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Correlation between increased maternal body mass index and pregnancy complications

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Abstract. – OBJECTIVE: Obesity in pregnancy carries significant maternal and fetal risk. The aim of this study was to investigate the effect of maternal body mass index on pregnancy outcomes.

PATIENTS AND METHODS: The study retrospectively reviewed the clinical outcome of 485 pregnant women who delivered at the Department of Obstetrics and Gynecology, Clinical Centre of Vojvodina, Novi Sad, during the period of three years (2018-2020) and compared them against the body mass index (BMI). Correlation coefficient was calculated for BMI and seven pregnancy complications (hypertensive syndrome, preeclampsia, gestational diabetes mellitus, intrauterine growth restriction, premature rupture of membranes, mode of delivery and postpartum hemorrhage). The collected data were presented in the form of median values and relative numbers (the measure of variability). The implementation of the simulation model and its verification were carried out using a specialized programming language, Python. Statistical models were created where the Chi-square and *p*-value were as determined for every observed outcome.

RESULTS: The average age of the subjects was 35.79 years and average was BMI 29.28 kg/m². A statistically significant correlation was found between the BMI and arterial hypertension, gestational diabetes mellitus, preeclampsia and cesarean section. The correlations between the body mass index and postpartum hemorrhage, intrauterine growth restriction and premature rupture of membranes were not statistically significant.

CONCLUSIONS: As high BMI correlates with a number of negative outcomes in pregnancy, weight control before and during pregnancy and proper antenatal and intranatal care are necessary to achieve a favorable pregnancy outcome.

Key Words:
Body mass index, Pregnancy, Complications, Obesity.

Introduction

The worldwide prevalence of obesity has nearly tripled over the past few decades[1]. The World Health Organization (WHO) has described this trend as a "global epidemic" and maternal obesity is one of the most common risk factors seen in obstetric practice. Obesity is associated with increased rates of maternal and perinatal morbidity and mortality. Having a high body mass index (BMI) during pregnancy increases the risk of various pregnancy complications, such as miscarriage, stillbirth, gestational diabetes, preeclampsia, induced labor, cesarean section and wound infection[2,3]. Also, there is an increased neonatal risk of fetal macrosomia, fetal injuries during delivery, impaired growth, NICU (neonatal intensive care unit) admissions and childhood obesity[2]. Weight control before and during pregnancy and proper antenatal and intranatal care is necessary to achieve a favorable pregnancy outcome. In Serbia, a 2006 analysis[4] has shown that 55.7% of the population is obese. Among women with a body mass index $\geq$ 25 kg/m², 41.7% classified themselves as above ideal body weight while 56.0% as ideal body weight. Currently the country in not showing any progress towards achieving the target for obesity, with an estimated 23.9% of adult (aged 18 years

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and over) women and 23.6% of adult men living with obesity. Serbia's obesity prevalence is lower than the regional average of 25.3% for women[5]. Because of all of the above, we carried out population cohort research to determine the effect of maternal overweight on pregnancy outcome.

Patients and Methods

This observational descriptive cross-sectional study retrospectively reviewed the clinical outcome of 485 pregnant women who delivered at the Department of Obstetrics and Gynecology, Univesity Clinical Centre of Vojvodina, Novi Sad, Serbia in the period of three years (2018-2020). We evaluated the following maternal parameters: age, weight and height as well as BMI before conception and BMI at delivery. We also monitored the following complications in pregnancy: hypertensive syndrome, preeclampsia, gestational diabetes mellitus (GDM), intrauterine growth restriction (IUGR), premature rupture of membranes, mode of delivery and postpartum hemorrhage. In the case of the women with a singleton pregnancy with the cephalic presentation, data about height and weight were collected during the first prenatal care after the positive pregnancy test. Then, the BMI was calculated according to the formula weight/height^2. Exclusion criteria from the study were: multiple gestations, abnormal fetal presentation, placenta previa, medical disorders such as diabetes mellitus, chronic hypertension, cardiac or endocrine disorders and patients with incomplete medical data.

Statistical Analysis

The collected data were presented in the form of median values and relative numbers (the measure of variability). The implementation of the simulation model and its verification was carried out using a specialized programming language, Python. Statistical models were created where the Chi-square and *p*-value were determined for every observed outcome. The level of significance was set at $p \leq 0.05$. The research was approved by the Ethics Committee of the Clinical Center of Vojvodina.

Results

The data set consisted of 485 subjects with an average age of 35.79 years (SD 5.93). BMI was calculated using the formula weight/ height2 and subjects were divided into three groups: normal (BMI $\leq$ 25 kg/m^2); overweight (25 kg/m^2 < BMI $\leq$ 30 kg/m^2) and obese (BMI > 30 kg/m^2). The average BMI was 29.28 kg/m^2 (SD 5.17). In our sample it can be seen that the majority of patients (46%) fall into the overweight category, then 35.9% of patients were obese and on the third place were patients (18.1%) with normal BMI. The BMI distribution is shown in Figure 1, while in Figure 2 we can see the histogram distribution.

When grouped by BMI we can see the number of occurrences for each complication (Figure 3). Then, a correlational analysis was conducted which is shown on Figure 4.

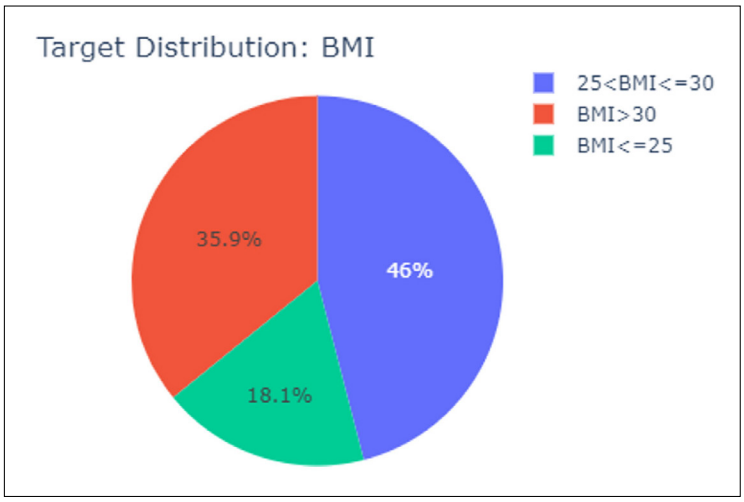
There is a slight correlation between the BMI and gestational diabetes mellitus and arterial hypertension, with 0.37 and r = 0.25 respectively. On the other hand, a significant negative correlation between BMI and intrauterine growth restriction (p = 0.2876) and premature rupture of membranes (p = 0.12644) is observed. These findings were then confirmed by results of relative risk and *p*-values, which were calculated for the three groups to determine if there was any statistical significance of the influence of BMI on pregnancy complications. Figures 5 and 6 are calculated Chi-square and *p*-values on the logarithmic scale and the exact values are given in Table I.

The risks for maternal complications like arterial hypertension (p < 0.00001), gestational diabetes mellitus (p < 0.00001), preeclampsia (p = 0.000294), caesarean section (p = 0.000017) or in general the chance of any complication (p = 0.010048) are statistically significant. For postpartum hemorrhage, intrauterine growth restriction and premature rupture of membranes no statistical significance in the impact of BMI was found (p > 0.05). We can see that women with a BMI > 30 kg/m^2 are more than 3 times more likely to have preeclampsia or gestational diabetes mellitus and almost three times more likely to have arterial hypertension (Table I). Also, there is an increased risk of general complications in people in groups that have a BMI higher than 25 kg/m^2.

Discussion

The obesity rate has dramatically increased worldwide, and in our study, more than a third of patients (35.9%) were obese. It is known that obesity is a strong risk factor for the development of various complications in pregnancy[2], which was confirmed by our study.

Figure 1. BMI distribution in the data set.



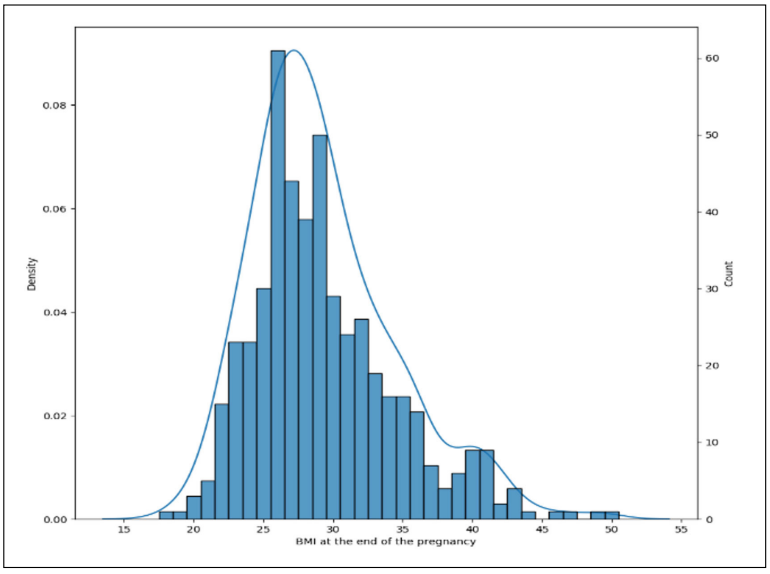


Figure 2. BMI distribution histogram.

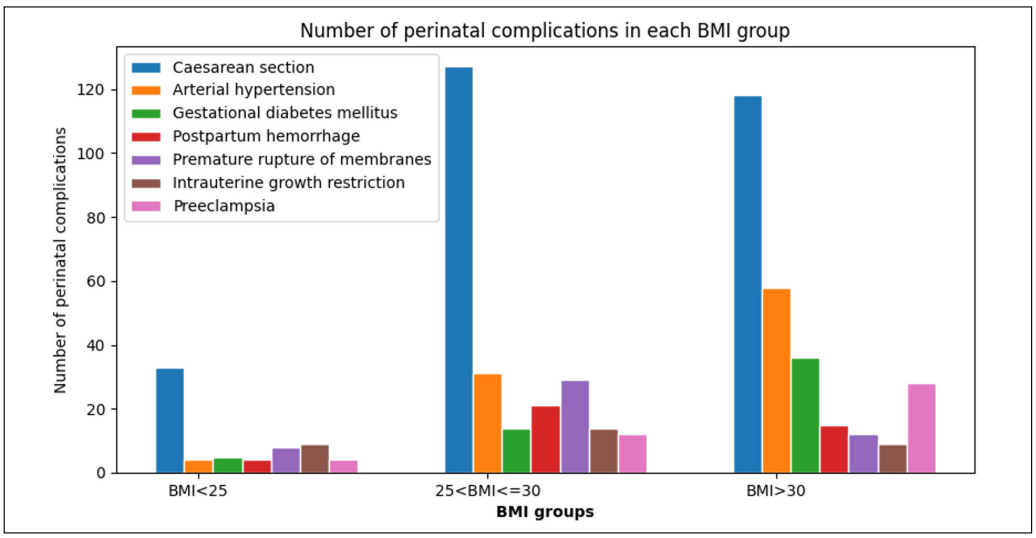


Figure 3. Number of pregnancy complications in each of the examined groups.

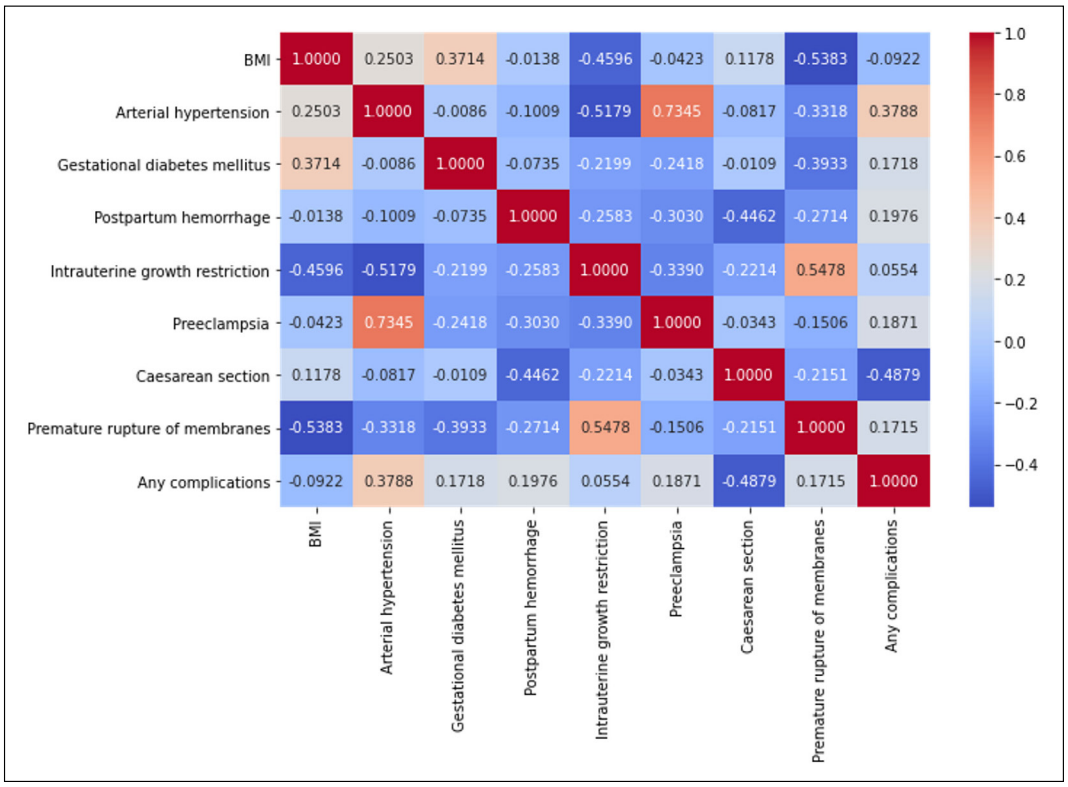


Figure 4. Correlation matrix of perinatal complications in relation to BMI.

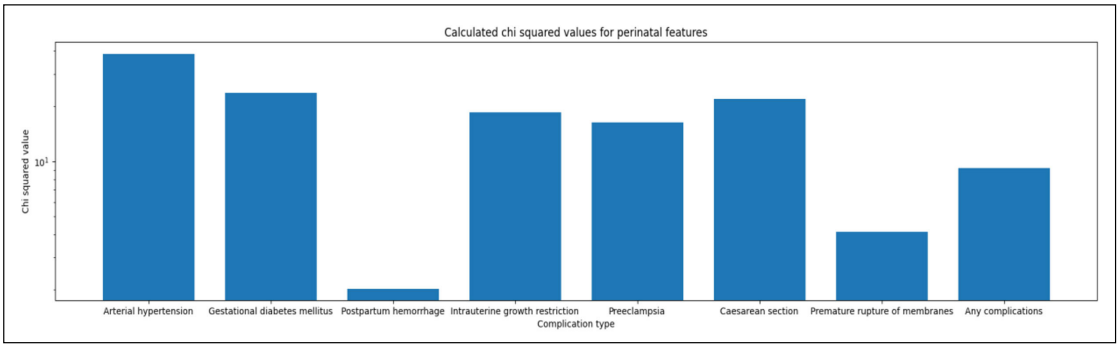


Figure 5. Calculated chi square values for perinatal features.

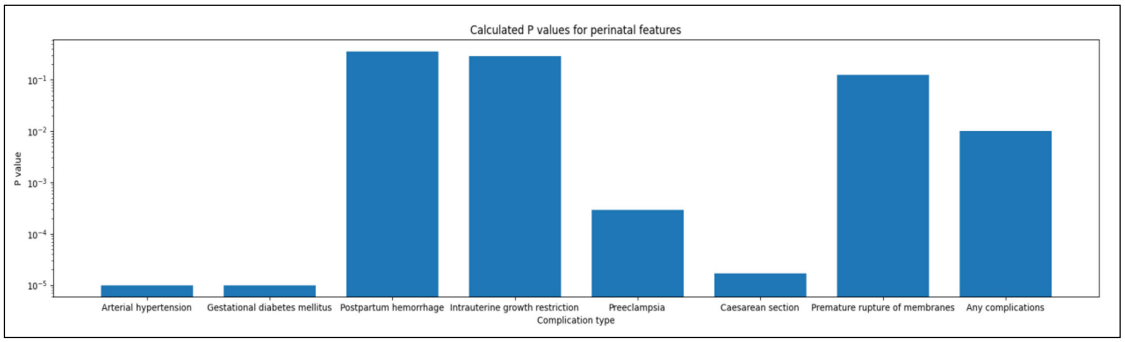


Figure 6. Calculated *p*-values for perinatal features.

Table I. Chi-square and *p*-values by which perinatal complications are affected by BMI.

Outcomes	I group (BMI≤25) (Relative risk)	II group (BMI > 25 and BMI ≤ 30) (Relative risk)	III group (BMI>30) (Relative risk)	*p*-value	Chi-square
Arterial hypertension	0.202757916	0.587443946	2.961904762	< 0.00001	38.6595
Gestational diabetes mellitus	0.451136364	0.401181232	3.386569873	< 0.00001	23.6138
Postpartum hemorrhage	0.501262626	1.298560302	1.072413793	0.3626	2.0289
Intrauterine growth restriction	1.765316206	0.913801694	0.6994003	0.2876	2.4917
Preeclampsia	0.451136364	0.44058296	3.127873563	0.000294	16.263
Caesarean section	0.607653061	0.988150744	1.318175287	0.000017	21.9786
Premature rupture of membranes	0.880266075	1.703587444	0.579683131	0.12644	4.136
Any complications	0.807711393	0.898443682	1.26698676	0.010048	9.2007

We have found that obesity was associated with an increased risk of gestational diabetes mellitus, hypertensive disorders of pregnancy, preeclampsia, cesarean delivery, and postpartum hemorrhage. Data from the literature showed that the risk of gestational diabetes mellitus is increased with increasing BMI[4]. Similarly, to the cited data from the literature[6-8] our results also show that when compared to the normal BMI group, patients with higher BMI have an increased incidence of gestational diabetes. A retrospective study[9] of 287.213 pregnancies showed that women with a BMI ≥30 kg/m^2 were more likely to develop gestational diabetes than women with a BMI of 20.0-24.9 kg/m^2. The pathogenesis of GDM in patients with increased maternal BMI is due to a decrease in the number of insulin receptors and a decrease in glucose tolerance in pregnancy[10]. The majority of observational studies[11] have shown a direct correlation between increased maternal BMI and risk of preeclampsia. Exact mechanism is not known, but hyperlipidemia, hyperinsulinemia, increased leptin levels along with inflammation can cause autonomic nervous system disturbances and elevation of pressure hormones[12]. In our data, patients with BMI > 30 kg/m^2 are more than 3 times more likely to have preeclampsia or arterial hypertension. Regarding cesarean section, we confirmed the known association with obesity and increased incidence of surgical termination of labor due to less effective uterine contractility in obese women, increased risk of cephalopelvic disproportion and fetal macrosomia[13,14]. Chu et al[15] performed a separate meta-analysis of 12 studies, and found that the odds of a cesarean section remained higher in overweight (OR 1.41, 95% CI 1.17-1.69) and obese women (OR 1.75, 95% CI 1.41-2.23) without complications, compared with women with a normal BMI. Following delivery, obese women have an increased risk of postpartum hemorrhage[9]. Fyfe et al[16] in their study, concluded that nulliparous obese women have twofold increased risk of major postpartum hemorrhage regardless of mode of delivery. This study has potential limitations due to BMI not being a gold standard measure of body composition analysis and the pathophysiology of all the complications mentioned in this study are mostly due to an excessive increase in body fat not merely weight gain, which would have been more precisely measured by using body fat calipers. But considering most of the patients included were sedentary individuals an increase in fat mass usually corresponds with an increase in BMI in that population.

Conclusions

This study shows that obesity during pregnancy is a risk factor for various complications. Therefore, we recommend a personal approach

when consulting the patient about their nutrition and lifestyle habits. We also emphasis the importance of adequate prenatal care and regular weight monitoring of the patient.

Ethics Approval

The study was conducted in accordance with relevant, local, national and international guidelines with the permission of the Ethics committee of the Faculty of Medicine, University of Novi Sad, Serbia Institutional Review Board Statement. (Statement number 19-539). The study was conducted according to the guidelines of the Declaration of Helsinki.

Informed Consent

Written informed consents have been obtained from the patients to publish this paper.

Conflict of Interest

The Authors declare that they have no conflict of interests.

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Authors' Contributions

A.K., D.S., B.B., M.S. treated the patients and designed the study; A.K., U.K., M.P., LJ.G. contributed to the design and implementation of the research, to the analysis of the results and to the writing of the manuscript; S.P.T.D., D.S., L.Ž. and A.Ž. analyzed the recent literature and took part in writing the manuscript. All authors have read and agreed to the published version of the manuscript.

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