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Correlation between Obesity and Pregnancy Outcomes, Miscarriage, and Mode of Delivery

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ABSTRACT

Introduction: The obesity pandemic is a source of problems in both developed countries. The obesity is associated with complications before and during pregnancy and even infant death. The study aims to find out the issue of obesity among women of reproductive age, particularly concerning its impact on maternal and fetal outcomes during pregnancy.
Methods: This is a cross-sectional observational study using secondary data with medical records taken at Sebelas Maret University Hospital (UNS Hospital). Subjects were obese pregnant women who gave birth at UNS Hospital. Data from 284 single births were added maternal parameters, obstetric parameters, and newborn parameters were taken and then analyzed univariately, and bivariate analysis was carried out using the Kruskall-Wallis test and the Spearman test for comparison and correlation of each variable.
Results: This study finds lower incidences of postdate pregnancy and instrumental deliveries among obese mothers, but a higher rate of emergency cesarean sections. Newborn anthropometric measurements increase with maternal BMI, indicating a direct association between maternal obesity and newborn health ($p = 0.001$), while APGAR scores show no significant differences among maternal BMI groups. The findings underscore the importance of addressing maternal obesity to improve both maternal and newborn health outcomes.
Conclusion: The research indicates a correlation between maternal BMI, maternal obstetric characteristics, newborn anthropometric measurements, and APGAR scores. This suggests that interventions aimed at promoting healthy maternal BMI, beginning before conception, continuing throughout pregnancy, and extending into the post-pregnancy period, could potentially improve newborn health outcomes and give long-term health benefits.

Keywords: pregnancy; obesity; outcome; miscarriage; childbirth

INTRODUCTION

The condition of a 3-fold increase in excess body weight and obesity can be said to be an "obesity pandemic" because it is a source of problems in developed and developing countries[1,2] . Obesity can increase the risk of cardiovascular disease, metabolic diseases such as type 2 diabetes mellitus, and cancer significantly[3]. In terms of reproduction, obesity greatly affects fertility and reproductive success in both men and women. So it needs to be seriously avoided in women of childbearing age because obesity is associated with complications before and during pregnancy such as preeclamsia[4,5]. It has a big influence, especially on pregnancy outcomes, such as increasing the risk of cesarean section[6,7],

causing a larger fetal head circumference and macrosomia[6,8], fetal acidosis[9], increased risk of oxygen deficiency during labor[10], low APGAR scores[11], increased risk of miscarriage, premature birth[12], congenital defects[13], and even the risk of infant death. Therefore, pregnancy in obese women is considered a high-risk pregnancy, which poses special risks to the mother and fetus.

METHOD

This study was conducted at Sebelas Maret University Hospital, utilized secondary medical record data from births that took place between 2022 and 2023. It focused on mothers with an obese BMI who received prenatal care at the same hospital until delivery, while excluding cases involving babies with congenital abnormalities, twins, and Intrauterine Fetal Death (IUFD).

The sampling technique used was purposive sampling. The sample size is determined based on the cross-sectional research formula where the size of the study population is unknown. The minimum number of samples required is 100 data from pregnant women with obesity. The independent variables in this study were divided into maternal parameters (BMI) and obstetric parameters (gestational age). The dependent variables are divided into newborn parameters (anthropometrics, APGAR score) and obstetric parameters (fetal presentation at birth, mode of delivery, number of miscarriages).

The BMI category is divided into severely underweight (BMI < 17.0), mildly underweight (BMI: 17.0 - 18.4), normal (BMI: 18.5 - 25.0), mildly obese (BMI: 25.1 - 27.0), severe obesity (BMI > 27.0). Gestational age categories when the baby is born are divided into preterm (UK < 37 weeks), term (UK: 37 - 41 weeks), and post-term (UK ≥ 42 weeks). Categories of fetal presentation at birth are divided into cephalic or breech presentation or latitudinal position. Categories of a mode of delivery are divided into spontaneous (without/with induction, vacuum) or cesarean (emergency or elective). The anthropometric categories of newborns are divided into very low birth weight babies (BBL <1000 grams), very low birth weight babies (BBL: 1000 - <1500 grams), low birth weight babies (BBL <2500 grams), normal birth weight babies (BBL: 2500-3999 grams), and the baby is overweight/macrosomia, (BBL ≥4000 grams). APGAR score categories are divided into severe asphyxia (Score: 0 - 3), mild asphyxia (Score: 4 - 6), and normal (Score: 7 - 10).

Univariate analysis was carried out to determine the percentage frequency distribution or proportion of the independent variable and the dependent variable. Bivariate analysis was performed using the Kruskal-Wallis test to analyze differences in neonatal parameters and maternal BMI, then the Sperman tests were performed to examine the association between maternal BMI category and miscarriage, as well as mode of delivery. This research has been declared to have passed the ethical feasibility of health research by the ethics committee of the Faculty of Medicine, Sebelas Maret University number 252/UN27.06.11/KEP/EC/2023.

RESULT

Sample Characteristics

Based on Table 1, characteristics of were under 20 years old, 79.6% were 20-30 years old, and 17.3% were over 35 years old. Average height was 155.3 cm, average pregnancy weight was 67.7. A total of 284 women (1.4%) met the definition of underweight, 29.2% had a normal weight, A total of 12.7% were classified as overweight and 56.7% were obese. From gestational age, 12.9% were categorized as preterm (<37 weeks) and an additional 1.0% had a post-termination classification (>42 weeks). In contrast, 85.3% met the criteria of at term (37-42 weeks). The number of pregnancies was 2.3, births 1.0, and miscarriages 0.2.

Table 1. Characteristics of Maternal, Newborns, and Obstetrics

Maternal, Newborn and Obstetric Parameters	Mean (SD)	Range	*n*
Age (years)	29.1 (6.1)	15.0-44.0	284
<20 years			9 (3.2%)
20-35 years			226 (79.6%)
>35 years			47 (17.3%)
Body height (cm)	155.3 (5.1)	143.0-174.0	284
Pregnancy weight (kg)	67.7 (12.9)	43.0-131.0	284
Pregnancy BMI (kg/m^2)	28.0 (5.0)	17.5-47.5	284
Underweight (17.0-18.4)			4 (1.4%)
Normal (18.5-25.0)			83 (29.2%)
Overweight (25.1-27.0)			36 (12.7%)
Obesity (>27.0)			161 (56.7%)
Gestational age	38.3 (1.8)	26.5-42.0	284
Preterm (<37 weeks)			37 (12.9%)
Aterm (37-42 weeks)			244 (85.3)
Postterm (>42 weeks)			3 (1.0%)
Number of pregnancies	2.3 (1.2)	1.0-7.0	284
Number of births	1.0 (1.1)	0.0-6.0	284
Number of miscarriages	0.2 (0.5)	0.0-3.0	284
Birth mode	3.6 (2.0)	1.0-7.0	284
Spontaneous vaginal			91 (32.0%)
Spontaneous with induction delivery			12 (4.2%)
Forceps			3 (1.1%)
Elective caesarean section			11 (3.9%)
Emergency caesarean section			134 (47.2%)
Re-planned caesarean section			26 (9.2%)
Re-emergency caesarean section			7 (2.5%)
Birth length (cm)	47.7 (2.6)	31.0-53.0	284
Birth weight (gram)	2995.7 (455.9)	800.0-4260.0	284
Severely very underweight birth weight			1 (0.4%)
Severely underweight birth weight			1 (0.4%)
Underweight birth weight			29 (10.2%)
Normal			250 (88.0%)
Macrosomia			3 (1.1%)
Birth presentation	1.0 (0.2)	1.0-3.0	284
Cephalic presentation			271 (95.4%)
Breech presentation			10 (3.5%)
Transverse presentation			3 (1.1%)
Head circumference (cm)	33.1 (1.8)	24.0-38.0	284
Chest circumference (cm)	32.0 (2.0)	18.0-37.0	284
Arm circumference (cm)	10.5 (2.0)	5.0-13.0	284
APGAR 1 min	7.7 (0.7)	3.0-8.0	284
APGAR 5 min	8.7 (0.7)	3.0-9.0	284
APGAR 10 min	9.7 (0.7)	4.0-10.0	284

The incidence of obstetrical interventions was higher than spontaneous birth modes. Vaginal instrumental deliveries used vacuum extractions or forceps, and 1.1% of deliveries in our unit used vaginal instrumental. Emergency caesarean section (47.2%) was more than spontaneous vaginal delivery (32.0%). Table 1 illustrates that the majority of infants were in cephalic presentation. On average, their birth length was 47.7 cm, head circumference was 33.1 cm, chest circumference was 32.0

cm, and arm circumference was 10.5 cm. A small percentage (0.4%) of newborns were classified as severely very underweight, while another 0.4% were severely underweight. Additionally, 10.2% fell under the definition of underweight, 88.0% had a normal birth weight, and 1.1% met the criteria for macrosomia (4000 g). The table also displays the range of APGAR values at 1 minute (3-8), 5 minutes (3-9), and 10 minutes (4-10).

Table 2. The Differences between Maternal Condition in Various Maternal BMI Status

Parameter	Maternal BMI Status				P value
	Underweight	Normal	Overweight	Obesity	
	Mean (SD)	Mean (SD)	Mean (SD)	Mean (SD)	
Maternal Age (Years)	24.75 (3.6)	26.9 (6)	29.9 (6.3)	30.3 (6.0)	0.000*
Maternal Height (cm)	160.8 (4.3)	155.5 (4.8)	155.4 (4.4)	155.2 (5.5)	0.298
Gestational age (weeks)	38.2 (1.1)	37.8 (2.2)	38.2 (2.0)	38.7 (1.5)	0.001*
Weight during pregnancy (gram)	46 (1.8)	55.3 (5.2)	62.8 (3.7)	75.8 (10.9)	0.000*
Number of pregnancies	1.3 (0.5)	2.1 (1.2)	2.4 (1.2)	2.4 (1.4)	0.068
Number of births	0.3 (0.5)	1.0 (1.1)	1.2 (1.1)	1.1 (1.1)	0.144
Number of miscarriages	0.0 (0.0)	0.1 (0.4)	0.3 (0.4)	0.3 (0.6)	0.066

Based on table 2, this research shows that there is a significant difference in maternal age in the maternal BMI status group (p = 0.000) with an increasing trend as the maternal weight increases. The highest mean of maternal age was found in the group of obese mothers. There was also a significant difference in maternal gestational age and maternal BMI status (p=0.001), but the average gestational age in all BMI groups tended not to be much different, namely, all groups showed average term. Apart from that, there are also significant differences in the parameters of the mode of delivery with the maternal BMI status in each group (p = 0.000), where the emergency caesarean section delivery mode is more common in the group of mothers with a BMI status of overweight and obesity, while mothers with a BMI status of underweight and normal is vaginal delivery mode. Meanwhile, maternal height (p=0.298), number of pregnancies (p=0.068), number of births (p=0.144), and number of miscarriages (p=0.066) when compared with each group, maternal BMI did not differ significantly.

Based on table 3, in the correlation between various maternal condition with maternal BMI status, we found that there was a significant correlation between overweight maternal BMI status and the number of pregnancies, the number of births with live children, and the number of miscarriages. However, our results were not in line with the difference test with Kruskall Wallis as carried out in Table 3, where there is no difference between all BMI groups in the number of pregnancies, the number of births with live children, and the number of miscarriages along with an increase in the maternal BMI status. Apart from that, in our study, there was a significant correlation between the maternal normal BMI status and with mode of delivery. This is also in line with the Kruskall Wallis difference test carried out in Table 3, which shows a tendency for a significant difference in the maternal s BMI status with mode of delivery (the group with a normal average BMI predisposed to vaginal delivery).

Table 3. The Correlation Between Various Maternal Condition with Maternal BMI Status

Parameter	Maternal BMI Status			
	Underweight	Normal	Overweight	Obesity
	N = 4	N = 83	N =36	N =161
Maternal Age (Years)	0.200	0.095	0.171	0.446
Maternal Height (cm)	0.600	0.317	0.995	0.751
Gestational age (weeks)	0.200	0.935	0.174	0.738
Weight during pregnancy (kg)	0.600	0.000*	0.093	0.000*
Mode of delivery	0.684	0.005*	0.960	0.084
Number of pregnancies	0.225	0.228	0.016*	0.930
Number of births	0.225	0.422	0.025*	0.696
Number of miscarriages	-	0.126	0.093	0.301

Table 4 Newborn Characteristics According to Maternal Weight Status

Parameter	Maternal BMI Status				p-value
	Underweight	Normal	Overweight	Obesity	
	Mean (SD)	Mean (SD)	Mean (SD)	Mean (SD)	
Birth weight (gr)	2752.5 (249.7)	2838.5 (456.72)	2984.7 (485.6)	3085.3 (430.8)	0.000*
Birth length (cm)	44.2 (8.2)	47.0 (2.6)	48.1 (2.4)	48.1 (2.2)	0.001*
Head circumference (cm)	32.0 (2.0)	32.3 (1.8)	33.2 (1.5)	33.5 (1.7)	0.000*
Chest circumference (cm)	30.7 (2.5)	31.4 (2.3)	32.0 (1.8)	32.4 (1.7)	0.003*
Arms circumference (cm)	10.2 (0.5)	10.1 (1.2)	10.7 (0.9)	10.6 (1.0)	0.006*
APGAR 1 minute	8.0 (0.0)	7.8 (0.7)	7.7 (0.7)	7.7 (0.7)	0.660
APGAR 5 minute	9.0 (0.0)	8.7 (0.8)	8.7 (0.7)	8.7 (0.7)	0.728
APGAR 10 minute	10.0 (0.0)	9.8 (0.8)	9.7 (0.7)	9.7 (0.6)	0.705

Table 4 shows that there is a significant difference in newborn birthweight among maternal BMI status groups (p = 0.000) with a tendency for birthweight to increase along with increasing maternal BMI. The highest birth weight of babies was found among mothers with obesity. With increasing maternal BMI, newborn babies were significantly longer (p = 0.001), but the average birth length of newborns in mothers with overweight and obesity BMI was the same. Head circumference also had significant differences in each maternal BMI group (p = 0.000), where head circumference tended to increase along with increasing maternal BMI. Chest circumference was the same, but there was a significant difference in each maternal BMI group (p = 0.003), where chest circumference tended to increase along with increasing maternal BMI. Results of the newborn's arm circumference showed differences in each maternal BMI group (p = 0.006). Specifically, the newborn's arm circumference in the underweight and normal maternal BMI groups was smaller than the overweight and obesity maternal BMI groups. Newborn's arm circumference did not show an increase as the maternal BMI increased. In the results of APGAR 1 (p = 0.660), 5 (p = 0.728), and 10 minutes (p = 0.705) BMI groups were not significant, however, there was a visible trend that the APGAR value decreased as the mother's BMI increased.

Table 5. Correlation Between Maternal BMI Status and Outcome of Newborn Birthweight

Parameter	Maternal BMI Status			
	Underweight	Normal	Overweight	Obesity
	N = 4	N = 83	N = 36	N = 161
Birth weight (gr)	0.200	0.605	0.675	0.043*
Birth length (cm)	0.368	0.945	0.345	0.317
Head circumference (cm)	0.225	0.086	0.027*	0.187
Chest circumference (cm)	0.600	0.248	0.903	0.317
Arms circumference (cm)	0.225	0.021*	0.368	0.112
APGAR 1 minute	-	0.213	0.607	0.144
APGAR 5 minute	-	0.213	0.607	0.072
APGAR 10 minute	-	0.210	0.607	0.071

Table 5 shows that there was a significant correlation between maternal BMI status and obesity on the outcome of newborn birthweight (p = 0.043). This shows that there is a significant correlation that mothers with obesity BMI will directly influence the outcome of the newborn birthweight, this is in line with the difference test carried out in Table 5 which shows that there is an increase in the newborn birthweight along with an increase in the maternal BMI status. Apart from that, the correlation test shows significance in the maternal overweight BMI status on the outcome of the baby's head circumference (p = 0.027), but our result is not in line with the difference test in Table 5, where there is an increase in the newborn's head circumference along with increasing maternal BMI status. So, the result of maternal overweight and obesity BMI status does not directly affect the outcome of the newborn's head circumference. A similar thing happened in the correlation test between the maternal normal BMI status and the newborn's arms circumference outcome (p = 0.027), the results are not in line with the difference test in Table 5, where the newborn's arms circumference for the maternal underweight and normal BMI status is smaller than the maternal overweight and obesity BMI status. So, the maternal normal BMI status does not directly influence the newborn's arm circumference outcome.

DISCUSSION

Obesity stands as a significant global public health challenge. Research revealed that 79.6% of women fell within the reproductive age bracket, namely 20-30 years old. Maternal obesity during pregnancy and excessive weight gain throughout gestation pose notable risks for various adverse fetal outcomes. The upward trajectory of obesity rates worldwide is particularly concerning among women of reproductive age, given the array of serious, sometimes enduring, complications associated with pre-pregnancy and prenatal obesity for both mother and child. This study utilized data from 284 births occurring at UNS Hospital in Indonesia, which were analyzed. A total of 12.7% of mothers met the criteria for being overweight (BMI 25.1-27.0 kg/m2), while 56.7% met the criteria for obesity (BMI >27.0 kg/m2). These proportions of overweight and obesity align with the norms of Indonesian society. Overweight and obesity tend to be prevalent among married Indonesian women with higher incomes and less active lifestyles.[15,16]

Our study indicates that 161 women were classified as obese, while 36 women were categorized as overweight. We focus on newborn parameters, miscarriage rate, mode of delivery, and the respective effect of maternal obesity on each of them in an Indonesian sample, specifically UNS hospital patients. A previous study involving 390 pregnant women revealed a notable correlation between elevated BMI and postdate pregnancy. A higher pre-pregnancy BMI was linked to an elevated likelihood of experiencing post-date pregnancy, instrumental deliveries, and cesarean sections.[17] The results in our study are not in line with previous studies. Only 3 women had post-term, and mostly 85.3% were aterm, followed by preterm 12.9%.

This aligns with previous research indicating an elevated risk of miscarriage with higher maternal BMI.[18] However, our results do not allow us to establish a direct causal relationship between obesity and an increased miscarriage rate, as we lack data on weight status at the time of miscarriage. Our study shows that 47.2% had an emergency caesarean section. The findings in our study align with those reported in earlier research. The previous study showed extremely obese women (with a BMI of ≥40 kg/m²) demonstrated a result in a diminished likelihood of achieving a vaginal delivery.[19] Our study observed that 95.4% had a cephalic presentation and 4.6% had other birth presentations, such as breech presentation and transverse presentation.

Newborn parameters were birth weight, birth length, head circumference, chest circumference, and arm circumference.[20] This study shows there are 3 women who had newborns with macrosomia, normal birthweight was 88%, and only 0.4% of newborns classified as severely very underweight birth weight and severely underweight birth weight. This research indicates the average birth length was 47.7 cm. Newborn Head Circumference (HC) is an essential indicator of brain growth and overall fetal development.[21] This study reveals the average head circumference was 33.1 cm, which is normal size. Chest circumference and Mid-Upper Arm Circumference (MUAC) measured within 24 hours of birth were found to be highly predictive of Low Birth Weight (LBW). Others have shown that MUAC can be used to identify infants with low birth weight and those at risk for neonatal mortality, with a MUAC ≤9.0 cm being a significant indicator.[22] But this research shows that the average chest circumference was 32.0 cm, which is normal in size.

Maternal and Obstetrics Characteristics According to Maternal Weight Status

The results of various tests revealed a notable contrast between maternal BMI status and several variables including maternal age, gestational age, maternal weight during pregnancy, and mode of delivery. However, subsequent non-parametric correlation analysis using the Spearman correlation test indicated that only the overweight and obese groups showed a significant correlation with maternal weight during pregnancy. These findings align with the theory suggesting that overweight or obese mothers are at a higher risk of premature birth and have a greater likelihood of undergoing emergency cesarean section compared to mothers with a normal weight[23,24].

However, based on the difference test and correlation test for abortion parameters and the mother's BMI status, there were no significant differences or correlations[25,26]. So the results of this research with existing theories cannot be fully verified. Based on the significance difference test and univariate test, it was found that the prevalence of premature birth (≤37 weeks of gestation) was significantly had the highest score observed among overweight mothers, while the lowest rate was noted among mothers with normal body weight. This correlates with the study of Dudenhausen et al. 2018 conducted an assessment of pregnant women from 1992 to 2009 with research results that the risk of premature birth increased in obese women and there was a correlation in women with advanced age[27].

The findings regarding the association between mode of delivery and maternal BMI status are consistent with previous literature. Through hypothesis testing, significant differences were observed between mode of delivery and maternal weight status, confirming the hypothesis. A significant relationship between maternal BMI status and mode of delivery was evident ($p < 0.000$). However, the Spearman correlation test for the overweight and obese groups did not yield significance ($p=0.084$), contrary to the results of the difference test and the overall correlation between maternal BMI and mode of delivery. Further analysis of univariate data distribution and various tests indicated that overweight and obese groups were more likely to undergo emergency cesarean section delivery[28].

Emergency cesarean delivery is a type of unplanned (elective) operation and requires a change in the physiology of a normal vaginal birth to a cesarean section. This occurs because the emergency cesarean section is an acutely medically necessary intervention, this type of operation is the focus of this study. As maternal BMI increases, the rate of emergency cesarean sections also increases. The

important thing to note is that the risk of emergency caesarean section is strongly related to the degree of severe obesity[24]. The results of this study are generally comparable and in line with the findings of Chu et al., which stated that there were differences between maternal BMI status groups and the mode of delivery used and that increasing body weight would increase the risk of having an emergency SC delivery mode[28]. Meanwhile, there is also a significant difference between maternal BMI and maternal age and it is significantly highest among mothers who are overweight, while the lowest level occurs in underweight mothers. This correlates with Dudenhausen et al. 2018 research which assessed pregnant women from 1992 to 2009 with research results that the risk of premature birth increased in obese women and there was a correlation in women with advanced age[27].

Our study found no differences and direct correlations between several outcome variables and all maternal BMI groups (Table 2) especially in terms of the mother's height, the number of pregnancies, the number of births with live children, and the number of miscarriages. However, the correlation test shows a significant correlation between overweight BMI and the parameters of the number of pregnancies and the number of births with live children, but this result is also not in line with the results of different tests which show there is no significant difference between variables[26]. Other studies have shown conflicting results that maternal body mass index (BMI) during early pregnancy is related to maternal height, number of pregnancies, the number of births with live children, and the number of miscarriages[26]. A retrospective cohort study in California in the period 2007-2010 found that maternal BMI at the beginning of pregnancy was positively correlated with maternal height, number of pregnancies, the number of births with live children, and the number of miscarriages[26].

Overall there is evidence to support differences and significant correlation between maternal BMI, maternal age, gestational age, gestational weight, and mode of delivery. So, it can be concluded that BMI status can influence and be related to maternal age, gestational age, pregnancy weight, and specifically in mode of delivery where overweight and obese BMIs tend to have an emergency SC delivery compared to normal delivery.

Newborn Characteristics According to Maternal Weight Status

Multiple research studies have consistently demonstrated a correlation between maternal body mass index (BMI) and newborn weight, indicating that as maternal BMI rises, newborn weight tends to increase as well. These studies have revealed various associations, such as higher maternal BMI being linked to increased birth weight, length, and head circumference of newborns. Additionally, maternal underweight has been associated with higher risks of low birth weight and being small for gestational age, while maternal overweight or obesity is associated with conditions like macrosomia, preterm birth, and neonatal asphyxia, as evidenced by a systematic review and meta-analysis involving Chinese mothers. Furthermore, there are strong connections between maternal BMI, gestational age, and various newborn measurements such as birth weight, head circumference, chest circumference, and mid-upper arm circumference. Collectively, these studies suggest that higher maternal BMI correlates with increased anthropometric characteristics in children, including BMI, weight for age Z score, and mid-upper arm for age Z score. Moreover, maternal pre-pregnancy BMI has been positively associated with outcomes like birth weight, BMI, and waist circumference in children. Importantly, higher maternal BMI has also been significantly linked to infant overweight[32–36].

Our study did not find a direct correlation between some outcome variables and all maternal BMI groups correlation test, significance only showed in 3 variables (Table 5). However, our study found (Table 5) similar results to studies above in terms of mean birthweight, baby length, arms circumference, head circumference, and chest circumference which increase along with increasing maternal BMI, suggesting a direct association between maternal obesity and newborn anthropometric measurements. Research has delved into the intricate connection between obesity during pregnancy and its effects on adipokines and metabolic hormones. This complex relationship influences the stimulation

of placental nutrients, contributing to fetal overgrowth. In pregnancies complicated by hypertension, such as preeclampsia, there is an observed increase in cesarean births due to indications like preeclampsia. In these scenarios, there is an upregulation of IL-1β and sFlt1 while PlGF is decreased, leading to reduced placental blood flow that restricts fetal growth. Several studies have shed light on the impact of adipokines in common gestational complications. The prevalence of obesity among European women poses challenges for obstetricians due to its association with metabolic issues during pregnancy. Adipokines like adiponectin have been studied extensively in pregnancy, showing their influence on glucose homeostasis and insulin sensitivity. These findings suggest that adipokines could serve as early markers for gestational complications and potentially lead to the development of new drugs for use during pregnancy[37].

This study showed no significance neither in difference nor correlation in APGAR outcomes among maternal BMI groups. Other studies have demonstrated the opposite results that maternal body mass index (BMI) during early pregnancy is linked to lower APGAR scores in newborns, especially in preterm infants. For instance, a Swedish cohort study found that maternal BMI in early pregnancy was positively correlated with severe asphyxia-related complications in preterm infants, with an increased risk of low Apgar scores at 5 and 10 minutes for those with BMI ≥30 compared to those with BMI <25[36,38]. Similar to our study, a Canadian study found no association between maternal overweight and obesity and low APGAR scores at 5 minutes, although they noted that some previous studies had identified such relationships[39]. These discrepancies might arise from variations in study design, participant demographics, and methodology.

In conclusion, the evidence consistently indicates a connection between maternal BMI, newborn anthropometric measurements, and APGAR scores. This underscores the importance of primary care health interventions aimed at promoting healthy maternal BMI, beginning before conception, continuing throughout pregnancy, and extending into the post-pregnancy period. Such efforts hold the potential to improve newborn health outcomes and yield long-term health benefits.

CONCLUSION

Our study analyzed 284 singleton births at UNS hospital, with 12.7% of mothers classified as overweight and 56.7% as obese, typical rates for Indonesian women associated with marriage, high income, and a sedentary lifestyle. The research identified similarities with previous studies regarding the link between increasing maternal BMI and newborn anthropometric measurements. No significant differences or correlations in APGAR outcomes were found across various maternal BMI groups. However, the study highlighted evidence supporting differences and significant relationships between maternal BMI and maternal age, gestational age, gestational weight, and mode of delivery. The conclusion is that BMI status can influence and be related to these factors, particularly the mode of delivery, with overweight and obese BMIs associated with a higher likelihood of emergency cesarean delivery compared to normal BMI.

While our study findings align with prior research, it's crucial to acknowledge certain limitations. A significant constraint is the absence of socioeconomic and educational data regarding the mothers. Maternal socioeconomic status and educational background are known to influence reproductive performance, birth outcomes, and the prevalence of overweight and obesity. However, existing studies suggest that the adverse effects of maternal obesity on neonates can persist regardless of socioeconomic status. Despite this limitation, investigating the relationships between maternal obesity and neonatal parameters remains valuable, even without socioeconomic information. Our study, as outlined in the methods section, relies solely on medical records and lacks access to socioeconomic data. Another notable limitation is the lack of pre-pregnancy maternal weight data, which could

contribute to the higher observed prevalence of obesity in our participant group. Additionally, we did not examine gestational weight gain, which could also impact pregnancy outcomes.

Conversely, the strength of studies providing detailed descriptive results of maternal BMI groups regarding obstetric and neonatal outcomes is evident in various research articles. For instance, a study published in the International Journal of Environmental Research and Public Health conducted a descriptive analysis using absolute and relative frequencies for categorical variables related to maternal BMI and its impact on obstetric and neonatal outcomes. These studies offer valuable insights into the correlation between maternal BMI, obstetric complications, and newborn outcomes, thus enhancing our understanding in this field.

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CONFLICT OF INTEREST

The authors reported no potential competing interests.

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