EFFECTS OF METABOLIC SYNDROME ON PREGNANCY OUTCOMES; A COMPARATIVE STUDY

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KEYWORDS

Metabolic syndrome, pregnancy outcomes, gestational diabetes, hypertensive disorders

ABSTRACT:

Background: Metabolic syndrome (MetS) is a cluster of metabolic abnormalities, including central obesity, insulin resistance, hypertension, and dyslipidemia, that significantly increase the risk of adverse pregnancy outcomes. Given the rising prevalence of MetS globally, its impact on maternal and fetal health has become a critical area of research.

Objective: This study aims to evaluate the effects of MetS on pregnancy outcomes by conducting a prospective comparative observational study in the Department of Obstetrics and Gynecology at PDU Medical College, Churu, Rajasthan

Methods: A total of 200 pregnant women were enrolled and divided into two groups: Group A (MetS, n=100) and Group B (Control, n=100). MetS was diagnosed based on the revised NCEP ATP III criteria. Maternal outcomes, including gestational diabetes mellitus (GDM), hypertensive disorders of pregnancy (HDP), preterm birth, mode of delivery, and postpartum complications, were assessed. Neonatal outcomes such as birth weight, Apgar scores, NICU admissions, and perinatal mortality were also evaluated. Data were analyzed using SPSS version 25.0, with statistical significance set at $p< 0.05$.

Results: Women with MetS had significantly higher rates of GDM (40% vs. 12%, $p< 0.001$), HDP (35% vs. 10%, $p< 0.001$), preterm birth (22% vs. 8%, $p = 0.005$), and cesarean delivery (58% vs. 32%, $p< 0.001$) compared to controls. NICU admissions were significantly higher in neonates born to MetS mothers (25% vs. 7%, $p< 0.001$), and they also had a higher prevalence of low birth weight (28% vs. 10%, $p = 0.002$) and macrosomia (18% vs. 5%, $p = 0.01$). Multivariate logistic regression analysis identified MetS as an independent risk factor for adverse pregnancy outcomes.

Conclusion: MetS in pregnancy is associated with an increased risk of GDM, HDP, preterm birth, cesarean delivery, and adverse neonatal outcomes. Early screening and targeted interventions for women with MetS may help improve maternal and fetal health outcomes.

Introduction

Metabolic syndrome (MetS) is a cluster of interrelated metabolic abnormalities, including central obesity, insulin resistance, hypertension, and dyslipidemia, that significantly increase the risk of cardiovascular diseases and type 2 diabetes mellitus (T2DM) [1]. In recent years, the prevalence of MetS has been rising globally, paralleling the increasing rates of obesity and sedentary lifestyles, making it a significant public health concern [2]. Pregnancy is a state of profound physiological adaptation, and the presence of MetS can substantially impact maternal

and fetal health outcomes [3].

Pregnancy itself is a diabetogenic and hypertensive state due to the hormonal and metabolic changes required to sustain fetal growth [4]. Women with MetS are at a heightened risk for developing gestational diabetes mellitus (GDM), hypertensive disorders of pregnancy (HDP), preterm birth, and adverse neonatal outcomes such as low birth weight and neonatal intensive care unit (NICU) admissions [5,6]. These complications not only increase maternal morbidity and mortality but also pose significant risks to fetal development and long-term metabolic programming in offspring [7].

The impact of MetS on pregnancy outcomes remains a critical area of research, given its implications for maternal and neonatal health. Several studies have suggested that maternal metabolic abnormalities can lead to long-term health consequences for both mother and child, including increased risks of obesity, T2DM, and cardiovascular diseases in later life [8,9]. However, there is a lack of comprehensive prospective studies evaluating the direct effects of MetS on pregnancy outcomes in different populations, particularly in resource-limited settings. This study aims to assess the impact of MetS on maternal and fetal outcomes by conducting a prospective comparative observational study in the Department of Obstetrics and Gynecology at PDU medical college and Hospital , Churu, Rajasthan. The study will compare pregnancy outcomes between women diagnosed with MetS and those without MetS, focusing on the prevalence of GDM, hypertensive disorders, preterm birth, cesarean delivery rates, and neonatal outcomes. The findings from this study could contribute to better risk stratification, early intervention, and improved perinatal care strategies for pregnant women with MetS.

MATERIAL AND METHODS

Study Design and Setting

This is a **prospective comparative observational study** conducted at the **Department of Obstetrics and Gynecology, PDU Medical College And Hospital, Churu, Rajasthan** from **January 1, 2024, to December 31, 2024**. The study aims to evaluate the impact of **metabolic syndrome (MetS) on maternal and fetal outcomes** by comparing pregnant women with and without metabolic syndrome.

Study Population and Sample Size

A total of **200 pregnant women** will be enrolled and divided into two groups:

- **Group A (MetS Group):** 100 pregnant women diagnosed with metabolic syndrome.
- **Group B (Control Group):** 100 pregnant women without metabolic syndrome.

The sample size was determined based on previous literature and statistical considerations to ensure adequate power for comparison.

Inclusion Criteria

- Pregnant women aged **18–40 years**.
- **Singleton pregnancies**.
- **Gestational age ≤12 weeks at enrollment**.
- **Group A:** Diagnosis of **metabolic syndrome** based on the **revised National Cholesterol Education Program Adult Treatment Panel III (NCEP ATP III) criteria**, requiring the presence of at least **three** of the following:
    1. **Central obesity:** Waist circumference ≥88 cm.
    2. **Hypertriglyceridemia:** Serum triglycerides ≥150 mg/dL.
    3. **Low HDL-C:** HDL cholesterol <50 mg/dL.
    4. **Hypertension:** Blood pressure ≥130/85 mmHg or on antihypertensive medication.

5. **Hyperglycemia:** Fasting plasma glucose ≥100 mg/dL or diagnosed gestational diabetes mellitus (GDM).

- **Group B:** Pregnant women **not meeting any of the above criteria**.

Exclusion Criteria

- Multiple gestations.
- Pre-existing **hypertension, diabetes mellitus, or cardiovascular disease**.
- Chronic kidney or liver disease.
- Autoimmune disorders.
- Known congenital fetal anomalies.
- Patients unwilling to participate.

Data Collection and Study Variables

Participants will be recruited from the **antenatal outpatient department (OPD)** and will undergo a **detailed clinical, anthropometric, and biochemical assessment** at the time of enrollment.

1. Maternal Parameters Assessed

Baseline Demographics:

- Age, BMI, socioeconomic status, and obstetric history.

Clinical and Biochemical Measurements (First Trimester):

1. **Blood pressure** (measured in the sitting position after 5 min rest).
2. **Fasting blood glucose (FBS)**.
3. **Lipid profile (Total cholesterol, HDL, LDL, Triglycerides)**.
4. **Waist circumference** measurement.

Maternal Outcomes (During Pregnancy and Delivery):

- **Gestational Diabetes Mellitus (GDM)**.
- **Hypertensive disorders of pregnancy** (gestational hypertension, preeclampsia, eclampsia).
- **Preterm birth (<37 weeks gestation)**.
- **Mode of delivery (vaginal delivery, cesarean section, instrumental delivery)**.
- **Postpartum hemorrhage (PPH)**.
- **Maternal intensive care unit (ICU) admission**.

2. Fetal Outcomes Assessed

1. **Birth weight**: Low birth weight (<2500 g), macrosomia (>4000 g).
2. **Apgar scores at 1 and 5 minutes**.
3. **Neonatal Intensive Care Unit (NICU) admission**.
4. **Stillbirth or neonatal mortality**.

Study Procedure

- **Recruitment and Enrollment:** Eligible pregnant women will be **screened during their first antenatal visit (≤12 weeks gestation)**. Informed consent will be obtained from all participants.
- **Baseline Data Collection:** Clinical history, anthropometric measurements, and biochemical investigations will be performed.
- **Follow-up Visits:** Participants will be followed at each **trimester and delivery** for maternal and fetal outcomes.

- **Delivery Data:** Mode of delivery, complications, and neonatal outcomes will be recorded.

Statistical Analysis

- Data will be analyzed using **SPSS version 25.0**.
- **Continuous variables** will be expressed as **mean ± standard deviation (SD)** and compared using **independent t-tests** or **Mann-Whitney U tests** for non-parametric data.
- **Categorical variables** will be expressed as **frequencies and percentages** and analyzed using the **Chi-square test or Fisher's exact test**.
- **Multivariate logistic regression analysis** will be performed to identify independent predictors of adverse pregnancy outcomes.
- A **p-value <0.05** will be considered statistically significant.

RESULTS AND OBSERVATIONS;

Table 1: Baseline Characteristics of Study Participants

Parameter	Group A (MetS) (n=100)	Group B (Control) (n=100)	p-value
Mean Age (years)	31.5 ± 4.2	29.8 ± 3.9	0.04*
BMI (kg/m²)	30.2 ± 3.5	24.1 ± 2.9	<0.001*
Fasting Glucose (mg/dL)	110.4 ± 12.6	89.3 ± 8.7	<0.001*
Triglycerides (mg/dL)	180.2 ± 30.5	120.8 ± 20.3	<0.001*
HDL (mg/dL)	38.6 ± 6.2	55.1 ± 5.9	<0.001*
Systolic BP (mmHg)	135.3 ± 8.1	118.6 ± 6.5	<0.001*
Diastolic BP (mmHg)	86.2 ± 6.7	74.5 ± 5.4	<0.001*

*p-value <0.05 considered statistically significant

Table 2: Maternal Outcomes

Maternal Outcome	Group A (MetS) (n=100)	Group B (Control) (n=100)	p-value
Gestational Diabetes (%)	40 (40%)	12 (12%)	<0.001*
Hypertensive Disorders (%)	35 (35%)	10 (10%)	<0.001*
Preterm Birth (%)	22 (22%)	8 (8%)	0.005*
Cesarean Delivery (%)	58 (58%)	32 (32%)	<0.001*
Postpartum Hemorrhage (%)	15 (15%)	5 (5%)	0.02*
Maternal ICU Admission (%)	7 (7%)	1 (1%)	0.03*

Table 3: Neonatal Outcomes

Neonatal Outcome	Group A (MetS) (n=100)	Group B (Control) (n=100)	p-value
Low Birth Weight (<2500 g) (%)	28 (28%)	10 (10%)	0.002*
Macrosomia (>4000 g) (%)	18 (18%)	5 (5%)	0.01*
Apgar Score <7 at 1 min (%)	12 (12%)	4 (4%)	0.04*

Neonatal Outcome	Group A (MetS) (n=100)	Group B (Control) (n=100)	p-value
NICU Admission (%)	25 (25%)	7 (7%)	<0.001*
Stillbirth/Neonatal Death (%)	5 (5%)	2 (2%)	0.22 (NS)

Table 4: Correlation of Metabolic Syndrome Components with Adverse Outcomes

Metabolic Syndrome Component	GDM (%)	Preterm Birth (%)	Cesarean (%)	NICU Admission (%)
Central Obesity (BMI >30 kg/m²)	38 (70%)	18 (81%)	45 (77%)	18 (72%)
Hypertension (≥130/85 mmHg)	30 (75%)	16 (72%)	40 (69%)	15 (60%)
Hyperglycemia (FPG ≥100 mg/dL)	40 (100%)	14 (64%)	35 (60%)	14 (56%)
Dyslipidemia (High TG/Low HDL)	28 (70%)	12 (54%)	38 (65%)	○ 40%)

Table 5: Multivariate Logistic Regression Analysis for Adverse Pregnancy Outcomes

Risk Factor	Adjusted OR (95% CI)	p-value
Gestational Diabetes	3.5 (1.8–6.7)	<0.001*
Hypertensive Disorders	4.2 (2.1–7.9)	<0.001*
Preterm Birth	2.8 (1.3–5.4)	0.006*
Cesarean Delivery	2.6 (1.5–4.8)	0.002*
NICU Admission	3.9 (2.0–7.1)	<0.001*

DISCUSSION

The present study aimed to evaluate the effects of metabolic syndrome (MetS) on pregnancy outcomes by comparing maternal and neonatal outcomes between pregnant women with and without MetS. Our findings indicate that women with MetS had significantly higher rates of gestational diabetes mellitus (GDM), hypertensive disorders of pregnancy (HDP), preterm birth, cesarean delivery, postpartum hemorrhage, and neonatal complications, including low birth weight, macrosomia, NICU admission, and stillbirths. These results align with previous studies that have highlighted the detrimental impact of MetS on pregnancy outcomes.

Metabolic Syndrome and Maternal Outcomes

Our study demonstrated that women with MetS had a significantly higher risk of developing GDM (40% vs. 12%, p<0.001). This finding is consistent with previous research showing that the insulin resistance characteristic of MetS predisposes pregnant women to glucose intolerance and hyperglycemia, increasing the likelihood of developing GDM (Aviram et al., 2011; Bozkurt et al., 2015) [1,2]. Insulin resistance, along with excessive maternal adiposity, exacerbates pancreatic β-cell dysfunction, leading to impaired glucose metabolism and increased fetal exposure to maternal hyperglycemia (McIntyre et al., 2019) [3].

Similarly, hypertensive disorders of pregnancy were significantly more common in the MetS group (35% vs. 10%, p<0.001). This finding is supported by previous studies suggesting that hypertension in MetS is driven by chronic low-grade inflammation, endothelial dysfunction,

and increased sympathetic activity (Sibai et al., 2005) [4]. MetS-associated hypertension increases the risk of preeclampsia and eclampsia, which are leading causes of maternal and fetal morbidity (Roberts et al., 2013) [5].
The higher rate of cesarean deliveries in the MetS group (58% vs. 32%, $p<0.001$) is likely a consequence of multiple factors, including an increased incidence of GDM, HDP, and fetal macrosomia. Previous studies have also reported similar findings, emphasizing that obesity and metabolic dysfunction contribute to labor dystocia, cephalopelvic disproportion, and an increased need for operative deliveries (Weiss et al., 2004) [6].

Metabolic Syndrome and Neonatal Outcomes
Neonates born to mothers with MetS had significantly higher rates of low birth weight (28% vs. 10%, $p=0.002$) and macrosomia (18% vs. 5%, $p=0.01$). This dual risk of fetal growth restriction and excessive fetal growth may reflect the complex metabolic environment in utero, where maternal hyperglycemia promotes fetal overgrowth, whereas placental insufficiency in hypertensive pregnancies can lead to growth restriction (Catalano & Shankar, 2017) [7]. The increased NICU admission rates in the MetS group (25% vs. 7%, $p<0.001$) may be attributed to neonatal respiratory distress syndrome, hypoglycemia, and birth trauma, which are commonly associated with maternal metabolic abnormalities (Hiersch et al., 2018) [8].
Although stillbirth and neonatal mortality rates were higher in the MetS group, the difference was not statistically significant. However, previous studies suggest that MetS is associated with an increased risk of stillbirth due to factors such as placental dysfunction, fetal hypoxia, and inflammatory processes (Lowe et al., 2010) [9].

Strengths and Limitations
One of the strengths of this study is its prospective design, which allowed for the systematic assessment of maternal and neonatal outcomes over the course of pregnancy. Additionally, the use of well-defined MetS criteria enhances the study's reliability and reproducibility.
However, our study has some limitations. First, the sample size, while adequate for detecting differences in major outcomes, may limit the generalizability of findings to other populations. Second, the study was conducted in a single institution, which may introduce selection bias. Finally, long-term follow-up of neonates was not performed, preventing an assessment of the potential long-term metabolic consequences of in utero exposure to MetS.

Clinical Implications and Future Directions
The findings of this study underscore the importance of early screening and management of MetS in pregnant women. Given the significant risks associated with MetS, targeted interventions such as preconception counseling, weight management, and lifestyle modifications should be implemented to improve pregnancy outcomes. Future studies should explore the long-term metabolic health of offspring born to mothers with MetS and evaluate the effectiveness of specific therapeutic interventions in reducing adverse outcomes.

CONCLUSION
Metabolic syndrome significantly increases the risk of adverse maternal and neonatal outcomes, including GDM, hypertensive disorders, preterm birth, cesarean delivery, and neonatal complications. Early identification and management of MetS in pregnancy are crucial to reducing these risks and improving maternal and fetal health.

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