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The Impact of Obesity on Mothers' Health in Pregnancy and Its Outcome

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Abstract— Obesity in pregnancy is defined as a BMI ≥ 30 and is related to complications and even cases of maternal and infant mortality. The objective was to assess the impact of obesity in pregnant women on the mothers' health and newborns at Regional Hospital Dr. H. Abdul Moeloek of Lampung in Indonesia. Retrospective data (2017-2023), Cross-Sectional design. The population is pregnant women with 3 categories of obesity: class I-III, with a total sampling method. Statistical analysis uses Chi-Square. A total of 61 obese pregnant women: class I (8.2%), class II (60.7%), and class III (31.1%). The health impacts observed included gestational hypertension (37.7%), preeclampsia (44.3%), CKD (16.4%), HELLP syndrome (6.6%), GDM (42.6%), C-Section (65.6%), PROM (8.2%), postpartum hemorrhage (6.6%), maternal mortality (1.6%), fetal distress (21.3%), asphyxia (3.3%), IUGR (8.2%), IUFD (4.9%), macrosomia (13.1%), LBW (3.3%), prematurity (29.5%), abortion (4.9%), congenital abnormalities (8.2%), neonatal mortality (13.1%). There was a significant correlation between the obesity class and newborn weight ($p = 0.038$) and there was no significant correlation between the obesity class and gestational hypertension, GDM, or delivery type. High maternal BMI increases the risk of pregnancy and newborn complications. Pregnant women are recommended to achieve a normal BMI before conception and regular pregnancy check-ups.

Keywords— BMI, Complications, Obesity, Pregnancy.

I. INTRODUCTION

Maternal BMI is defined as underweight (BMI < 18.5), normal (BMI = 18.5 to 24.9), overweight (BMI = 25.0 to 29.9), and obese (BMI ≥ 30) based on guidelines from the Institute of Medicine (IOM) that were implemented by the Pediatrics and Pregnancy Nutrition Surveillance System (PNSS) [1]. Being obese raises the risk of metabolic syndrome, which in turn raises the risk of several non-communicable diseases (NCDs) [2]. Calculated by dividing weight in kilograms by height in meters squared, the Body Mass Index (BMI) represents the proportion of fat and muscle mass in the human body [3]. An internationally recognized metric for evaluating the nutritional status of mothers is the body mass index, or BMI [4]. Body Mass

Index (BMI) ≥ 30 kg/m² from the first trimester or before pregnancy is generally considered obesity in pregnancy [2]. A BMI of 30–34.9 kg/m² is considered class I obesity; a BMI of 35–39.9 kg/m² is class II obesity; and a BMI of ≥ 40 kg/m² is class III obesity [5].

Given their large populations and high birth rates, Upper-middle-income countries (UMICs) and lower-middle-income countries (LMICs) accounted for more than 70% of overweight pregnant women. Middle-income countries had a sharp rise in the proportion of overweight and obese pregnant women between 2005 and 2014. Especially according percentage of the 20 high overweight burden countries in 2014: India (11.1%), China (11.0%), Nigeria (5.5%), United States of America (4.9%), Egypt (3.5%), Brazil (3.2%), Mexico (3.0%), Indonesia (2.8%), Pakistan (2.8%), Russian Federation (2.1%), Turkey (1.8%), Islamic

Republic of Iran (1.7%), Democratic Republic of the Congo (1.7%), Iraq (1.5%), Ethiopia (1.5%), South Africa (1.4%), United Republic of Tanzania (1.3%), Bangladesh (1.3%), Philippines (1.2%), and Algeria (1.1%). Meanwhile, the percentage of the 20 high obesity burden countries in 2014: United States of America (7.3%), China (7.3%), India (6.9%), Nigeria (5.7%), Egypt (5.2%), Mexico (4.0%), Brazil (3.8%), Russian Federation (2.6%), Turkey (2.5%), Pakistan (2.3%), South Africa (2.2%), Indonesia (2.2%), Islamic Republic of Iran (2.1%), Iraq (2.1%), Algeria (1.5%), Saudi Arabia (1.3%), Democratic Republic of the Congo (1.3%), Argentina (1.2%), United Kingdom of Great Britain and Northern Ireland (1.2%), and United Republic of Tanzania (1.1%) [6].

Lewandowska (2021) states that the obesity epidemic is a major public health issue. With obesity rates appearing to be rising unabated since the 1970s, it has emerged as a significant global public health concern in the twenty-first century. According to current estimates, there are approximately 2.1 billion overweight or obese people on the planet (30% of the total population), and by 2030, nearly half of all people will be overweight or obese (≥ 30 kg/ kg/m²). Obese people make up around one billion people (out of seven billion people) on the planet [7]. The issue of obesity has become a significant barrier to obstetric care, with women accounting for over 50% of all obesity cases in the human population [8]. Women are disproportionately affected by obesity from 6.4% in 1975 to 14.9% in 2014, obesity prevalence among women has increased globally [9].

Pregnancy-related obesity has become more common, and prenatal outcomes are getting worse as a result of the global obesity pandemic. According to Reed et al. (2023), maternal obesity has detrimental consequences on the kid during the newborn period and later in life, as well as on the mother and fetus during pregnancy and delivery. Maternal mortality during pregnancy is lowest in women with a normal BMI before becoming pregnant, and high BMI is also linked to higher blood pressure, gestational diabetes, postpartum hemorrhage, induction of labor, cesarean section, and macrosomic fetus [5]. There is an increased risk of death and physical and neurological disability in infants weighing more or less than the normal range [3].

Though many studies have established the correlation between maternal obesity and adverse perinatal outcomes, fewer studies have compared perinatal outcomes by obesity class. Despite the seriousness of this issue, limited research has been undertaken in Indonesia to assess the prevalence and effects of obesity on pregnancy and neonatal outcomes among pregnant women. This highlights the fundamental importance of the outcomes obtained, offering critical insights into the incidence and consequences among pregnant women. The timely identification of obesity-related complications by healthcare providers can aid in reducing maternal and birth outcome morbidity and mortality rates, mitigating both short-term and long-term adverse consequences for both mother and fetus. Hence, this study assumes paramount significance in elucidating the effects of obesity on maternal and neonatal outcomes within the context of pregnant women. Therefore, this study aimed to assess the impact of obesity among pregnant women on the mothers' health and newborns and determine the correlation

between obesity class and adverse outcomes, specifically adjusting for known comorbidities likely to be encountered by women with obesity, including gestational hypertension, gestational diabetes mellitus, delivery type and newborn weight at Regional Hospital Dr. H. Abdul Moeloek of Lampung in Indonesia.

II. MATERIALS AND METHODS

A retrospective cross-sectional study design was employed to investigate maternal and fetal outcomes among women with obesity during pregnancy. The study was conducted using data about obese pregnant women defined as diagnosed by a health professional from Medical Record Installation of Regional Hospital Dr. H. Abdul Moeloek of Lampung in Indonesia for 7 years (2017-2023). The population is pregnant women with 3 categories of obesity: class I (BMI 30.0 – 34.9), class II (BMI 35.0 – 39.9), and class III (BMI ≥ 40.0), with a total sampling method.

Descriptive statistics, including percentages and frequency counts, were used to describe each maternal and newborn characteristic for gestational hypertension, preeclampsia, chronic kidney disease (CKD), HELLP syndrome, gestational diabetes mellitus (GDM), cesarean section, premature rupture of membranes (prom), postpartum hemorrhage, maternal mortality, fetal distress, asphyxia, intrauterine growth retardation (IUGR), intrauterine fetal death (IUID), macrosomia, low birth weight (LBW), prematurity, abortion, congenital abnormalities (8.19%), and neonatal mortality. The correlation between the obesity class and gestational hypertension, gestational diabetes mellitus, delivery type, and newborn weight variables was examined with a Chi-square test. Statistical significance is assumed at p-values less than 0.05. The specialized Statistical Package for the Social Sciences (SPSS) version 25.0 was used to analyze data.

Official permissions from the relevant authorities in the study setting were obtained. Ethical approval was secured from the institutional review board (Health Research Ethics Committee of Regional Hospital Dr. H. Abdul Moeloek of Lampung) with approval number 297/KEPK-RSUDAM/VII/2024. Research ethics and hospital protocols were stringently followed to maintain the confidentiality of all patient data. This study was conducted retrospectively, and due to the nature of the data collection, obtaining individual consent from participants was not feasible. Therefore, a waiver of consent was granted by the Health Research Ethics Committee of Regional Hospital Dr. H. Abdul Moeloek of Lampung for the use of deidentified data. All data analyzed in this study were anonymized to ensure confidentiality and privacy.

III. RESULTS AND DISCUSSIONS

Table 1. describes the data on the impact of obesity in pregnant women on maternal and pregnancy outcomes. Among the 61 obese pregnant women: class I with a BMI of 30.0 – 34.9 (8.2%), class II with a BMI of 35.0 – 39.9 (60.7%), and class III with a BMI ≥ 40.0 (31.1%). The health impacts observed included gestational hypertension (37.7%), preeclampsia (44.3%), chronic kidney disease (CKD) (16.4%), HELLP syndrome (6.6%), gestational diabetes

mellitus (GDM) (42.6%), Caesarean Section (65.6%), Premature Rupture of Membranes (PROM) (8.2%), postpartum hemorrhage (6.6%), maternal mortality (1.6%), fetal distress (21.3%), asphyxia (3.3%), intrauterine growth retardation (IUGR) (8.2%), intrauterine fetal death (IUFD) (4.9%), macrosomia (13.1%), Low Birth Weight (LBW) (3.3%), prematurity (29.5%), abortion (4.9%), congenital abnormalities (hydrocephaly and Omphalocele) (8.2%), and neonatal mortality (13.1%).

Table 1. Data of the impact of obesity in pregnant women on maternal and pregnancy outcomes

| Variables | N (61) | % |
|-----------------------------------------|--------|------|
| Categories Of Obesity | | |
| Class I (BMI 30.0 – 34.9) | 5 | 8.2 |
| Class II (BMI 35.0 – 39.9) | 37 | 60.7 |
| Class III (BMI ≥40.0) | 19 | 31.1 |
| Gestational Hypertension | | |
| Yes | 23 | 37.7 |
| No | 38 | 62.3 |
| Preeclampsia | | |
| Yes | 27 | 44.3 |
| No | 34 | 55.7 |
| Chronic Kidney Disease | | |
| Yes | 10 | 16.4 |
| No | 51 | 83.6 |
| HELLP Syndrome | | |
| Yes | 4 | 6.6 |
| No | 57 | 93.4 |
| Gestational Diabetes Mellitus | | |
| Yes | 26 | 42.6 |
| No | 35 | 57.4 |
| Cesarean Section | | |
| Yes | 40 | 65.6 |
| No | 21 | 34.4 |
| Premature Rupture of Membranes | | |
| Yes | 5 | 8.2 |
| No | 56 | 91.8 |
| Postpartum Hemorrhage | | |
| Yes | 4 | 6.6 |
| No | 57 | 93.4 |
| Maternal Mortality | | |
| Yes | 1 | 1.6 |
| No | 60 | 98.4 |
| Fetal Distress | | |
| Yes | 13 | 21.3 |
| No | 48 | 78.7 |
| Asphyxia | | |
| Yes | 2 | 3.3 |
| No | 59 | 96.7 |
| Intra Uterine Growth Retardation | | |
| Yes | 5 | 8.2 |
| No | 56 | 91.8 |
| Intra Uterine Fetal Death | | |
| Yes | 3 | 4.9 |
| No | 58 | 95.1 |
| Macrosomia | | |
| Yes | 8 | 13.1 |
| No | 53 | 86.9 |
| Low Birth Weight | | |

| | | |
|---------------------------------|----|------|
| Yes | 2 | 3.3 |
| No | 59 | 96.7 |
| Prematurity | | |
| Yes | 18 | 29.5 |
| No | 43 | 70.5 |
| Abortion | | |
| Yes | 3 | 4.9 |
| No | 58 | 95.1 |
| Congenital Abnormalities | | |
| Yes | 5 | 8.2 |
| No | 56 | 91.8 |
| Neonatal Mortality | | |
| Yes | 8 | 13.1 |
| No | 53 | 86.9 |

Table 2. presents the correlation between obesity class with maternal and pregnancy outcomes. There was no significant correlation between the obesity class and gestational hypertension (p= 0.506), gestational diabetes mellitus (p= 0.545), or delivery type (p= 0.241). Meanwhile, there was a significant correlation between the obesity class and newborn weight (p = 0.038).

Table 2. Maternal and Pregnancy Outcomes in correlation to obesity class

| Variables | Obesity (Class I) | Obesity (Class II) | Obesity (Class III) | P-Value |
|-------------------------------------------|-------------------|--------------------|---------------------|---------|
| Gestational Hypertension | | | | |
| | | | | .506 |
| Yes | 3 (60.0%) | 14 (37.8%) | 6 (31.6%) | |
| No | 2 (40.0%) | 23 (62.2%) | 13 (68.4%) | |
| Gestational Diabetes Mellitus | | | | |
| | | | | .545 |
| Yes | 1 (20.0%) | 17 (45.9%) | 8 (42.1%) | |
| No | 4 (80.0%) | 20 (54.1%) | 11 (57.9%) | |
| Delivery Type | | | | |
| | | | | .241 |
| Vaginal Delivery | 3 (60.0%) | 10 (27.0%) | 8 (42.1%) | |
| C-Section | 2 (40.0%) | 27 (73.0%) | 11 (57.9%) | |
| Newborn Weight | | | | |
| | | | | .038 |
| Normal (2.5 kg-4.0 kg) | 2 (40.0%) | 21 (56.8%) | 4 (21.1%) | |
| Abnormal (LBW: <2.5 kg, Macrosomia >4 kg) | 3 (60.0%) | 16 (43.2%) | 15 (78.9%) | |

*Chi-Square Test

Of the 42.5% of obese women who underwent Caesarean section deliveries, 22.3% had gestational diabetes, and 11.2% experienced hypertensive disorders. Pregnancy-related diabetes, hypertension, and cesarean delivery were substantially more common in women with higher BMI

classes. Interestingly, 6.2% of obese women who were classified as class III or higher suffered pre-eclampsia. The International Society for the Study of Hypertension in Pregnancy and the World Health Organization both define preeclampsia as the new onset of hypertension (BP >140 mmHg systolic or >90 mmHg diastolic) at or after 20 weeks of gestation and significant proteinuria (>0.3 g/24 h) [10].

According to some research, insulin resistance linked to obesity raises the chance of developing chronic kidney disease (CKD) after a time of "silent" glomerular hyperfiltration [11]. The development and progression of renal illnesses other than obesity-related glomerulopathy (ORG) are strongly correlated with obesity [12]. Even if known risk factors for cardiovascular diseases including smoking, high blood pressure, and hyperlipidemia are declining, the prevalence of obesity and chronic kidney disease (CKD) is rising. BMI and the risk of chronic kidney disease are also strongly correlated. Due to its increased likelihood of acquiring various illnesses such as focal and segmental glomerulosclerosis, hypertensive nephron sclerosis, and diabetic nephropathy, obesity has an impact on the evolution of stable kidney disease. Obesity is associated with changes in the structure, histology, and hemodynamics of the kidney. Adipokines generated by active adipose tissue include leptin, adiponectin, tumor necrosis factor-, monocyte chemoattractant protein-1, transforming growth factor-1, and angiotensin-II [13], [14]. When comparing the offspring of obese mothers to those of lean mothers, we discovered that the former had a worse renal tubular injury and glomerulosclerosis scores, worse glucose tolerance, and higher retroperitoneal and epididymal fat deposits ($P < 0.01$ vs control) despite having similar body weights, and higher serum creatinine levels. According to Wong et al. (2018), these data imply that maternal obesity has a substantial negative impact on the kidneys of kids throughout the course of their lives, starting on days 1 and 20 of postnatal life and continuing until week 32 of middle adulthood [15]. Anticoagulation, however, should also be taken into account in patients with less severe nephrotic syndrome who have other risk factors, such as obesity, immobility, or renal diseases such as membranous nephropathy or vasculitis that are known to have high rates of thrombosis. The preferred anticoagulant during pregnancy is subcutaneous low-molecular-weight heparin. The Food and Drug Administration's pregnancy category X designation for statins indicates that they are currently teratogenic and should not be used during pregnancy. However, pregnancy also affects lipid profiles, with significant increases in serum triglyceride, low-density lipoprotein, and total cholesterol [16].

Obesity is one risk factor that can affect immunocompetence and affect how HELLP syndrome or preeclampsia (PE) develops [17]. A serious multisystemic pregnancy condition is called hemolysis, elevated liver enzymes, and low platelets (HELLP) syndrome. Preterm preeclampsia complicates approximately 25% of cases, and it affects 0.5% to 0.9% of pregnancies. HELLP syndrome typically manifests in patients as non-specific symptoms like emesis or epigastric discomfort between weeks 27 and 37 of pregnancy. Notably, materno-fetal imbalance caused by reduced placental function is a feature of HELLP syndrome

patients and may be important for the diagnosis. Given the patient's comorbidities and obesity, it was actually more difficult to make the right diagnosis in the case study [18], [19].

Obese mothers have a higher risk of developing gestational diabetes than normal-weight mothers, according to a study by Al-Hakmani et al. (2016). This increased risk may be brought on by metabolic abnormalities or hormonal changes that worsen insulin resistance and increase the likelihood of gestational diabetes [20].

According to Othman et al. (2018), obese women had a higher risk of cesarean sections than non-obese women. These findings demonstrated that pregnant obese women have a higher prevalence of postdated cesarean sections and are thought to be at high risk during their pregnancy, especially during labor and the postpartum period for both the mother and the fetus [21].

There has also been conflicting research on the connection between maternal obesity and PROM. High prepregnancy BMI has been associated, according to some research, with a higher risk of PROM (premature rupture of membrane). It is believed that obesity damages the placenta and causes inflammation. According to other research, obese moms had a decreased rate of PROM, which may be related to their diet. The variability of PROM and the variations in ethnicity among the study populations could account for this discrepancy [22], [23].

Maternal obesity and postpartum problems such as deep vein thrombosis and bleeding are statistically significantly correlated [21]. Hormonal and physiological changes that a woman's body goes through to support the growth and development of the fetus can be the cause of these issues. Certain issues may become more likely as a result of these changes, and obesity may make these risks worse in the postpartum period [24]. The odds of hemorrhage and atonic hemorrhage were slightly higher for overweight women (aOR for hemorrhage: 1.06; 99% CI 1.04-1.08; aOR for atonic hemorrhage: 1.07; 99% CI 1.05-1.09) and obesity class I (aOR for hemorrhage: 1.08; 99% CI 1.05-1.11; aOR for atonic hemorrhage: 1.11; 99% CI 1.08-1.15) as compared to women with a normal body mass index. Obese and overweight women had a 19% higher risk of atonic or hemorrhagic hemorrhage after vaginal birth. On the other hand, women in any obesity class had a 14% lower risk of severe bleeding following cesarean delivery [25].

Underweight women (<18.5 kg/ kg/m²) had an adjusted OR of mortality of 0.75 (95% CI, 0.42-1.33) compared to women with normal BMI, while overweight women (25-29.9 kg/ kg/m²) had an adjusted OR of death of 1.33. Women with class 1 obesity (30-34.9 kg/ kg/m²) had a 1.65 (95% CI, 1.24-2.19) rate. Class 2-3 obesity (≥ 35 kg/ kg/m²): 2.22 (95% CI, 1.55-3.19) and 3.40 (95% CI, 2.17-5.33). An examination of the causes indicated that there was a considerably higher risk of maternal death in obese women from cardiovascular illnesses, venous thromboembolism, hypertensive problems, and stroke. Subpar treatment was equally common in women with (35/62, 57%) and without obesity (136/244, 56%), however in 14/35 (40%) obese women with subpar care, obesity was strongly linked to this poor management. Maternal mortality rises with BMI; in overweight women, it multiplied by 1.6, and in severely

obese pregnant women, it more than quadrupled [26].

Additionally, there was a higher prevalence of unfavorable prenatal outcomes in obese women, including fetal distress and excessive development. Negative prenatal outcomes, such as excessive fetal growth (aOR 3.18, 95% CI 2.96–3.43) and fetal distress (aOR 1.28, 95% CI 1.21–1.35), were more common in obese women [27]. According to Cunningham et al. (2014), fetal distress raises the chance of emergency cesarean delivery, whereas excessive fetal growth, which is frequent in obese women, increases the risk of birth trauma, shoulder dystocia, brachial plexus injury, and meconium aspiration [28].

More recently, it was discovered that higher rates of fetal acidosis, which is caused by prolonged oxygen deprivation after birth, are associated with obesity among mothers [29]. They discovered a correlation between this relationship and a higher incidence of cerebral palsy in the offspring of obese mothers, which is most likely attributable to hypoxia during childbirth [30]. Pregnancy BMI and gestational weight growth were observed to worsen asphyxia-related newborn morbidity in similar Japanese investigations [31], [32].

Furthermore, the current study found that for a variety of medical reasons, over 25% of newborns needed to be admitted right away to the neonatal intensive care unit following delivery. These include low birth weight, meconium aspiration, respiratory distress, congenital abnormalities, acrocyanosis, and cyanosis. Several research that demonstrates a direct correlation between maternal body weight and birth weight corroborate this conclusion. There is a correlation between a larger birth weight and a higher risk of numerous neonatal problems, especially in infants delivered to obese mothers. These problems may include hyperbilirubinemia (high blood levels of bilirubin), respiratory distress syndrome, and newborn hypoglycemia (low blood sugar) [33], [34]. To receive specialist care, infants with these difficulties might need to be admitted right away to the neonatal intensive care unit (NICU) [7], [35], [36].

The risk of intrauterine fetal death is independent of weight and increases with both the degree of obesity and the number of weeks of gestation; consequently, the risk is highest in term pregnancies. Furthermore, the current data indicate that the risk of maternal obesity applies to intrauterine death across the gestational range studied, rather than being limited to stillbirths, even though increased maternal BMI has been linked to an increased risk of stillbirth in a dose-related manner. The conceivable processes by which elevated maternal BMI could result in these fetal deaths, which appear to be occurring throughout the second and third trimesters, are called into question by these data. Possible explanations encompass persistent systemic inflammation, placental illness, and the release of proinflammatory cytokines, C-reactive protein, and subsequent metabolic impacts [37], [38].

Pregnancy-related risks of macrosomia and low birth weight (LBW) newborns were higher in overweight and obese women with excess GWG before to conception [39]. According to Aji et al. (2022), pregnant women who gained too much weight were more likely than those who gained enough weight to give birth to low-weight (LBW) babies (p-value = .002) or to have macrosomia (p-value = .001) [40].

The fetus's growth will be influenced by the mother's weight both before and throughout the pregnancy. Interventions can be provided during the preconception period since additional research has demonstrated that maternal obesity and overweight are risk factors that may result in preterm delivery [4], [41], [42]. Numerous other studies have also demonstrated that obesity and excessive weight gain are associated with an increased risk of preterm birth [41], [43]. Nonetheless, some research studies have documented a correlation between reduced excess weight growth and premature birth [44]. Micronutrient and macronutrient deficits linked to low weight gain will raise the risk of preterm delivery; on the other hand, excessive weight gain is also linked to preterm birth risk, however, the association is not constant and is population-specific [45].

Women who are obese have greater levels of the inflammatory biomarker C-reactive protein (CRP) in their blood. Obesity is an inflammatory state. Several pro-inflammatory adipokines, including leptin, interleukin (IL) 6, and tumor necrosis factor-alpha (TNF α), are produced by adipose tissue. Like all of our body's cells, the reproductive tissues are adversely affected by inflammation. Lipotoxicity, a state in which dietary fatty acids surpass adipocytes' capacity to store them, might accumulate in other tissues and have toxic effects, is one potential reason for cellular and organelle damage in obesity [46]. Numerous studies indicate a link between being overweight and an increased risk of infertility and miscarriages during pregnancy. Using data from a trial conducted by Zhou et al. from 2006 to 2009, a prospective cohort analysis was conducted among 18,481 Chinese nulliparous women. Obesity was linked to lower rates of fetal loss (ARR 1.51; 95% CI: 1.15-1.99) and overall mortality (ARR 1.34; 95% CI: 1.03-1.74) when compared to normal weight, but not with newborn death (ARR 0.53; 95% CI: 0.20-1.46). Subsequent investigations revealed that obesity was more closely linked to spontaneous abortion (ARR 1.51; 95% CI: 1.13-2.02) than stillbirth (ARR 1.52; 95% CI: 0.65-3.57) [47].

In addition to increasing the risk of neural tube defect (NTD, and subsequently associated hydrocephalus), being very overweight or obese also increases the risk of premature birth, thus increasing the risk of hydrocephalus as a result of intraventricular hemorrhage (IVH) [48]. According to Raitio et al. (2020), their sample included 226 (12.7%) obese women (BMI \geq 30), and obesity was linked to an increased risk of omphalocele (OR 2.03 (95% CI: 1.21, 3.42) [49].

For all BMI values above normal, there is a statistically significant risk of fetal macrosomia. Conversely, the risk of newborn mortality is statistically significant only for BMI levels \geq 40 kg/ kg/m². This shows a potential relationship between the risk of fetal macrosomia and newborn mortality and the BMI at the start of pregnancy. However, compared to neonatal mortality, the relationship between BMI levels and fetal macrosomia appears to be more stable [50].

However, in our study, it was found that there was no correlation between obesity class in pregnant women with gestational hypertension, diabetes mellitus, and type of delivery. On another hand, Neal et al. (2022) conducted a study that found a strong relationship between obesity class and pregnancy-related problems, such as maternal hypertensive disorders (p <0.001), diabetic disorders (p =

0.02), and cesarean section ($p < .001$) [51].

IV. CONCLUSION

These results suggest that a high pregnant woman's body mass index (BMI) raises the risk of pregnancy-related problems and its outcome. Thus, to lower the risk of difficulties, it is advised to implement several techniques to reach a normal BMI before conception, such as a nutritious diet, frequent exercise, and regular prenatal checkups.

V. STRENGTH AND LIMITATIONS

This study is limited by its use of a cross-sectional retrospective technique, which is good at finding correlations but not very good at demonstrating causality. By using longitudinal methods to monitor changes over time, future research projects could improve the study design and provide a stronger basis for determining the causal links between pregnancy outcomes and obesity. The fact that this study addresses particular health issues and offers insights that may have a substantial impact on the well-being of both the mother and the fetus makes it essential. It also serves as the foundation for the development of evidence-based interventions and guidelines that will help medical professionals effectively manage and support obese pregnant women, ensuring that medical practices are in line with the most recent scientific findings.

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VII. AUTHOR CONTRIBUTIONS

Conceptualization: Juwita Desri Ayu.
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REFERENCES

- [1] Institute of Medicine [IOM]. Weight gain during pregnancy: reexamining the guidelines. Washington, DC: National Academies Press; 2009.
- [2] Joewono HT, Sulistyono A, Kartiningsih NKA, Aditiawarman. Birth Outcomes of Maternal Morbid Obesity; 2020.
- [3] Mohammadnuri M, Shojaei P, Khanjari M. The Association Between the Maternal Body Mass Index and the Birth Weight of Infants Born. *J Clin Res Paramed Sci.* 2023 Jun;12(1)
- [4] Guo Y, Xiong C, Zhou A, Hu R, Yang R, Du Y. Associations between prepregnancy body mass index, gestational weight gain and preterm birth: a cohort study in Wuhan, China. *Res Sq.* 2020. p. 1–15. <https://doi.org/10.21203/rs.3.rs-49045/v2>.
- [5] Reed J, Case S, Rijhsinghani A. Maternal obesity: Perinatal implications. *SAGE Open Medicine.* 2023;11:1–10. <https://doi.org/10.1177/20503121231176128>.
- [6] Chen C, Xu X, Yan Y. Estimated global overweight and obesity burden in pregnant women based on panel data model. *PLoS One.* 2018;13(8). Available from: <https://doi.org/10.1371/journal.pone.0202183>.
- [7] Lewandowska M. Maternal Obesity and Risk of Low Birth Weight, Fetal Growth Restriction, and Macrosomia: Multiple Analyses. *Nutrients.* 2021;13:1213. <https://doi.org/10.3390/nu13041213>.
- [8] Robillard P. Obesity class I and II and IOM 2009 gestational weight gain recommendations 5–9 kg. An audit on 10,000 term singleton deliveries. *J Matern Fetal Neonatal Med.* 2023;36(1):2184222. DOI: 10.1080/14767058.2023.2184222.
- [9] NCD Risk Factor Collaboration [NCD-RisC]. Trends in adult body-mass index in 200 countries from 1975 to 2014: a pooled analysis of 1698 population-based measurement studies with 19.2 million participants. *Lancet.* 2016;387(10026):1377–96.
- [10] Brown MA, Magee LA, Kenny LC, et al. Hypertensive disorders of pregnancy: ISSHP classification, diagnosis, and management recommendations for international practice. *Hypertension.* 2018;72(1):24–43.
- [11] Hong S, Choi YM, Ihm SH, Kim D, Choi MG, Yu JM, et al. Association between metabolic parameters and glomerular hyperfiltration in a representative Korean population without chronic kidney disease. *PLoS One.* 2018;13.
- [12] D'Agati VD, Chagnac A, de Vries AP, Levi M, Porrini E, Herman-Edelstein M, et al. Obesity-related glomerulopathy: clinical and pathologic characteristics and pathogenesis. *Nat Rev Nephrol.* 2016;12:453–71.
- [13] Câmara NO, Iseki K, Kramer H, Liu ZH, Sharma K. Kidney disease and obesity: epidemiology, mechanisms and treatment. *Nat Rev Nephrol.* 2017;13:181–90. doi:10.1038/nrneph.2016.191.
- [14] Schmidt MI, Duncan BB, Mill JG, et al. Cohort profile: longitudinal study of adult health (ELSA-Brasil). *Int J Epidemiol.* 2015;44:68–75. doi:10.1093/ije/dyu027.
- [15] Wong MG, The NL, Glastras S. Maternal obesity and offspring risk of chronic kidney disease. *Nephrology.* 2018;23(Suppl. 4):84–7. doi:10.1111/nep.13462.
- [16] Hladunewich MA. *Seminars in Nephrology.* Elsevier; 2017;37(4):337–46.
- [17] Rimboeck J, Gruber M, Weigl M, Huber P, Lunz D, Petermichl W. Obesity correlates with chronic inflammation of the innate immune system in preeclampsia and HELLP syndrome during pregnancy. *Biomedicines.* 2023;11:2851. <https://doi.org/10.3390/biomedicines11102851>.
- [18] Dusse LM, Alpoim PN, Silva JT, Rios DRA, Brandão AH, Cabral ACV. Revisiting HELLP syndrome. *Clin Chim Acta.* 2015;451(Pt B):117–20.
- [19] Wallace K, Harris S, Addison A, Bean C. HELLP syndrome: pathophysiology and current therapies. *Curr Pharm Biotechnol.* 2018;19(10):816–26.
- [20] Al-Hakmani FM, Al-Fadhil FA, Al-Balushi LH, Al-Harthy NA, Al-Bahri ZA, Al-Rawahi NA, et al. The Effect of Obesity on Pregnancy and its Outcome in the Population of Oman, Seeb Province. *Oman Med J.* 2016;31:12–7.
- [21] Othman M, Himayda SS, Shaaban L. Obesity and pregnancy in Saudi women. *Arch Clin Med Case Rep.* 2018;2:50–5.
- [22] Liu L, Hong Z, Zhang L. Associations of prepregnancy body mass index and gestational weight gain with pregnancy outcomes in nulliparous women delivering single live babies. *Sci Rep.* 2015;5:12863.
- [23] Lim J, Han K, Kim SY, Cho YH, Yoon YS, Park HS, et al. Effects of central obesity on maternal complications in Korean women of reproductive age. *Obes Res Clin Pract.* 2019;13(2):156–63.
- [24] AlAnnaz WAA, Gouda ADK, Abou El-Soud FA, Alanazi MR. Obesity Prevalence and Its Impact on Maternal and Neonatal Outcomes among Pregnant Women: A Retrospective

- Cross-Sectional Study Design. *Nurs Rep.* 2024;14:1236–50. <https://doi.org/10.3390/nursrep14020094>.
- [25] Butwick AJ, Abreo A, Bateman BT, Lee HC, El-Sayed YY, Stephansson O, Flood P. Effect of Maternal Body Mass Index on Postpartum Hemorrhage. *Anesthesiology.* 2018;128(4):774–83. doi:10.1097/aln.0000000000002082.
- [26] Saucedo M, Esteves-Pereira AP, Pencilé L, Rigouzzo A, Proust A, Deneux-Tharaux C. Understanding maternal mortality in women with obesity and the role of care they receive: a national case-control study. *Int J Obes.* 2020. doi:10.1038/s41366-020-00691-4.
- [27] Rubens M, Ramamoorthy V, Saxena A, McGranaghan P, EmirVeledar, Hernandez A. Obstetric outcomes during delivery hospitalizations among obese pregnant women in the United States. *Sci Rep.* 2022;12:6862. <https://doi.org/10.1038/s41598-022-10786-9>.
- [28] Cunningham F, Leveno K, Bloom S, Spong CY, Dashe J. *Williams Obstetrics, 24e.* McGraw-Hill; 2014.
- [29] Johansson S, Sandström A, Cnattingius S. Maternal overweight and obesity increase the risk of fetal acidosis during labor. *J Perinatol.* 2018;38(9):1144–50.
- [30] Villamor E, Tedroff K, Peterson M, et al. Association between maternal body mass index in early pregnancy and incidence of cerebral palsy. *JAMA.* 2017;317(9):925–36.
- [31] Murata T, Kyojuka H, Yamaguchi A, et al. Japan environment and children's study [JECS] group. Maternal pre-pregnancy body mass index and foetal acidosis in vaginal and caesarean deliveries: the Japan environment and children's study. *Sci Rep.* 2021;11(1):4350.
- [32] Murata T, Kyojuka H, Yamaguchi A, et al. Japan environment, children's study [JECS] group. Gestational weight gain and foetal acidosis in vaginal and caesarean deliveries: the Japan environment and children's study. *Sci Rep.* 2020;10(1):20389.
- [33] Chavkin U, Wainstock T, Sheiner E, Sergienko R, Walfisch A. Perinatal Outcome of Pregnancies Complicated With Extreme Birth Weights at Term. *J Matern Fetal Neonatal Med.* 2019;32:198–202.
- [34] Vieira MC, Sankaran S, Pasupathy D. Fetal macrosomia. *Obstet Gynaecol Reprod Med.* 2020;30:146–51.
- [35] Alfadhli EM. Maternal obesity influences birth weight more than gestational diabetes. *BMC Pregnancy Childbirth.* 2021;21:1–7.
- [36] Akram U, Khattak SN, Kalsoom O, Anwar A, Munir TA. Impact and comparison of pregnancy induced hypertension and obesity on fetal and maternal outcome. *Pak Armed Forces Med J.* 2019;69:1309–14.
- [37] Yao R, Ananth CV, Park BY, Pereira L, Plante LA, Perinatal Research Consortium. Obesity and the risk of stillbirth: A population-based cohort study. *Am J Obstet Gynecol.* 2014;210:457.e1–457.e9.
- [38] Deep JP, Sharma R, Ansari S, Shah RK, Raut RK, Shah P. Evaluation of intrauterine fetal death at tertiary care centre: a descriptive cross-sectional study. *Med Phoenix.* 2023;7:10–6.
- [39] Sun Y, Shen Z, Zhan Y, Wang Y, Ma S, Zhang S, et al. Effect of pre-pregnancy body mass index and gestational weight gain on maternal and infant complications. *BMC Pregnancy Childbirth.* 2020;20:390.
- [40] Aji AS, Lipoet NI, Yusrawati Y, Malik SG, Kusmayanti NA, et al. Association between pre-pregnancy body mass index and gestational weight gain on pregnancy outcomes: a cohort study in Indonesian pregnant women. *BMC Pregnancy Childbirth.* 2022;22:492. Available from: <https://doi.org/10.1186/s12884-022-04815-8>.
- [41] Cnattingius S, Villamor E, Johansson S, Bonamy AKE, Persson M, Wikström AK, et al. Maternal obesity and risk of preterm delivery. *Survey Anesthesiol.* 2014;58(2):70–1. doi:10.1097/sa.0000000000000036.
- [42] Shaw GM, Wise PH, Mayo J, Carmichael SL, Ley C, Lyell DJ, et al. Maternal prepregnancy body mass index and risk of spontaneous preterm birth. *Paediatr Perinat Epidemiol.* 2014;28(4):302–11. Available from: <https://doi.org/10.1111/ppe.12125>.
- [43] Faucher MA, Hastings M, Song JJ, Willoughby DS, Gerding SB. Gestational weight gain and preterm birth in obese women: a systematic review and meta-analysis. *BJOG.* 2016;123(2):199–206. doi:10.1111/1471-0528.
- [44] Chowdhury R, Choudhary TS, Dhahhai N, Mittal P, Dewan R, Kaur J, et al. Gestational weight gain and pregnancy outcomes: findings from North Indian pregnancy cohort. *Matern Child Nutr.* 2021;18(1). Available from: <https://doi.org/10.1111/mcn.13238>.
- [45] Eick SM, Welton M, Claridy MD, Velasquez SG, Mallis N, Cordero JF. Associations between gestational weight gain and preterm birth in Puerto Rico. *BMC Pregnancy Childbirth.* 2020;20(1):1–8. Available from: <https://doi.org/10.1186/s12884-020-03292-1>.
- [46] Hunter T, Hart R. *Reproductive consequences of obesity.* IntechOpen. 2018. doi:10.5772/intechopen.80897.
- [47] Zhou Y, Li H, Zhang Y, Zhang L, Liu J, Liu J. Association of maternal obesity in early pregnancy with adverse pregnancy outcomes: a Chinese prospective cohort analysis. *Obesity (Silver Spring).* 2019;27:1030–6. doi:10.1002/oby.22478.
- [48] International Federation for Spina Bifida and Hydrocephalus [IFSBH]. *Reducing hydrocephalus risk factors.* Brussels: International Federation for Spina Bifida and Hydrocephalus; 2018.
- [49] Raitio A, Tauriainen A, Leinonen MK, Syvänen J, Kempainen T, Löyttyniemi E, et al. Extended spectrum penicillins reduce the risk of omphalocele: a population-based case-control study. *J Pediatr Surg.* 2020. doi:10.1016/j.jpedsurg.2020.10.034.
- [50] Chéry O, Bedregal P, Valdivia G, Dor VJ, Padilla O. Maternal obesity, neonatal morbidity, and mortality, Southeast Metropolitan Health Service, Chile, 2014–2018. A retrospective pregnancy cohort study. *Am J Field Epidemiol.* 2023;1(1):1–12.
- [51] Neal K, Ullah S, Glastras SJ. Obesity class impacts adverse maternal and neonatal outcomes independent of diabetes. *Front Endocrinol (Lausanne).* 2022;13:832678. doi:10.3389/fendo.2022.832678.