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EVALUATION OF MATERNAL TRIGLYCERIDES AS A PREDICTING FACTOR FOR PREECLAMPSIA IN A TERTIARY CARE CENTRE

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ABSTRACT

Background: Preeclampsia is a pregnancy-specific multisystem hypertensive disorder and remains a major cause of maternal and perinatal morbidity and mortality worldwide. Increasing evidence suggests that maternal dyslipidaemia, particularly elevated serum triglyceride levels, contributes to endothelial dysfunction and abnormal placentation, predisposing women to the development of preeclampsia. Identification of a simple and inexpensive biomarker for early prediction may facilitate timely antenatal surveillance and improve pregnancy outcomes.

Materials and Methods: This prospective observational study was conducted in the Department of Obstetrics and Gynaecology, Sree Balaji Medical College and Hospital, Chennai, over a period of 18 months. A total of 100 pregnant women with singleton pregnancies between 13 and 20 weeks of gestation were enrolled using consecutive sampling. After obtaining informed consent, fasting maternal serum triglyceride levels were estimated using the enzymatic Glycerol-3-Phosphate Oxidase–Phenol Aminophenazone (GPO-PAP) method. Participants were followed until delivery for the occurrence of preeclampsia. Data were analysed using appropriate statistical tests, and the diagnostic performance of serum triglycerides was assessed by calculating sensitivity, specificity, positive predictive value, negative predictive value, overall accuracy, and receiver operating characteristic analysis.

Results: The mean maternal age was 25.8 ± 4.2 years, and the mean gestational age at enrolment was 16.2 ± 2.1 weeks. Elevated serum triglyceride levels (≥150 mg/dL) were observed in 40.0% of participants. Overall, 22.0% of women developed preeclampsia during follow-up. The incidence of preeclampsia was significantly higher among women with elevated triglyceride levels (40.0%) compared with those having triglyceride levels <150 mg/dL (10.0%). Women with elevated triglycerides also had significantly higher systolic (122 ± 10 vs. 116 ± 9 mmHg; p=0.010) and diastolic blood pressure (78 ± 6 vs. 72 ± 5 mmHg; p=0.020). Maternal serum triglyceride estimation demonstrated a sensitivity of 72.7%, specificity of 69.2%, positive predictive value of 40.0%, negative predictive value of 90.0%, and an overall diagnostic accuracy of 70.0% for predicting preeclampsia.

Conclusion: Elevated maternal serum triglyceride levels during the early second trimester were significantly associated with the subsequent development of preeclampsia. Maternal serum triglyceride estimation demonstrated satisfactory diagnostic performance and a high negative predictive value, indicating its potential utility as a simple, inexpensive, and readily available adjunctive screening tool for early risk stratification during routine antenatal care. Larger multicentric studies are warranted to validate these findings and establish standardized cut-off values for clinical application.

KEYWORDS: Preeclampsia, maternal serum triglycerides, dyslipidaemia, hypertensive disorders of pregnancy, early prediction, antenatal screening, endothelial dysfunction, pregnancy outcomes, biomarker, prospective observational study.

1. INTRODUCTION

Preeclampsia is a pregnancy-specific multisystem hypertensive disorder characterized by new-onset hypertension after 20 weeks of gestation, accompanied by proteinuria and/or maternal organ dysfunction. It remains one of the most important causes of maternal and perinatal morbidity and mortality worldwide. Williams Obstetrics describes preeclampsia as a complex syndrome involving abnormal placentation, endothelial dysfunction, inflammatory activation, and multisystem involvement rather than an isolated hypertensive disorder.[1] Chesley's Hypertensive Disorders in Pregnancy further emphasizes that impaired trophoblastic invasion of the maternal spiral arteries initiates placental ischemia, resulting in the release of antiangiogenic factors and systemic endothelial injury that ultimately manifest as the clinical syndrome of preeclampsia.[2]

High-risk pregnancy literature highlights that preeclampsia has an unpredictable clinical course, progressing from mild disease to severe maternal complications including eclampsia, HELLP syndrome, acute kidney injury, pulmonary edema, cerebrovascular accidents, and maternal death when not recognized early.[3] Creasy and Resnik's Maternal-Fetal Medicine explains that placental hypoperfusion and oxidative stress represent the principal mechanisms responsible for the maternal systemic manifestations of the disease.[4] Similarly, Gabbe's Obstetrics describes preeclampsia as a major contributor to fetal growth restriction, preterm birth, placental abruption, and perinatal mortality because of impaired uteroplacental perfusion.[5]

Globally, preeclampsia affects approximately 2–8% of all pregnancies and contributes to nearly 70,000 maternal deaths and over 500,000 fetal and neonatal deaths every year. The burden is substantially greater in low- and middle-income countries because of delayed diagnosis, inadequate antenatal surveillance, and restricted access to emergency obstetric care.[1] In India, hypertensive disorders of pregnancy account for nearly 8–10% of maternal deaths, making early prediction and timely intervention important priorities for maternal health services.[3]

Normal pregnancy is associated with marked physiological adaptations in lipid metabolism. Maternal triglyceride concentrations progressively increase during the second and third trimesters because of estrogen-mediated hepatic lipogenesis, insulin resistance, and reduced lipoprotein lipase activity, ensuring adequate nutrient supply to the growing fetus.[5] However, excessive hypertriglyceridemia is believed to promote endothelial dysfunction, oxidative stress, and vascular inflammation, thereby contributing to abnormal placental perfusion and subsequent development of preeclampsia.[2]

Maternal obesity and metabolic disturbances further increase the likelihood of developing hypertensive disorders during pregnancy. Bodnar et al. demonstrated that the risk of preeclampsia increased progressively with increasing prepregnancy body mass index, highlighting obesity as an independent risk factor for disease development.[6] Wolf et al. subsequently proposed that chronic low-grade inflammation associated with obesity contributes to endothelial dysfunction and enhances susceptibility to preeclampsia.[7]

Growing evidence suggests that maternal dyslipidemia precedes the clinical onset of preeclampsia. Enquobahrie et al. reported that elevated maternal plasma lipid concentrations measured during early pregnancy were significantly associated with subsequent development of preeclampsia.[8] Likewise, Cekmen et al. observed significantly higher serum triglyceride and lipoprotein concentrations among women with pregnancy-induced hypertension than normotensive pregnant women, supporting the hypothesis that lipid abnormalities contribute to disease pathogenesis.[9]

Mikhail et al. demonstrated a direct relationship between increasing maternal triglyceride concentrations and the severity of preeclampsia, suggesting that serum triglycerides may serve not only as a marker of disease but also as an indicator of disease progression.[10] Sattar et al. further reported that women with preeclampsia exhibit atherogenic alterations in lipoprotein subfractions, indicating similarities between endothelial injury in preeclampsia and early atherosclerosis.[11]

A meta-analysis by Spracklen et al., including multiple observational studies, confirmed that maternal hyperlipidemia, particularly elevated triglyceride levels, significantly increases the risk of preeclampsia across different populations.[12] More recently, Liu et al. demonstrated that elevated mid-trimester postprandial triglyceride concentrations were effective predictors of late-onset preeclampsia, reinforcing the potential utility of maternal triglycerides as an early screening biomarker.[13] Pecks et al. further showed that disturbances in maternal lipid metabolism closely reflect placental pathology and are associated with adverse pregnancy outcomes.[14] Tesfa et al., in a systematic review and meta-analysis, concluded that women with preeclampsia consistently exhibit significantly higher triglyceride concentrations than normotensive pregnant women, providing strong evidence that maternal hypertriglyceridemia is an important component of disease pathophysiology.[15]

Although these studies demonstrate a consistent association between maternal triglyceride levels and preeclampsia, routine lipid screening has not been incorporated into standard antenatal care in many developing countries. Serum triglyceride estimation is inexpensive, readily available, and technically simple, making it a promising biomarker for early risk stratification, particularly in resource-limited settings. However, evidence from the Indian population remains limited. Therefore, the present study was undertaken to evaluate maternal serum triglyceride levels measured during the early second trimester as a predictor of preeclampsia among pregnant women attending a tertiary care centre.

2. MATERIALS AND METHODS

Study Design

The present study was a prospective observational study conducted to evaluate the role of maternal serum triglyceride levels measured during early pregnancy as a predictor of preeclampsia. Pregnant women were enrolled during the early second trimester and followed prospectively until delivery to determine the subsequent development of preeclampsia.

Study Setting

The study was carried out in the Department of Obstetrics and Gynaecology at Sree Balaji Medical College and Hospital, Chennai, a tertiary care teaching hospital catering to both urban and rural populations. Laboratory investigations were performed in the Department of Biochemistry using standardized laboratory protocols.

Study Duration

The study was conducted over a period of 18 months, from August 2024 to February 2026. Participant recruitment was carried out during the initial study period, and all enrolled women were followed until delivery.

Study Population

The study population comprised antenatal women attending the outpatient and antenatal clinics of the Department of Obstetrics and Gynaecology who fulfilled the eligibility criteria. Only singleton pregnancies between 13 and 20 weeks of

gestation were included to facilitate early assessment of maternal serum triglyceride levels before the onset of clinical preeclampsia.

Sample Size

A total of 100 pregnant women fulfilling the inclusion criteria were enrolled consecutively during the study period. Sample size adequacy was based on previous studies evaluating maternal triglyceride levels and the anticipated incidence of preeclampsia among women with elevated triglyceride concentrations.

Sampling Technique

A consecutive sampling technique was adopted. All eligible pregnant women attending the antenatal clinic during the study period who satisfied the inclusion and exclusion criteria and provided written informed consent were recruited until the required sample size of 100 participants was achieved.

Inclusion Criteria

Pregnant women were eligible for inclusion if they had a singleton pregnancy with a gestational age between 13 and 20 weeks, confirmed by ultrasonography or a reliable last menstrual period. Women aged 18–35 years who were willing to participate in the study and provided written informed consent were enrolled.

Exclusion Criteria

Women with chronic hypertension diagnosed before pregnancy or before 20 weeks of gestation, pregestational diabetes mellitus, chronic kidney disease, chronic liver disease, thyroid disorders, multiple pregnancy, known dyslipidaemia receiving lipid-lowering therapy, autoimmune disorders, chronic inflammatory diseases, or any other serious medical illness likely to influence lipid metabolism or pregnancy outcomes were excluded from the study.

Study Procedure

After obtaining approval from the Institutional Ethics Committee, eligible pregnant women attending the antenatal clinic were informed about the objectives and methodology of the study. Written informed consent was obtained before enrolment. A detailed history was recorded using a predesigned case record proforma, including maternal age, obstetric history, parity, gestational age, socioeconomic details, and relevant medical history.

General physical examination included measurement of height, weight, body mass index, pulse rate, and blood pressure using standardized techniques. Obstetric examination was performed to assess gestational age and fetal well-being.

Following an overnight fast of 8–12 hours, approximately 5 mL of venous blood was collected under aseptic precautions. Blood samples were transported immediately to the Department of Biochemistry, where serum triglyceride estimation was performed using the enzymatic Glycerol-3-Phosphate Oxidase–Phenol Aminophenazone (GPO-PAP) method on a fully automated biochemistry analyser with routine internal quality control procedures.

Participants continued routine antenatal follow-up according to institutional protocol until delivery. Blood pressure and urine protein estimation were performed during each antenatal visit. Women who subsequently developed hypertension after 20 weeks of gestation with proteinuria and/or evidence of maternal organ dysfunction were diagnosed with preeclampsia according to accepted obstetric diagnostic criteria. Final maternal outcome was recorded after delivery.

For analysis, participants were categorized into two groups based on fasting serum triglyceride concentration:

- **Normal triglyceride group:** <150 mg/dL
- **Elevated triglyceride group:** ≥150 mg/dL

Maternal triglyceride levels were correlated with the occurrence of preeclampsia and other clinical parameters.

Data Collection Tool

Data were collected using a structured and prevalidated case record proforma specifically designed for the study. Laboratory reports and clinical follow-up records were reviewed to ensure completeness and accuracy of data collection.

Statistical Analysis

The collected data were entered into Microsoft Excel and analysed using appropriate statistical software. Continuous variables were expressed as mean ± standard deviation, whereas categorical variables were expressed as frequency and percentage.

The independent Student's t-test was used for comparison of continuous variables between groups. The Chi-square test was applied to assess the association between categorical variables. Diagnostic performance of maternal serum triglyceride estimation for predicting preeclampsia was evaluated by calculating sensitivity, specificity, positive predictive value, negative predictive value, overall diagnostic accuracy, and receiver operating characteristic (ROC) curve analysis. A p-value <0.05 was considered statistically significant.

Ethical Considerations

The study was conducted only after obtaining approval from the Institutional Ethics Committee of Sree Balaji Medical College and Hospital. Written informed consent was obtained from every participant before enrolment. Confidentiality of participant information was maintained throughout the study, and participation was entirely voluntary. Women received routine antenatal care irrespective of their participation status, and no additional financial burden was imposed on the participants.

3. RESULTS

Table 1. Baseline Characteristics of Study Participants (n=100)

Variable	Value
Age (years), Mean ± SD	25.8 ± 4.2

Gestational age (weeks), Mean ± SD	16.2 ± 2.1
BMI (kg/m²), Mean ± SD	24.6 ± 3.5
Age 18–20 years	8 (8.0%)
Age 21–25 years	62 (62.0%)
Age 26–35 years	30 (30.0%)
Primigravida	56 (56.0%)
Multigravida	44 (44.0%)
BMI <18.5	6 (6.0%)
BMI 18.5–24.9	54 (54.0%)
BMI 25–29.9	40 (40.0%)

Table 2. Distribution Of Maternal Serum Triglyceride Levels

Triglyceride Level	N	%
<150 mg/dL	60	60.0
≥150 mg/dL	40	40.0
Total	100	100

Table 3. Association Between Maternal Triglyceride Levels And Preeclampsia

Triglycerides	PE (+)	PE (−)	Total
<150 mg/dL	6 (10.0%)	54 (90.0%)	60
≥150 mg/dL	16 (40.0%)	24 (60.0%)	40
Total	22 (22.0%)	78 (78.0%)	100

Table 4. Stratified Analysis Of Preeclampsia According To Maternal Characteristics

Variable	TG <150 mg/dL	TG ≥150 mg/dL	p value
Age			
18–20 yrs	1	2	0.210
21–25 yrs	3	9	0.002
26–35 yrs	2	5	0.010
Gestational age			
13–16 weeks	3	7	0.010
17–20 weeks	3	9	<0.001
Parity			
Primigravida	4	10	<0.001
Multigravida	2	6	0.030
BMI			
<18.5	1	3	0.150
18.5–24.9	2	6	0.010

25–29.9	3	7	0.020

Table 5. Diagnostic Accuracy Of Maternal Triglycerides

Parameter	Value
Sensitivity	72.7%
Specificity	69.2%
Positive Predictive Value	40.0%
Negative Predictive Value	90.0%
Overall Accuracy	70.0%

Table 6. Comparison Of Clinical Parameters According To Triglyceride Levels

Variable	≥150 mg/dL	<150 mg/dL	p value
SBP (mmHg)	122 ±10	116 ±9	0.010
DBP (mmHg)	78 ±6	72 ±5	0.020
Triglycerides (mg/dL)	232 ±35	118 ±22	<0.001

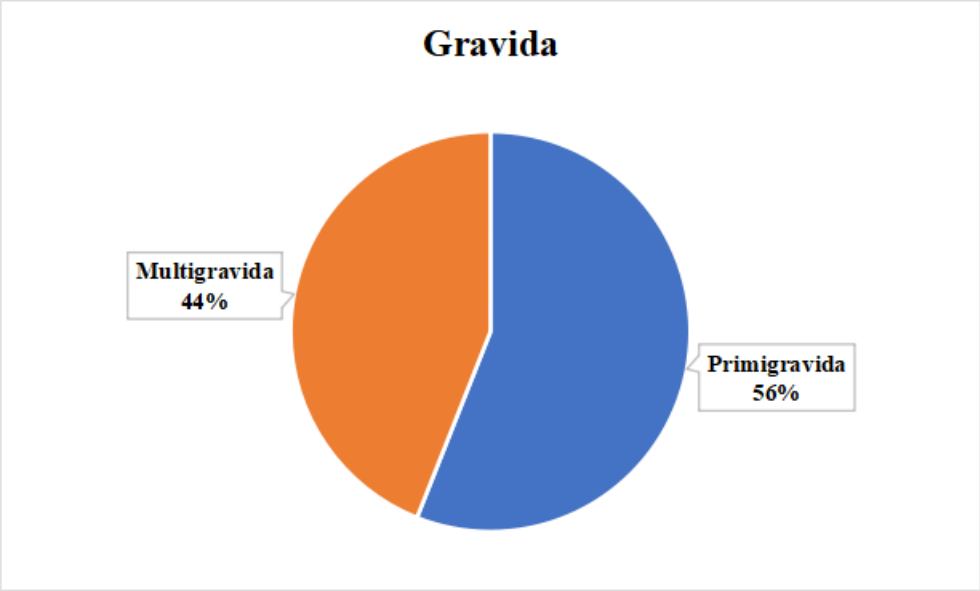

Figure 1: Baseline Characteristics of Study Participants

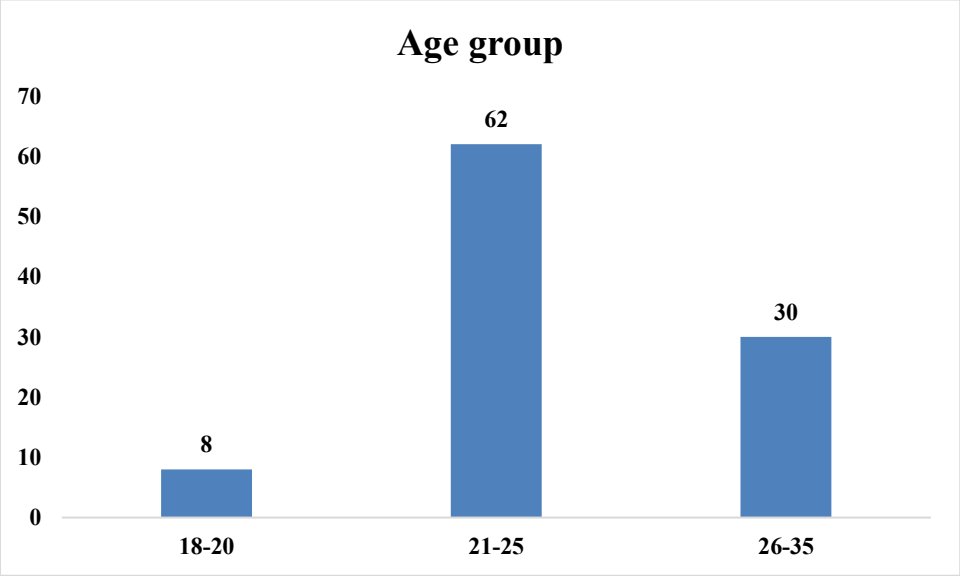

Figure 2: Age Distribution of Study Participants

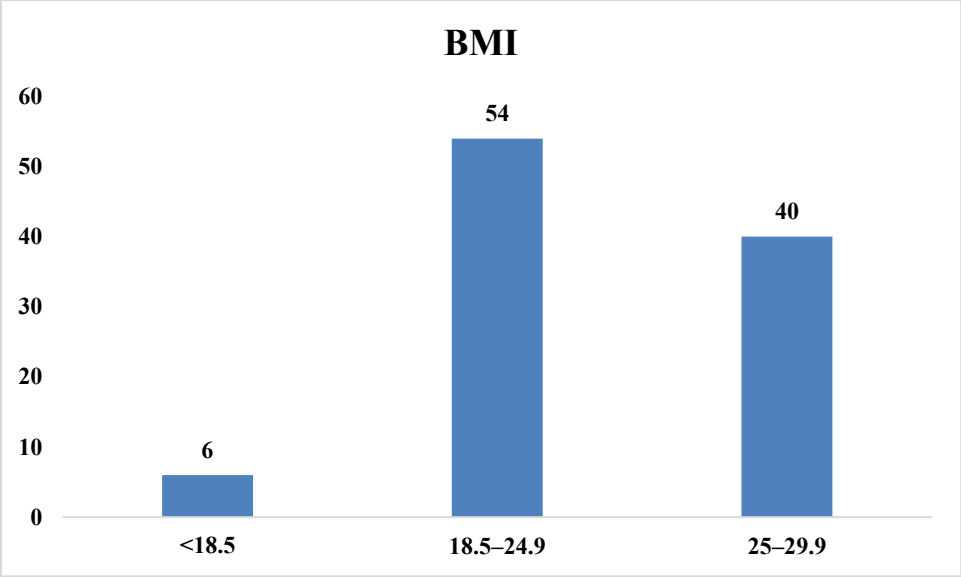

Figure 3: Body Mass Index Distribution of Study Participants

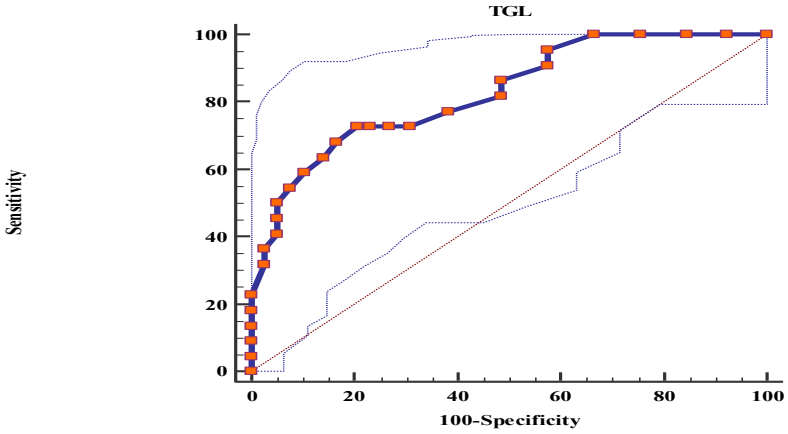

Figure 4: Receiver Operating Characteristic (ROC) Curve for Triglyceride Levels in Predicting Preeclampsia

4. DISCUSSION

The present prospective observational study evaluated maternal serum triglyceride levels during the early second trimester as a predictor of preeclampsia. Of the 100 pregnant women included, 22 (22.0%) developed preeclampsia. Women with maternal serum triglyceride levels ≥150 mg/dL had a markedly higher incidence of preeclampsia (40.0%) than those with triglyceride levels <150 mg/dL (10.0%), indicating a nearly four-fold increased occurrence of preeclampsia among women with elevated triglyceride levels. Furthermore, maternal serum triglyceride estimation demonstrated a sensitivity of 72.7%, specificity of 69.2%, positive predictive value of 40.0%, negative predictive value of 90.0%, and overall diagnostic accuracy of 70.0%, suggesting that serum triglycerides may serve as a useful screening marker, particularly for identifying women at low risk because of the high negative predictive value.

Emet et al.[16] reported that women who subsequently developed preeclampsia had significantly higher maternal plasma triglyceride and lipoprotein concentrations than normotensive pregnant women. The authors suggested that exaggerated maternal hypertriglyceridaemia contributes to endothelial dysfunction and placental vascular injury, thereby increasing the risk of hypertensive disorders. The present study similarly demonstrated a significantly higher incidence of preeclampsia among women with elevated triglyceride levels, supporting the role of maternal hypertriglyceridaemia as an early marker of disease.

Charlton et al.[17] highlighted that pregnancy-associated dyslipidaemia is associated not only with preeclampsia but also with increased long-term maternal cardiovascular risk. Likewise, Murai et al.[18] demonstrated that disturbances in maternal lipid metabolism occur before the clinical onset of preeclampsia and are closely related to placental dysfunction. These observations are consistent with the present findings, indicating that abnormal lipid metabolism precedes the development of clinical disease and may represent an important pathogenic mechanism.

In the present study, women with elevated triglyceride levels also had significantly higher systolic blood pressure (122 ± 10 mmHg vs. 116 ± 9 mmHg; p=0.010) and diastolic blood pressure (78 ± 6 mmHg vs. 72 ± 5 mmHg; p=0.020) than women with normal triglyceride levels. Zhu et al.[19] similarly demonstrated that elevated triglyceride concentrations measured during early pregnancy, when combined with maternal blood pressure, significantly improved prediction of preeclampsia. Bartho et al.[20] further reported that plasma lipid abnormalities are evident before the clinical diagnosis

of preeclampsia, suggesting that dyslipidaemia is an early event in disease pathogenesis. The present findings are therefore in agreement with these studies.

The diagnostic performance observed in the present study further supports the clinical utility of maternal triglyceride estimation. With a sensitivity of 72.7%, specificity of 69.2%, and particularly a negative predictive value of 90.0%, serum triglycerides showed reasonable ability to identify women at risk of developing preeclampsia. Li et al.[21] reported that an elevated triglyceride-glucose (TyG) index was independently associated with an increased risk of preeclampsia and improved early prediction. Similarly, Ye et al.[24] and Zhang et al.[25] demonstrated that triglyceride-based metabolic indices are promising biomarkers for predicting adverse pregnancy outcomes. Although the present study evaluated fasting serum triglycerides rather than the TyG index, the findings consistently support the role of triglyceride-based metabolic markers in antenatal risk stratification.

Mulder et al.[22] reviewed physiological lipid metabolism during pregnancy and concluded that excessive maternal hypertriglyceridaemia promotes oxidative stress, endothelial dysfunction, and placental vascular injury. Likewise, Poornima et al.[23] emphasized that maternal hyperlipidaemia is an important cardiovascular risk factor associated with preeclampsia. The findings of the present study provide further clinical evidence supporting these proposed mechanisms.

Liu et al.[26] observed significant disturbances in serum lipid metabolism among women with hypertensive disorders of pregnancy, particularly elevated triglyceride concentrations, while Chen et al.[27] demonstrated that abnormal lipid profiles were positively associated with inflammatory markers and disease severity. These observations are comparable with the present study, where elevated maternal triglyceride levels were associated with both increased blood pressure and a higher incidence of preeclampsia.

Further evidence supporting the present findings comes from Hosier et al.[28], who demonstrated through Mendelian randomization analysis that dyslipidaemia has a probable causal relationship with preeclampsia. In addition, Qin et al.[29], in a systematic review and meta-analysis, concluded that elevated maternal triglyceride concentrations consistently increase the risk of gestational hypertension and preeclampsia across different populations. These high-level evidence studies strengthen the findings of the present study and reinforce the role of maternal triglycerides as an important biomarker of preeclampsia.

Hart[30] proposed that excessive maternal lipid accumulation promotes placental hypoxia, oxidative stress, and endothelial dysfunction, thereby contributing to the development of preeclampsia. This proposed pathophysiological mechanism is consistent with the observations of the present study. Overall, the present findings indicate that maternal serum triglyceride estimation is an inexpensive, readily available, and clinically useful investigation that may facilitate early identification of women at increased risk of preeclampsia and enable closer antenatal surveillance and timely intervention.

5. CONCLUSION

The present prospective observational study demonstrated a significant association between elevated maternal serum triglyceride levels measured during the early second trimester and the subsequent development of preeclampsia. Among the 100 pregnant women included, 22.0% developed preeclampsia, with a markedly higher incidence among women with serum triglyceride levels ≥150 mg/dL (40.0%) compared with those having levels <150 mg/dL (10.0%). Women with elevated triglyceride levels also had significantly higher systolic and diastolic blood pressure, supporting the relationship between maternal dyslipidaemia and hypertensive disorders of pregnancy. Maternal serum triglyceride estimation demonstrated a sensitivity of 72.7%, specificity of 69.2%, positive predictive value of 40.0%, negative predictive value of 90.0%, and overall diagnostic accuracy of 70.0%, indicating good screening performance, particularly for identifying women at low risk because of its high negative predictive value.

The findings suggest that maternal hypertriglyceridaemia reflects underlying metabolic and endothelial disturbances that precede the clinical onset of preeclampsia. As serum triglyceride estimation is inexpensive, simple, widely available, and minimally invasive, it has considerable potential as an adjunctive screening tool during routine antenatal care, particularly in resource-limited settings. Early identification of high-risk women would facilitate closer surveillance, timely preventive interventions, and appropriate obstetric management, thereby improving maternal and perinatal outcomes. Further multicentric studies with larger sample sizes are recommended to validate these findings and establish clinically useful triglyceride cut-off values for routine obstetric practice.

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