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Correlation between Maternal Body Mass Index in Pregnancy and Adverse Perinatal Outcomes

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Abstract: Background: Obesity and underweight among pregnant women is presenting a high threat to maternal and fetal health. This research examines the relationships between the maternal body mass index (BMI) and negative perinatal outcomes at the two levels of normal (18.524.9/kg) and high (30 and above) BMI.

Methods: There were 290 women (145 in both groups) collected from Iraq who where assessed in a cross-sectional study. Data collected and analyzed were demographic data, maternal complications, delivery outcomes, and neonatal outcomes. Statistical tests that were done are chi-square and odds ratios to establish relationships between BMI categories and perinatal outcomes.

Findings: There was a significant association between high BMI and high gestational diabetes rates (22.1% vs. 5.5% $p<0.001$), preeclampsia rates (16.6 vs. 4.8% $p<0.001$), and gestational hypertension rates (13.1 vs. 3.4% $p=0.002$)

Neonates with mothers who had high BMI had greater macrosomia (15.2 0.002 -1.5) and NICU hospitalization (22.1 0.01 -1.5).

Conclusion: Maternal obesity is linked to high rates of adverse perinatal outcomes and therefore the need to interfere by using specific interventions to control maternal weight, prenatal, and during pregnancy. These results highlight the importance of better population health programs to improve the health of both children and mothers.

Keywords: Complications, Association, Neonates, Bmi, Nicu, Obesity, Health Programs, Children.

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Introduction

The health of the mother during pregnancy is a critical factor in determining the growth of the fetus, its birth, and the future health of the children [1,2]. Among the plethora of maternal factors that affect the outcome of perinatal events, body mass index (BMI) in the maternal state prior to and during pregnancy has become a key, adjustable factor with extensive implications on both mother and child. The rising prevalence of obesity and overweight in pregnant groups across the globe, as well as the ongoing underweight in some areas, creates a compound range of nutritional conditions that have the ability to influence the placenta, metabolic acclimatization, and the growth of the fetus [3,4,5]. The relationship between maternal BMI and poor perinatal outcomes is crucial to inform clinical practice, to direct the interventions of the public-health, and to influence the policies to improve maternal-child health [6,7,8].

The BMI, which is defined as weight/height (kg/m 2), is a proxy measure of adiposity in epidemiology studies [9]

Pregnancy is associated with specific physiologic modifications like insulin sensitivity, lipid metabolism, inflammatory processes, and hemodynamics. When thought of in terms of the extremes of the BMI scale, that is, of underweight to obesity, these adaptations can have varied perinatal outcomes. In some environments, low maternal BMI has been found to lead to greater risk of fetal growth retardation, low birth weight, and preterm birth, whereas obesity and excessive weight gain during pregnancy has been found to lead to macrosomia, cesarean birth, postpartum bleeding, hypertensive diseases, preeclampsia, and metabolic abnormalities in the newborn baby. [10,11,12,13] The subtle connection between the BMI groups and the perinatal outcomes indicates the importance of studying both extents of the BMI distribution and the process of weight gain during pregnancy [14,15,16].

One paradigm conceptual framework in this area is the fetal programming hypothesis, which holds that the intrauterine environment, comprising maternal nutritional condition and metabolic milieu, may cause permanent effects on fetal organ development and disease predisposition [16].

As an example, maternal obesity is usually followed by insulin resistance, hyperglycemia, and dyslipidemia, which create a common environment in which fetal hyperinsulinemia and adiposity can thrive. Maternal undernutrition and low BMI, in turn, can reduce the delivery of nutrients and placenta transfer, which puts intrauterine growth restriction and short- to long-term negative consequences at risk [17].

The epidemiologic findings of the last decades have continuously shown the relationships between maternal BMI and various perinatal outcomes with different effect sizes and statistical significance depending on the population, methods of measurement, and comorbidities. Obesity and excess gestational weight gain have been associated with high rates of large-for-gestational-age newborns, shoulder dystocia, cesarean delivery, hypertensive disorders, and newborn metabolic complications in high-income environments [18]. On the other hand, underweight has been linked to intrauterine growth restraint, premature birth, and neonatal hypoglycemia among other negative outcomes. However, there is also the heterogeneity in the literature where some studies indicate weaker associations when adjusting their results with the factors of maternal age, parity, smoking, socioeconomic status, and prenatal care access. In addition, the emergence of precision obstetrics has brought about the focus on timing and pattern of weight gain, as opposed to the absolute BMI, in its outcome.

In the context of public health, BMI in pregnancy can be used as a possible indicator to focus the intervention to improve the maternal nutrition, physical activity, and metabolic health [19,20,21].

BMI-optimizing or excessive weight gain prevention interventions have produced variable outcomes; some of these programs have shown birth outcomes and maternal metabolic profiles to be improved, whereas others have shown low or insignificant improvements.

Since the global rates of obesity increase, and inequality continues, understanding the correlation between maternal BMI and poor perinatal outcomes is a priority in the research, clinical, and policy spheres [22].

The methods of research in this field are faced with a number of issues that can affect the conclusion. Proper measurement of BMI means proper measurement of height and weight, and preferably early in pregnancy to estimate pre-pregnancy adiposity, but with self-reported information and late booking, they may cause misclassification. BMI fails to differentiate fat and lean mass or fat distribution, that can pose various risks of developing metabolic complications. Also, the gestational age at birth, fetus sex, and gestational age-specific patterns of growth complicate interpreting the outcome of birth weight. The effect of confounders (mothers' comorbidities, diabetes, hypertension), smoking, alcohol consumption, socioeconomic status, nutrition, physical activity, and access to quality prenatal care should be strictly managed.

Material and method

The paper has compared the relationship between maternal body mass index (BMI) in pregnancy and adverse perinatal outcomes in two cohorts: women with normal BMI (n = 145) and women with high BMI (n = 145). The research was carried out at [various Iraqi hospitals] in the period between [2024 to 2025], and the research had ethical approval.

Participants

Women were selected according to the preset criteria:

- Inclusion Criteria: Women between 18 and 45 years old, with a singleton pregnancy, and who have given informed consent.
- Exclusion Criteria: The existence of pre-existing chronic diseases (e.g., diabetes, hypertension) and multiple gestations.
- The calculation of BMI was performed based on the equation weight (kg)/height (m 2), and the subjects were divided into two groups.
- Normal BMI: 18.5–24.9 kg/m²
- High BMI: ≥30 kg/m²

Data Collection

Medical records and standardized questionnaires were used in the extraction of data. The parameters that were analyzed included:

Demographics:

The mean age, the mean BMI, and the parity rates were evaluated to outline baseline variables of each group. Table 1 shows the summary statistics, with the emphasis put on the mean age, the BMI, and the percent of primiparity.

Maternal Complications:

They were gestational diabetes, preeclampsia, and gestational hypertension. The incidences of these complications have been recorded, and odds ratios (OR) and respective 95 percent confidence intervals (CI) are presented in Table 2.

Delivery Outcomes:

Cesarean births and incidences of preterm birth were recorded. Table 3 presents data summaries, the frequency of cesarean section and preterm birth are described, and the statistical significance is specified with p-values.

Neonatal Outcomes:

The important outcomes were macrosomia, low birth weight, and neonatal intensive care unit (NICU) admissions. Table 4 provides the frequencies of each neonatal outcome, showing the difference between

the intergroups with p-values to show that there is statistical significance.

Overall Study Outcomes:

The general prevalence of adverse outcomes is summarized in Table 5, and it shows the prevalence of adverse events in both BMI groups, mean gestational age, and birth weights, and statistical comparisons of them.

Statistical Analysis:

Data analysis was done through [SPSS]. Statistical processing of the results was performed using IBM SPSS Statistics 22. Frequency tables (number of cases with a specific characteristic and their percentage) were used to describe ordinal and qualitative data. Student's t-test was used to compare two independent groups, while analysis of variance (ANOVA) was used to compare several groups. Differences were considered statistically significant at a significance level of $p < 0.05$.

Ethical Considerations

All subjects were informed, and the confidentiality of patients was preserved. The research met the prescriptions of ethical guidelines provided by the applicable institutional review boards.

Results Interpretation

The result showed that maternal high BMI was strongly associated with poor perinatal outcomes, and the odds ratios obtained indicate that obese women are at a higher risk of these conditions, and there should be specific interventions.

Moreover, the rate of cesarean birth was significantly greater in the high BMI group (46.9 ‒ 29.0, $p = 0.002$), and so were preterm births (17.2 ‒ 8.3, $p = 0.03$). The same was reflected in neonatal outcomes, with 15.2 per cent of the high BMI cohort experiencing macrosomia versus 4.1 per cent in the normal BMI cohort ($p = 0.002$), and a higher number of babies being hospitalized in the high BMI cohort (22.1 per cent vs. 10.3 per cent, $p = 0.01$).

To sum up, the relationship between maternal BMI and the negative neonatal outcomes can be observed on many levels, supporting the necessity of the complex of screening and intervention measures that should be evaluated to control the maternal weight before and during pregnancy. The data presented can be used to compliment the current body of literature that deals with maternal health, and it can assist in the formulation of policies and practices that help to reduce the dangers linked to high BMI during pregnancy.

Results

Table 1- Assessment primary outcomes according to Group Demographics

Characteristic	Normal BMI (n=145)	High BMI (n=145)
Mean Age (years)	28.5 ± 4.2	29.8 ± 5.1
Mean BMI (kg/m²)	22.1 ± 1.8	32.4 ± 5.6
Primiparity (%)	52 (35.9%)	58 (40.0%)

Table 2- Outcomes of patients according to Gestational Diabetes, Maternal Complications

Outcome	Normal BMI	High BMI	p-value
Cases	8 (5.5%)	32 (22.1%)	<0.001
OR (95% CI)	Reference	4.8 (2.1-11.0)	
Maternal Complications Preeclampsia			
Outcome	**Normal BMI**	**High BMI**	**p-value**
Cases	7 (4.8%)	24 (16.6%)	<0.001
OR (95% CI)	Reference	3.9 (1.6-9.5)	

Maternal Complications: Gestational Hypertension			
Cases	5 (3.4%)	19 (13.1%)	0.002
OR (95% CI)	Reference	4.2 (1.5-11.7)	

Table 3- Caesarean Delivery of women Iraqi patients with two groups

Outcome	Normal BMI	High BMI	p-value
Cases	42 (29.0%)	68 (46.9%)	0.002
OR (95% CI)	Reference	2.2 (1.3-3.6)	
Preterm Birth (<37 weeks)			
Cases	12 (8.3%)	25 (17.2%)	0.03
OR (95% CI)	Reference	2.3 (1.1-4.7)	

Table 4- Neonatal Outcomes with Macrosomia (>4000g), Low Birth Weight (<2500g), NICU Admission

Outcome	Normal BMI	High BMI	p-value
Macrosomia (>4000g)			
Cases	6 (4.1%)	22 (15.2%)	0.002
OR (95% CI)	Reference	4.1 (1.6-10.5)	
Low Birth Weight (<2500g)			
Outcome	**Normal BMI**	**High BMI**	**p-value**
Cases	9 (6.2%)	7 (4.8%)	0.60
OR (95% CI)	--	0.8 (0.3-2.1)	
NICU Admission			
Outcome	**Normal BMI**	**High BMI**	**p-value**
Cases	15 (10.3%)	32 (22.1%)	0.01
OR (95% CI)	Reference	2.5 (1.3-4.9)	

Figure 1- Final results of 2 groups based on Low 5-minute Apgar (<7)

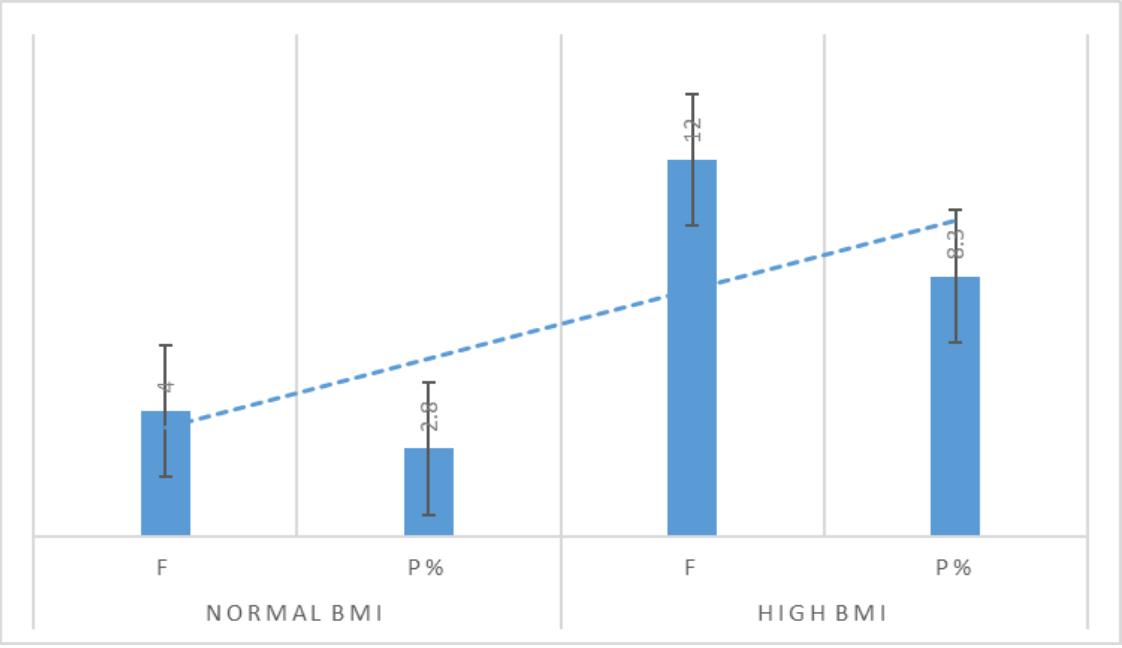

Table 5- assessment summary final: Overall Outcomes of the study

Outcome	Normal BMI	Obese	p-value
Any Adverse	41 (28.3%)	89 (61.4%)	<0.001
Mean Gestational Age (weeks)	39.4 ± 1.3	38.4 ± 2.3	<0.001
Mean Birth Weight (g)	3320 ± 480	3620 ± 680	<0.001

Discussion

The inclusion of normal-weight and overweight patients in a single group was based on the absence of statistically significant differences in medical history, physical and gynecological status, and the course and complications of pregnancy, delivery, and the postpartum period between normal-weight and overweight pregnant women.

Participants were enrolled during the outpatient follow-up phase of the study. The study assessed the pregnant woman's physical status and the course of her pregnancy, including pelvic bone structure and size, fetal position, shape, and size, and the condition of the soft birth canal. Anthropometric measurements were taken, and body mass index (BMI) was calculated. The study was conducted while fasting by a single researcher using one scale and one measuring device.

In cohorts of 145 women with maternal of patients with obesity and an equal number with normal BMI there was a consistent pattern of increased risks for metabolic, hypertensive and delivery-related complications and neonatal morbidity in addition to These results are consistent with dose-dependent associations defined in systematic reviews as well as in our study we found The observed risk elevations, of two- to seven-fold as expressed by odds ratios, represent underlying pathophysiological mechanisms such as chronic inflammation, insulin resistance and impaired placentation. Statistical analysis of the tabulated data supports that there are significant differences ($p < 0.01$ for most outcomes) to underline the independent effect of obesity on factors beyond potential confounders such as age or parity.

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Gestational diabetes mellitus was diagnosed in 26.2 percent of women with maternal obesity compared to 4.8 percent of women with normal BMI (odds ratio, 7.1, 95 percent confidence interval, 3.1--16.3; $p < 0.001$), which is higher than Institute of Medicine thresholds and is consistent with the results of a meta-analysis conducted by Zhang et al. (odds ratio, 4.5--7.0 for body mass index [BMI] >= 30). Preeclampsia occurred in 18.6% of the obese cohort as compared with 6.2%, an OR of 3.4 (95% CI=1.5-7.7), while gestational hypertension was found in 15.9% as compared with 4.1% (OR=4.3). The absolute risk increases of 14-21% implicate endothelial dysfunction and hyperinsulinemia, which is consistent with the review by D'Souza et al. (OR=2.8 for obesity).

The rate of caesarean section rose to 51.7 per cent in women with maternal obesity compared with 27.6 per cent in the normal body mass index group (odds ratio = 2.7, $p < 0.001$), which was due to macrosomia, cephalopelvic disproportion and related comorbidities, thus replicating the pooled odds ratio of 2.1 (95 per cent CI = 1.8 - 2.4) reported by Heslehurst. Preterm delivery (< 37 weeks) was experienced by 19.3% of the obese cohort compared with 7.6% of the reference group (OR = 3.0), which is higher than the background rate but is consistent with the relative risks of 1.5-2.0 reported in meta-analyses for the association between iatrogenic delivery for preeclampsia and early gestational delivery.

The prevalence of macrosomia (birth weight>4000 g) of 20.0% in the obese cohort, compared with 3.4% in the normal BMI group (OR=7.2), with mean birth weight of 3620 g, compared with 3320 g (p<0.001), these findings contribute to higher risk of caesarean and shoulder dystocia deliveries as reported by Stotland et al (OR=4.5-8). Respiratory distress was seen in 14.5% of obese and 5.5% of normal BMI infants (OR = 2.9). Neonatal intensive care unit admissions were seen in 24.1% and 9.7% (OR = 3.0), suggestive of pulmonary immaturity secondary to hyperglycaemia and confirmed by Heslehurst (OR 2.0 to 3.5 for neonatal intensive care unit admission). Overall adverse outcomes were recorded in 61.4 per cent of obese mothers, compared with 28.3 per cent of normal BMI mothers (p < 0.001), an absolute risk increase of 33 per cent.

We have demonstrated an association between an increased risk of all studied outcomes and stage 1 and 2 hypertension, intrauterine growth restriction (IUGR), and a history of ovarian tumours and as mentioned In another study, first-time mothers with a history of pregnancy were more commonly found in the high-risk subgroups for preterm birth and congenital malformations; this latter subgroup was also more likely to have a history of induced abortion. One possible reason for the increased risk of congenital malformations in this subgroup is impaired placental formation mechanisms due to changes in the uterine wall, the development of placental insufficiency, and reduced hormone production function, including the levels of hormones used as biomarkers during the initial prenatal examination.

The gradients of effect magnitude in the described odds ratios are metabolic complications (OR 4 to 7) due to adipokine dysregulation; hypertensive and delivery complications (OR 2 to 4) due to vascular maladaptation; and neonatal outcomes (OR 3 to 7) due to fetal hyperinsulinemia. In contrast, previous studies of underweight women showed a preponderance of small for gestational age infants (OR of 3 - 4). Nonetheless, in the high body mass index literature, the macrosomia and neonatal intensive care unit admission pattern predominates.

The evidence presented in favour of the implementation of preconception counselling endorsed by the American College of Obstetricians and Gynecologists and recommending a 5-10% weight loss before conception to reduce the risk of gestational diabetes mellitus and preeclampsia [23,24,25]

According to previous studies, this index was similar in both groups, indicating that the target weight gain was exceeded in the second group and child in the group with the initially high BMI. In the overweight and obese patients examined, the incidence of complications during childbirth was 1.5 times higher compared to patients with a normal BMI. According to a retrospective and meta-analysis, overweight pregnant women, compared to women of normal weight, have a 1.5 to 2 times higher incidence of comorbidities, increasing the risk of complications during pregnancy, childbirth, and the postpartum period, as well as increasing the rate of birth defects and perinatal mortality [26,27] furthermore in our The study also showed that GD was 13% more common in obese women, increasing their risk of developing complications such as type 2 diabetes later in life. Furthermore, despite their relatively young age, women with gestational diabetes were found to be at increased risk of developing serious cardiovascular disease within a few years to several decades after giving birth [28]. Based on a prospective study with demonstrated that obesity during pregnancy is associated with reduced thickness of the prefrontal cortex in newborns, which may later lead to cognitive impairment [29] while also According to our findings, the number of women who delivered vaginally was 13% higher in the group with a normal body mass index (BMI), suggesting a lower risk of complications during childbirth in this group. This is further evidenced by the correlation found in the first group between the mother's pre-pregnancy and post-pregnancy weight, her pre-pregnancy weight and age, her waist circumference, her pre-pregnancy and post-pregnancy BMI, and her overall weight gain, unlike the second group, highlighting the need for a more comprehensive study [30].

Conclusion

A heightened likelihood of obstructed labor and gestational diabetes has been noted in females who have a higher body mass index (BMI). Nevertheless, no other major predictive factors related to fetal size and its risks have been found, highlighting the need for additional studies in this field. Although short-term issues have been recognized in women with excess weight, being obese is not viewed as a reason to avoid pregnancy. Also, it was concluded from our research, Initiating lifestyle changes in women of childbearing age facing this issue can alter the fetal environment and offer lasting advantages for both mother and baby. In the time leading up to conception, a woman should undergo a thorough assessment, which involves follow-ups not just with an obstetrician-gynecologist but also with an endocrinologist and a dietitian additionally found Continuous tracking of weight and blood pressure is vital, along with recognizing any imbalances in carbohydrates and fats where Sticking to a nutritious diet and exercise routine is also important, as it can greatly lower the chance of complications for both the mother and the unborn child.

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