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Metabolic Syndrome in Pregnancy and its Complications in Obstetrics and Newborn

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Abstract

Metabolic syndrome (MS) during pregnancy causes a serious threat to the mother and child's health that will shortly become a major public health issue, especially in developing countries. However, in India, the epidemiological data on MS during pregnancy are still scarce. This study aimed to determine the prevalence and identification of MS among pregnant women at Sree Balaji Medical College and Hospital, Chennai, India. This study was a hospital-based cross-sectional study, carried out among pregnant women followed up at the Obstetrics and Gynecology OP unit. Proforma was collected from the participants who were assessed on sociodemographics, lifestyle parameters and dietary habits. Anthropometric parameters, blood pressure, and biochemical parameters were measured as per standard operating procedures The study participants were included in the MS group if she has at least three of the following criteria: Pre-gestational BMI >30 kg/m^2; triglycerides ≥150 mg/dl; HDL cholesterol <50 mg/dl; fasting blood glucose ≥100 mg/d, SBP ≥130 and DBP ≥85 mm/Hgl. The prevalence of MS in pregnant women and its major determinant is pre-gestational obesity. This work provides quality preliminary data for the design and improvement plan of prevention strategies.

Keywords: *Blood Glucose, Blood Pressure, Metabolic Syndrome, Pregnancy, Prevalence, Risk Factors.*

Introduction

Metabolic syndrome (MS) is a complex set of interlinked cardiovascular diseases and type II diabetes risk factors that occur more often together. Metabolic abnormalities related to MS include obesity, hyperglycemia, dyslipidemia and elevated blood pressure, all related to chronic low-grade inflammation and alterations of insulin sensitivity [1]. MS is a common and serious health issue, both in developed and developing countries. Its prevalence is reaching astounding proportions all around the world. About one-third of US adults have MS. Its prevalence varies from 24% to 33% in India [2].

The relatively high prevalence of MS observed in India, especially in Tamil Nadu shows a strong predominance among females. Indeed, women seem to be more affected by MS and its components than men, regardless of age and other risk factors [3]. Determinants of the feminine predominance of MS may include sociocultural parameters, metabolic variations related to the reproductive cycle and multiple pregnancies. When occurring during pregnancy, MS constitutes a serious threat to the mother and child's health [4]. Few studies have highlighted an interconnection between MS in early pregnancy or its features and adverse maternal and fetal pregnancy but also perinatal outcomes, including gestational diabetes, preterm birth, neural tube defects and increased risk for the newborn to develop obesity, MS or type 2 diabetes later in life [5], The complications of MS during pregnancy thus affect not only the pregnant mother but also the child to be born. MS during pregnancy therefore has to become a special concern to be addressed,

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in other to prevent maternal and fetal complications, as well as a future expansion of its incidence. However, no clear definition of MS during pregnancy, for the metabolic changes that occur all along normal pregnancy overlap with MS-related disorders. Existing definitions with cut-off points adapted to pregnancy are available and may be used for diagnosis purposes [6]. In India still, very little epidemiological data is available on MS during pregnancy, with a lack of information on its determinants and potential targets for efficient prevention strategies. More attention on the diagnosis of MS during pregnancy could help to identify the phenotype of women presenting a higher risk of adverse pregnancy outcomes and cardiometabolic conditions later in life, but also newborns with predispositions to childhood obesity and MS. This study aims to determine the prevalence and determinants of MS among pregnant women.

Materials And Methods

Study Design

This study was a hospital-based cross-sectional study, conducted from January 2024 to June 2024, among pregnant women attending antenatal care at the Obstetrics and Gynecology outpatient unit in Sree Balaji Medical College and Hospital, Chennai, India.

Sample Size and Sampling Method

The sample size was calculated using the Statcalc tool of the software Épi info version 7.2.3.1, assuming an estimated prevalence of MS of 35% in India, the acceptable range of 5% of error, an estimated design effect of 5 and a 95% confidence level. The minimum sample size was thus 95 participants. A percentage of imponderables of 10% was added to the model for a final minimal sample size of 110 participants. The selection of participants was included and samples were collected from the pregnant women meeting the selection criteria.

Study Participants

We included in the study, healthy pregnant women aged from 19 to 45 years of any pregnancy age, coming for antenatal consultation at the Obstetrics and Gynecology outpatient unit in Sree Balaji Medical College and Hospital. Pregnant women with recorded diabetes mellitus, cardiovascular diseases (For, the definition of MS during pregnancy considered in the study is not applicable for pregnant women with previously diagnosed diabetes mellitus or cardiovascular diseases.) and mental illness were excluded from the study. Participants with multiple pregnancies detected after the first ultrasound scan were excluded from the study sample.

Data Collection

The study questionnaire was organized into three different parts: A survey form inspired by the WHO STEPS instrument for chronic disease surveillance collected personal and family history of chronic diseases. The data collected from participants were evaluated for the level of physical activity and food habits of participants.

Measurement of Anthropometric Parameters

Height was measured with a height gauge and weight was measured using a weighing machine. Body Mass Index (BMI) was calculated using the Quételet's formula: BMI = Weight (kg)/Height^2 (m) and expressed as kg/m^2. A BMI $\geq$ 25 is defined as overweight and a BMI $\geq$ 30 is defined as obesity.

Blood Pressure Measurement

Blood pressure (BP) was measured with a manual Blood Pressure Monitor in a sitting position after at least 10 minutes of rest and two measurements were taken after 5-minute intervals. The average of the two measurements was used to assess blood pressure levels.

Blood Sampling

A sample of 5 ml of blood was collected on plain tubes by vine-puncture from each participant after overnight fasting. The serum was obtained by centrifugation at 3000 g for 10 minutes and aliquots were used for biochemical analyses.

Biochemical Analyses

The concentration of fasting blood glucose, serum total cholesterol, HDL-cholesterol and triglycerides were analyzed by the standard enzymatic spectrophotometric method [7,8]. LDL-cholesterol concentrations were assessed using Friedewald's formula for triglyceride levels lower than 350 mg/dl. The atherogenicity index was defined as the ratio of Total cholesterol/HDL-cholesterol.

Diagnosis of MS

Diagnosis of MS using the HNLBI/AHA and NECP ATP III definitions, modified for pregnant women by Chatzi et al [9]. A participant was recorded as having MS if presenting at least three of the following criteria: Pte-gestational BMI >30 kg/m2; triglycerides ≥150 mg/dl; HDL cholesterol <50 mg/dl; SBP ≥130/DBP ≥85 mm/Hg; and fasting blood glucose ≥100 mg/dl.

Statistical Analyses

For descriptive statistics, categorical variables are presented as frequency distribution tables and continuous variables as mean ± standard deviation (SD). The comparison of MS prevalence among potential determinants was performed using the Pearson Chi-squared test and means of biological parameters were compared among participants with MS and participants without MS using the Student's *t*-test. Generalized linear models (binary logistic regression) were performed to predict MS and identify its determinants. The level of significance for all inferential statistics was set at $p < 0.05$.

Results

A total of 502 pregnant women were included in the study. After verification of exclusion criteria, a final sample of 465 pregnant women was considered. Their sociodemographic and obstetric characteristics are summarized as age distribution in Figure 1, stages of pregnancy in Figure 2 and educational status in Figure 3. The mean age was 27.45± 6.10 and 64.35% of participants were aged between 20–30 years. Most participants were in the second trimester when compared to the other trimester. The percentage of MS is higher in highly educated women when compared to less educated women.

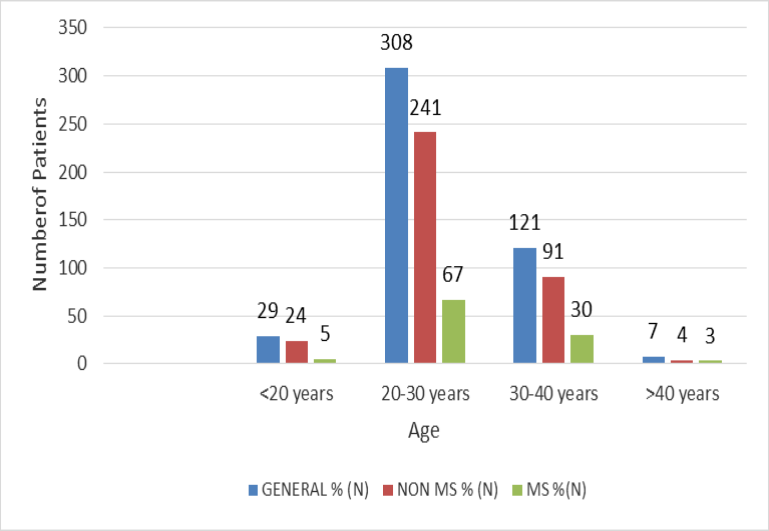


Figure 1. Age Distribution of Metabolic Syndrome Patients

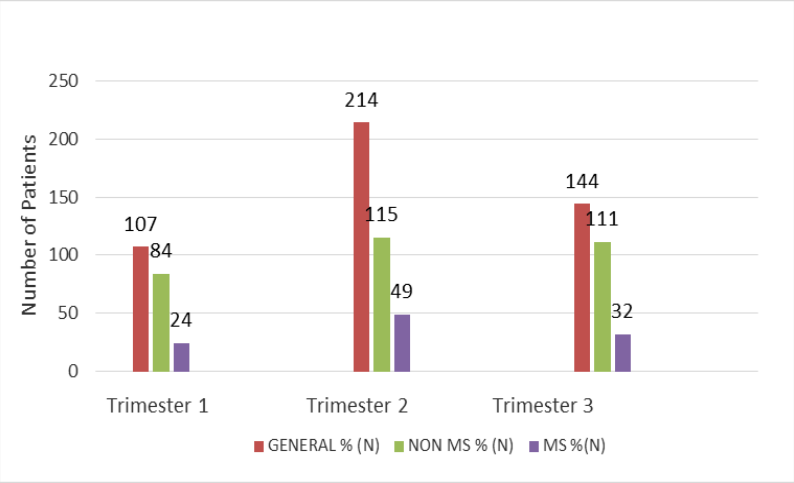


Figure 2. Stages of Pregnancy among Metabolic Syndrome Patients

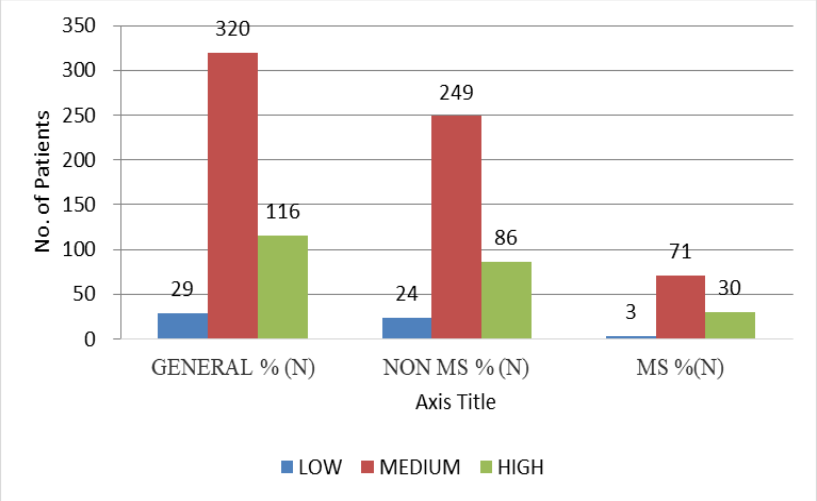


Figure 3. Educational Status of Metabolic Syndrome Patients

The mean gestational age was 23.15 ± 8.50 weeks of the study population. Concerning Pte-gestational BMI, 39.73% (185) had a normal BMI and 60.27% (280) were overweight before pregnancy (Table 1).

Table 1. Body Mass Index and Blood Pressure in Pregnant Patients with Metabolic Syndrome

S.NO	Parameters	General	Non-MS	MS
1	Height cm	151.77±10.51	152.02±9.25	151.24±11.68^{NS}
2	Weight kg	60.53±5.29	58.35±4.96	69.17±5.72*
3	BMI %	26.41±2.16	25.17±2.04	30.32±2.11*
4	Systolic BP	110.36±8.40	107.48±8.57	121.65±8.51^{NS}
5	Diastolic BP	78.20±5.97	74.61±5.64	90.27±5.73*

Note: Data are presented as mean ± standard deviation,

Statistical Significance: NS- Non Significant, * - p< .05

Abbreviations: BMI- Body mass index, BP- Blood pressure

Figure 4 shows the percentage of the physical activity levels of metabolic syndrome patients. The data show that the percentage of physically inactive women was significantly higher in MS when compared to non-MS pregnant patients,

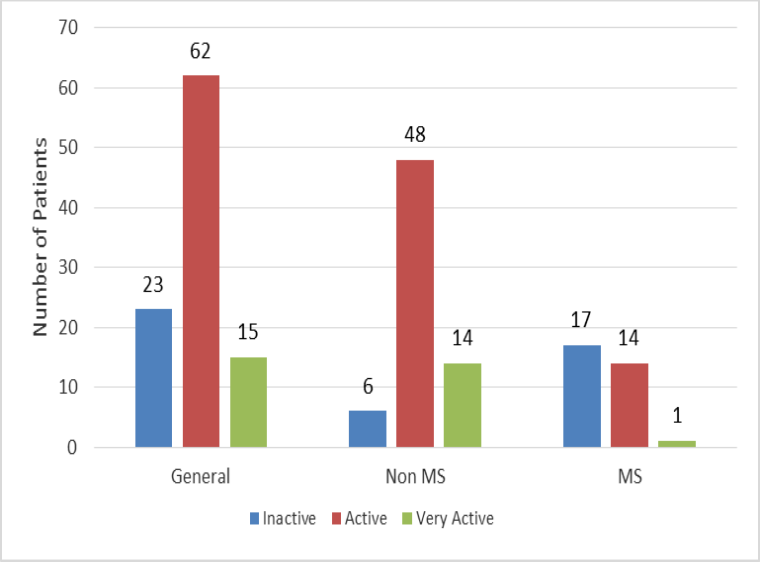


Figure 4. Physical Activity of Pregnant Patients with Metabolic Syndrome

Levels of lipid profiles are depicted in Table 2. The data show that the triglyceride and LDL levels were significantly higher in MS when compared to non-MS pregnant patients, Levels of HDL were found to be significantly lower in MS when compared to non-MS pregnant patients.

Table 2. Lipid Profile in Pregnant Patients with Metabolic Syndrome

S.NO	Parameters	General	Non-MS	MS
1	Total Cholesterol mg/dl	187.68 ± 11.25	167.29 ± 15.87	207.05 ± 18.43 *
2	Triglyceride mg/dl	128.56 ± 10.31	112.37 ± 9.65	184.13 ± 15.75***
3	HDL mg/dl	52.55 ± 4.28	56.18 ± 5.03	41.78 ± 4.05**
4	LDL mg/dl	117.97 ± 9.63	88.55 ± 7.78	148.05 ± 12.7***
5	LDL/HDL Ratio %	2.33 ± 0.19	1.57 ± 0.14	3.61 ± 0.31***
6	Total Cholesterol/HDL %	3.45 ± 0.31	2.98 ± 0.25	5.04 ± 0.48***

Statistical Significance: * - p< .05 - Significant, p< .01 -High significant, p<.001 - Very high significant

Note: Data are presented as mean ± standard deviation

Abbreviations: n-Frequency, % Percentage, S.D- Standard Deviation

Table 3 shows the levels of blood glucose and urine albumin. The data show that the blood glucose levels and urine albumin levels were significantly higher in MS when compared to non-MS pregnant patients.

Table 3. Glucose and Urine Protein in Pregnant Patients with Metabolic Syndrome

S.NO	Parameters	Generals	Non-MS	MS
1	Glucose mg/dl	87.97 ± 6.15	79.52 ± 5.37	118.74 ± 9.85***
2	Urine Albumin	14.89 ± 1.32	9.17 ± 0.84	34.95 ± 2.86***

Statistical Significance: p<.001 - Very high significant

Note: Data are presented as mean ± standard deviation

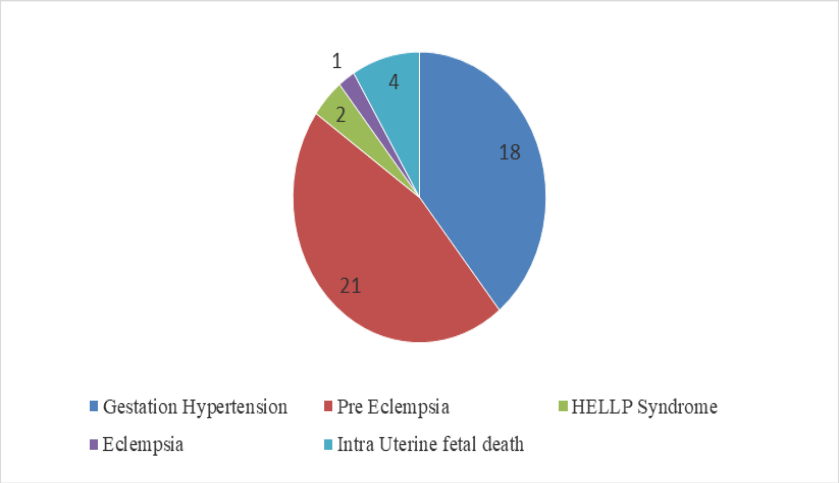
Table 4 shows the percentage of the metabolic syndrome-causing factors in MS patients. The data show that the high triglyceride, low HDL, Obesity and GDM were significantly higher in MS when compared to non-MS pregnant patients.

Table 4. Constituents of Pregnant Patients with Metabolic Syndrome

S.NO	Parameters	General	Non-MS	MS
1	GDM	18.40	14.18	22.62
2	Hypertenson	17.15	13.09	20.91
3	Obesity	29.87	22.33	35.67
4	Low HDL	34.35	15.58	47.22
5	High Triglyceride	37.12	17.16	49.65
6	Proteinuria	11.92	8.47	13.03

Abbreviations: S.D- Standard Deviation

Figure 5 shows the percentage of the pregnancy outcome of metabolic syndrome patients. The data show that pre-eclampsia and gestational hypertension were significantly higher in MS when compared to non-MS pregnant patients.



Abbreviations: n-Frequency, % Percentage,

Figure 5. Percentage of Pregnancy Outcome of Metabolic Syndrome

Table 5 shows the percentage of the delivery pattern of metabolic syndrome in pregnant patients. The data show that the Cesarian and induction were significantly higher in MS when compared to non-MS pregnant patients.

Table 5. Delivery Pattern in Pregnant Patients with Metabolic Syndrome

S.NO	Parameters	General	Non-MS	MS
1	Induction	42	46	30
2	Instrumental	23	21	27
3	Cesarian	37	33	41
4	Spontaneous Preterm	3	0	3

Abbreviations: n-Frequency, % Percentage.

Table 6 shows the status of newborns of metabolic syndrome patients. The data show that intrauterine growth retardation and low birth weight were significantly higher in MS when compared to non-MS pregnant patients.

Table 6. New Born in Pregnant Patients with Metabolic Syndrome

S.No.	Parameters	General	Non-MS	MS
1	Small for Gestation	5	2	7
2	Appropriate for Gestation	40	54	38
3	Large for Gestation	9	7	10
4	Intra Uterine Growth Restriction	7	1	11
5	Normal Birth Weight >2500 gm	30.5	33	23
6	Low Birth Weight <2500 gm	8	3	10
7	Very Low Birth Weight <1500 gm	0.5	0	1

Abbreviations: n-Frequency, % Percentage

Discussion

Traditionally, antenatal care is based on individual needs, history, and specific risk factors such as obesity. Even though the best care is provided, several women still develop pregnancy complications. Available screening tests are not offered to all women, and some tests are only offered to those who are prone to risk.

The comparison of MS prevalence according to sociodemographic and obstetric parameters shows a significant increase in MS with the age of participants. The higher prevalence of MS among multiparous and grand multiparous compared with pauciparous. Associations between age, parity and MS are strengthened by the results which showed that pregnant women aged 30 years or above present a higher risk of having MS when compared to younger ones and grand multiparous shows a higher risk of developing MS when compared to nulliparous. These results are similar to the results of dos Prazeres et al [10] who found significant associations between age, parity and MS in Angolan pregnant women. Age is a well-known risk factor for an extensive set of chronic diseases, including obesity and MS. Besides, several authors have shown that multiparous women have a higher risk of developing MS, this may be associated with the proven correlation between multiparity and the development of abdominal obesity that leads to adipose tissue mediated dysregulation of insulin sensitivity and other metabolic pathways [11].

This result is similar to the review of Saklayen, presenting evidence that genetic predisposition may play a minor role in the development of MS despite the existence of some genes associated with obesity and MS. On the contrary, epigenetics may have a bigger role in promoting MS [1].

Lifestyle parameters and level of physical activity, influence the higher prevalence of MS among pregnant women, During pregnancy the prevalence of MS tends to decrease with an increase in the duration of daily walking practice.

Concerning physical activity, our results suggest that moderate but consistent daily effort may lower the risk of developing MS in pregnant women. There is evidence that exercise benefits MS by promoting energy balance, but also by triggering healthy physiological modifications in muscle cells and tissues.

The comparison of our study participants' metabolic profiles shows a significant increase in per-gestational BMI, Systolic BP, Diastolic BP, triglycerides, blood glucose levels, atherogenicity index and a significant decrease of HDL- --cholesterol in pregnant women with MS compared to healthy ones (Table 4). These results are similar to those of dos and paint a picture of an MS-related degradation of pregnant women's metabolism with alteration of different metabolic pathways mostly driven by impaired insulin sensitivity [12].

The prevalence of MS in the study population was 22.58%. A similar result was obtained by Grieger et al [13] among nulliparous pregnant

women in the UK, New Zealand and Australia, but a lower prevalence was obtained by Djeufouata et al in the littoral and centre regions of Cameroon [14]. The relatively high prevalence of MS observed can be attributed to the higher prevalence of per-gestational obesity in our study which appears to be the major determinant of MS during pregnancy [15]. Our study took place in Chennai, India, where the prevalence of obesity is among the highest in the country.

Among individual components of MS, hypertension, GDM, obesity, low levels of HDL-cholesterol (47.22%) and hypertriglyceridemia (49.65%) were the most frequent in the study population. (Table 5) A strong association between MS and HDL-cholesterol levels suggest a close relationship between low HDL-cholesterol and high triglyceride levels and the physiopathology of MS during pregnancy [16]. Grieger et al [13] in their study in Australia, also found hypertriglyceridemia to be the most common component of MS among pregnant women. This predominance of hypertriglyceridemia and low levels of HDL-cholesterol may be the consequence of impaired insulin sensitivity-related modifications in triglyceride metabolism. The amount of circulating triglycerides increases with gestational age, transported through lipoproteins. The enrichment of HDL with triglycerides was associated with a greater clearance of HDL, leading to low levels of HDL cholesterol. Using this cutoff the rate of isolated proteinuria in pregnancy may reach 8%, whereas pr-eclampsia occurs among 3% to 8% pregnancy. (Table- 5)

In this study, to identify predictors of MS among its individual components and relevant independent variables were studied. Pregestational obesity is the best predictor of MS during pregnancy even after adjustment on age, parity and lifestyle, Indeed, pregestational BMI has been previously reported as the major component of MS during pregnancy [17]. Pregestational obesity may contribute to a worsening of metabolic profile alteration in pregnant women, leading to a higher risk of developing MS. Metabolic syndrome during pregnancy increases the risk of adverse pregnancy outcomes, obesity has been demonstrated to be an independent risk factor for: macrosomia, delivery by cesarean section, pregnancy-induced hypertension, congenital malformation and lead to fetal death [18, 19, 20].

Conclusion

Pregestational obesity, GDM, hypertension and dyslipidemia mainly determine the prevalence of MS in pregnant women. Interventions need to target women of reproductive age. This work provides a valuable starting point for further studies in the region and the country, to reduce the risk factors and clinical recommendations that may contribute to better prevention of MS during pregnancy as well as its maternal and perinatal adverse outcomes.

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