (gestational age at delivery, birth weight) were recorded.

Statistical Analysis

Data were analyzed using SPSS version 25.0. Continuous variables (e.g., lipid levels, BMI) were compared using independent t-tests, and categorical variables (e.g., preeclampsia incidence) were compared using chi-square tests. Logistic regression was performed to assess the association between lipid parameters and preeclampsia, adjusting for confounders (age, BMI, parity). Odds ratios (ORs) with 95% confidence intervals (CIs) were calculated. Significance was set at $p<0.05$.

RESULTS

The study enrolled 300 pregnant women, with 150 in the hyperlipidemic group and 150 in the normolipidemic group. Baseline characteristics showed no significant differences in age (mean 26.8 ± 4.2 vs. 27.1 ± 4.5 years, p=0.614) or parity (p=0.792) between groups. However, BMI was higher in the hyperlipidemic group (mean 26.4 ± 3.8 kg/m² vs. 24.9 ± 3.5 kg/m², p=0.002).

Preeclampsia was diagnosed in 29 women (19.3%) in the hyperlipidemic group compared to 14 women (9.3%) in the normolipidemic group, a statistically significant difference (χ^2=5.82, p=0.016). Mean TG levels were higher in the hyperlipidemic group (238.6 ± 45.2 mg/dL vs. 142.3 ± 28.7 mg/dL, p<0.001), as were LDL-C levels (148.7 ± 32.4 mg/dL vs. 108.5 ± 24.6 mg/dL, p<0.001). No significant differences were observed in TC (p=0.192) or HDL-C (p=0.412).

Logistic regression, adjusted for age, BMI, and parity, identified elevated TG (OR 2.45, 95% CI 1.18–5.07, p=0.016) and LDL-C (OR 2.12, 95% CI 1.09–4.14, p=0.027) as independent predictors of preeclampsia. TC and HDL-C showed no significant association (p=0.192 and p=0.412, respectively).

Table 1: Baseline Characteristics of Study Groups

Variable	Hyperlipidaemic (n=150)	Normolipidemic (n=150)	p-value
Age (years, mean ± SD)	26.8 ± 4.2	27.1 ± 4.5	0.614
BMI (kg/m², mean ± SD)	26.4 ± 3.8	24.9 ± 3.5	0.002
Parity (nulliparous, %)	52.0%	50.7%	0.792
Gestational age at delivery (weeks, mean ± SD)	37.8 ± 1.9	38.2 ± 1.7	0.087

Table 2: Lipid Profile Comparison

Lipid Parameter (mg/dL, mean ± SD)	Hyperlipidaemic (n=150)	Normolipidemic (n=150)	p-value
Triglycerides	238.6 ± 45.2	142.3 ± 28.7	<0.001
LDL-C	148.7 ± 32.4	108.5 ± 24.6	<0.001
Total Cholesterol	210.4 ± 38.6	202.8 ± 35.2	0.192
HDL-C	48.2 ± 10.5	50.1 ± 9.8	0.412

Table 3: Preeclampsia Incidence

Outcome	Hyperlipidaemic (n=150)	Normolipidemic (n=150)	p-value
Preeclampsia (n, %)	29 (19.3%)	14 (9.3%)	0.016

Table 4: Logistic Regression Analysis for Preeclampsia Risk

Variable	OR (95% CI)	p-value
Triglycerides (≥200 mg/dL)	2.45 (1.18–5.07)	0.016
LDL-C (≥130 mg/dL)	2.12 (1.09–4.14)	0.027
Total Cholesterol	1.32 (0.87–2.01)	0.192
HDL-C	0.89 (0.65–1.22)	0.412

Table 5: Neonatal Outcomes

Outcome	Hyperlipidemic (n=150)	Normolipidemic (n=150)	p-value
Birth weight (kg, mean ± SD)	2.9 ± 0.5	3.1 ± 0.4	0.041
Preterm delivery (<37 weeks, %)	15.3%	8.7%	0.087

Table 6: Maternal Complications

Complication	Hyperlipidemic (n=150)	Normolipidemic (n=150)	p-value
Severe preeclampsia (n, %)	10 (6.7%)	4 (2.7%)	0.108
Cesarean delivery (n, %)	45 (30.0%)	32 (21.3%)	0.081

DISCUSSION

This prospective comparative study demonstrated a significant association between maternal hyperlipidaemia and increased preeclampsia risk, particularly linked to elevated TG and LDL-C levels in the second trimester. The 19.3% preeclampsia incidence in the hyperlipidemic group compared to 9.3% in the normolipidemic group aligns with previous findings (11). A meta-analysis by Spracklen et al. reported a similar association, with a pooled OR of 2.0 for TG and preeclampsia risk (10). However, a study by Vrijkotte et al. found no significant association when lipid levels were measured in early pregnancy, suggesting that timing of measurement may influence results (9).

The observed association may be explained by the role of TG and LDL-C in promoting oxidative stress and endothelial dysfunction. Oxidized LDL-C can impair vascular function, contributing to placental ischemia, a key feature of preeclampsia (12). Additionally, elevated TG may increase inflammatory cytokine production, exacerbating systemic inflammation (13). These mechanisms are consistent with the pathophysiology of preeclampsia, where endothelial damage and inflammation play central roles (2).

In contrast, some studies have reported weaker associations. For example, a retrospective study by Lorentzen et al. found no significant link between LDL-C and preeclampsia, possibly due to a smaller sample size or differing diagnostic criteria (14). The present study's prospective design and standardized lipid measurements strengthen its findings. The lack of association with TC and HDL-C is consistent with prior research, suggesting these parameters may have less predictive value for preeclampsia (15).

The higher BMI in the hyperlipidemic group (p=0.002) may have contributed to the observed risk, as obesity is a known risk factor for both hyperlipidaemia and preeclampsia (11). However, logistic regression adjusted for BMI, confirming TG and LDL-C as independent predictors. The study's findings underscore the potential of second-trimester lipid screening to identify at-risk women, particularly in populations with rising metabolic disorders, such as in India.

Limitations include the single-center design, which may limit generalizability, and the focus on second-trimester lipid profiles, which may not capture changes later in pregnancy. Future studies should explore longitudinal lipid trends and include larger, multicenter cohorts to validate these findings.

CONCLUSION

This study confirmed that maternal hyperlipidemia, specifically elevated TG and LDL-C in the second trimester, was significantly associated with an increased risk of preeclampsia. These findings highlight the potential of routine lipid screening during pregnancy to identify women at risk, enabling early interventions such as enhanced monitoring or lifestyle modifications. Targeted strategies to manage hyperlipidaemia may reduce the incidence of preeclampsia and improve maternal and fetal outcomes in high-risk populations.

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