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Babies born to obese mothers: what are the characteristics and outcomes?

Ari Yunanto[1], Pudji Andayani[1], Pricilia Gunawan Halim[1], Julia Kasab[2]
[1]Department Child Health, Faculty of Medicine, Lambung Mangkurat University, Banjarmasin, Indonesia
[2]Ulin General Hospital, Banjarmasin, Indonesia

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ABSTRACT

Obesity during pregnancy puts the mothers at risk of significant medical conditions and is also associated with some medical problems in neonates. This study aimed to analyze the characteristics and outcomes of babies born to obese mothers at a tertiary hospital in Banjarmasin, Ulin General Hospital. This study was observational using secondary data of neonates born at Ulin General Hospital, Banjarmasin, on January 2020-October 2021. The total number of subjects included in this study was 110, divided into two groups based on the obesity status of the mother (obese and non-obese). Common maternal characteristics of the obese mothers were having higher education (43.6%), being a housewife (67.3%), being diagnosed with severe preeclampsia (58.2%), and having infection risk (54.5%). Of the babies, 100% were delivered by C-section, 21.8% were premature, 12.7% had excessive birth weight, and 54.5% were requiring treatment before being discharged. For the outcomes, the average length of stay was 4.5±3.6 days ($p<0.05$) and the need for NICU admission was 20% ($p>0.05$). The most compelling characteristics and outcomes of babies born to obese mothers in this study were delivered by C-section, had excessive birth weight, unwell babies, and had a longer hospital stay.

Corresponding Author:

Julia Kasab
General Pratitioner, Ulin General Hospital
Road of A. Yani KM. 2, 5 No. 43, RW.5, Sungai Baru, Central Banjarmasin Sub-district, Banjarmasin City, South Kalimantan 70233, Indonesia
Email: juliakasab@gmail.com

1. INTRODUCTION

Obesity is an excessive accumulation of fat due to an imbalance between energy intake and energy used for a long time [1]. In Indonesia, overweight and obesity is generally determined based on a body mass index (BMI) of 25.1–27 kg/m^2 and >27 kg/m^2 [2], [3]. Other parameters that can be used to determine obesity status are waist circumference (WC), waist-hip ratio, skinfold, and body fat percentage measurement [4]. Obesity has become a global health burden and is a risk factor in pregnancy associated with short-term and long-term complications for mother and baby [5], [6].

The current number of obese people in the world has nearly tripled compared to 1975 [7]. According to the world health organization (WHO), in 2016 an estimated 1.9 billion adults worldwide were overweight and 650 million of them were obese. This epidemic is being taken seriously by WHO with the 2030 sustainable development goals (SDGs) agenda which targets a one-third reduction in mortality due to obesity through prevention and treatment [7], [8]. The prevalence of obesity has also been reported to increase in women of reproductive age. WHO reveals that about 15% of women in the world suffer from obesity [7], [9]. In western countries, about 30% of women are estimated to have obesity before their first

pregnancy and 40% of pregnant women are gained excessive weight gain during pregnancy [5], [10], [11]. In Indonesia, according to the 2016 national health indicators survey (*SIRKESNAS*) obesity occurs in 20.7% of the population and 58.9% of them are women of reproductive age [3]. Obesity in adults reached 19.5% in 2018 in South Kalimantan. Based on gender, obesity occurred in 26.6% of women and only 12.7% of men [12].

Currently, the trend that causes obesity is the consumption of processed foods with high caloric content. Other influencing factors are age, genetic predisposition, lifestyle, diet, socioeconomic status, and culture. In pregnant women, other factors such as pre-pregnancy BMI status, parity, and the amount of weight gain during pregnancy can also facilitate obesity in pregnancy [13]–[15]. Obesity in pregnancy put the mothers at a higher risk of complications such as gestational diabetes, gestational hypertension, preeclampsia, the risk of C-section, and is also associated with infant outcomes, such as macrosomia, prematurity, and any other serious conditions like respiratory distress, neonatal jaundice, and hypoglycemia [16]–[18].

To date, scientific data and information regarding pregnancy and neonatal outcomes from obese mothers in South Kalimantan are not available, whereas according to a national survey, the incidence of obesity continues to increase in rural areas [12]. It is crucial to have the basic data and associated risk of obesity in pregnancy and newborns to determine the next step to solve the problem. Therefore, this paper aims to describe the characteristics (mother and babies) and the outcomes of neonates born to obese mothers at the Ulin General Hospital, Banjarmasin, which is one tertiary referral hospital in Kalimantan. It is hoped that the result of this study not only provides a scientific basis for the early effective treatment and prevention of the complications for babies born to obese mothers but also constructs awareness of obesity in society and government.

2. RESEARCH METHOD

2.1. Study design

This was observational study with cross-sectional design to observe and compare the characteristics of the mother and the babies, also the outcomes of babies born to obese and non-obese mothers. This study used secondary data from the register of newborns at ULIN Hospital, Banjarmasin, Indonesia for the period January 2020 to October 2021. Some of the data available in the quantitative form are grouped into categories according to the guidelines and internal agreements used.

2.2. Subjects

The sampling method was purposive sampling, with the following criteria: singleton babies born to pregnant women diagnosed with obesity (cases), without obesity or malnutrition (control), the mother had no congenital disease (congenital heart disease, epilepsy, and malignancy), the fetus was not diagnosed with any congenital abnormalities during prenatal screening, and did not appeal for discharge at their request. Maternal data observed included patient demographic data, parity, diagnosis of comorbidities/complications, and risk factors for infection. The characteristics of the infants observed included gestational age, sex, birth weight, birth length, birth head circumference, history of asphyxia at birth, general condition, and other diagnoses such as neonatal infection, neonatal sepsis, respiratory distress, anemia, and neonatal jaundice. The baby's outcomes were observed in the form of a length of stay, history of neonatal intensive care unit (NICU) stay, and condition when discharged from the hospital.

The following is the operational definition defined for the research variables: i) Obesity and obesity grades were determined based on the diagnosis from the Obstetrics and Gynecology Department; ii) Parity is grouped into 1-2 and ≥3; iii) The education level is grouped into basic (elementary), intermediate (junior-senior high school), and high (college); iv) The diagnosis of comorbidities was grouped into no comorbidities, preeclampsia, and other diseases; v) The diagnosis of maternal infection risk factors adjusted with the criteria used at Ulin General Hospital, namely premature rupture of membranes, fever, chorioamnionitis, gestational age <37 weeks, abnormal vaginal discharge, and urinary tract infections; vi) Birth weight was grouped into low birth weight (LBW) (<2,500 g), normal birth weight (NBW) (2,500-4,000 g), and excessive birth weight (EBW) (>4,000 g); vii) Prematurity was grouped into premature, mature, and post-mature; viii) Anthropometric classification based on gestational age was made with the Lubchenco's curve, namely small for gestational age (SGA), appropriate to gestational age (AGA), and large gestational age (LGA); ix) History of asphyxia was grouped into no asphyxia, moderate-severe based on the APGAR score; x) The condition of babies is generally grouped into healthy babies and unhealthy babies. Healthy babies are babies who do not require care beyond the standard of care for healthy neonates; xi) Infant diagnoses such as neonatal infection, neonatal sepsis, respiratory distress, anemia, and neonatal jaundice were grouped into diagnosed and not; xii) The history of NICU admission was classified as requiring NICU care and not requiring NICU care; and xiii) Conditions when discharged from the hospital were grouped into healthy and dead.

2.3. Statistical method

Data were tabulated and processed using the 2013 Microsoft Excel application. Data analysis was made using the IBM SPSS version 21 application. Quantitative data were assessed for normality using the Shapiro-Wilk, normally distributed data were compared using the T-test, and abnormal data using the Mann-Whitney test. Chi-square is used to compare categorical data between control and case groups, if the table does not meet the requirements, a substitute test is used, namely the Fisher's Exact test. p-value <0.05 on the test results was considered significant. Odds ratio and 95%CI were calculated on eligible variables with the significant p-value.

3. RESULTS AND DISCUSSION

3.1. Maternal characteristics

The number of samples in this study was 55 data on mothers and babies in each case and control group. The characteristics of mothers and babies are shown in Table 1. The demographic characteristic that has a significant value is the level of education. Samples with higher education levels were more commonly found in the obese group (OR 3. 09 95% CI 1.23-7.32, p 0.008). The most occupations in both groups were housewives, namely 71% in the control group and 67.3% in the case group. A questionnaire survey conducted in Japan involving 2145 respondents showed that those with higher education tend to be obese (OR 3.21 95% CI: 1.59–6.51) [19]. This result are also similar to a population-based study in Kuwait which showed that women who worked as housewives were more at risk for obesity (OR2.42 95% CI: 1.82–3.23) [20]. Obesity is caused by many interrelated factors, including genetics, social environment, education level, social level, stress level, and lifestyle [15], [21].

Number of mothers diagnosed with severe preeclampsia and other comorbidities was significantly higher in the obese group (OR 2.86 95% CI 1.3-6.2, p 0.006 and OR5.7 95% CI 1.77-18.3, p 0.004). While in the control group, mothers with no comorbidities are significantly more common to be found (OR 0.082 95%CI 0.03-0.2, p 0.000). Other comorbidities found were anemia, diabetes mellitus, chronic hypertension, placenta previa, hepatitis B, and Covid-19 infection (data for other comorbidities were not included in the table). A retrospective study involving 24,161 medical records in Australia showed the similar result, it was found that obesity increased the risk of preeclampsia by 36.2%, operative delivery (15.5%), large baby (25.2%), and the need for NICU care (6.5%) [17]. A cohort involving 6,558 pregnant women also stated that obesity was a major risk factor for preeclampsia and other comorbidities (RR 8.80 95% CI: 3.46–22.40) [22]. Even one study revealed that someone with a body mass index >35 kg/m2 had a 30% higher risk of developing preeclampsia [23].

In the last three decades there has been an increase in the incidence of obesity and preeclampsia simultaneously, and the relationship between the two has been widely studied [17], [23], [24]. An increase in pro-inflammatory products (leptin, adiponectin, cytokines), a decrease in the amount of protein-expressing, nitric oxide, or other antioxidant compounds, as well as hyperinsulinemia and insulin resistance, are possible mechanisms that explain the relationship between obesity and preeclampsia [25]. As already mentioned obesity is a condition of accumulation of fat in the body, unesterified fatty acids, and excess fatty tissue can cause fat accumulation in the placenta which will interfere with placental development such as trophoblast invasion, angiogenesis, and transport of nutrients from mother to baby causing increased levels of oxidative stress and inflammation at the maternal-fetal interface [26].

Obese mothers in this study had a significantly higher percentage of infection risk factors than the control group (OR 7.05 95% CI 2.8-17.6, p 0.00). Several recent studies have shown that obesity is also associated with a higher risk of infection, such as urinary tract infection, septic shock, catheter-associated sepsis, and ventilator-associated pneumonia [27]. As is generally known, conditions related to infection during pregnancy such as maternal fever, chorioamnionitis, premature rupture of membranes, untreated vaginal discharge and urinary tract infections are the risk factors for preterm labor and neonatal sepsis that will affect neonatal morbidity and mortality [28], [29]. A population-based cohort study in South Korea found that urinary tract infections were more common in adults with a BMI≥30.0 kg/m^2 than in adults with normal weight (HR: 1.66, 95% CI: 1.06-2.60; p<0.05) [30]. W Nseir *et al.* conducted the first retrospective study to seek the relationship between obesity with the risk of recurrent urinary tract infections in women pre-menopause, the results showed that obese women tend to experience recurrent urinary tract infections (OR 4.0, 95% CI 3.2-4.61; p=0.001) [31]. Hadley *et al.* in their randomized controlled trial (RCT) study revealed that women with obesity are at 60% higher risk of chorioamnionitis (HR 1.6, 95% CI 1.1-2.1, p=0.008) and premature rupture of membranes that are associated with preterm labor [18].

The number of samples according to the degree of obesity in this study was 43.6% for grade I, 27.3% for grade II, and 29.1% for grade III. Analysis based on obesity level was carried out for comorbidities and infectious diseases suffered by the mother. Preeclampsia remains the most common comorbidity found in obesity grades I-III (45.8%; 66.7%; 68.8%), with insignificant differences between groups. The percentage of

risk factors for infection experienced by mothers in groups I-III were 50%, 53.5%, and 62.5%, respectively, there was no significant difference between groups. Durst *et al.* found similar results, from 10,196 samples of which 1,119 were mothers with preeclampsia, it was found that obese mothers were more at risk of developing preeclampsia (OR 2.0 95% CI 1.4-2.8), but there was no significant difference between grades of obesity [32].

Table 1. Maternal characteristics of the obese and control group

No	Variable	Group (Mean±SD or n (%))		p-value	OR (95%CI) *
		Non-Obese	Obese		
1	Age	30.3±5.4	28.7±6.9	>0.05	
2	Parity				
	1 s.d 2	14 (25.5)	18 (32.7)	>0.05	
	≥3	41 (74.5)	37 (67.3)	>0.05	
3	Education level				
	Elementary	11 (20)	7 (12.7)	>0.05	
	Intermediate	33 (60)	24 (43.6)	>0.05	
	College	11 (20)	24 (43.6)	0.008	3. 09 (1.23-7.32)
4	Profession				
	Housewifes	39 (71)	37 (67.3)	>0.05	
	Healthcare worker	2 (3.6)	3 (5.5)	>0.05	
	Government employee	2 (3.6)	3 (5.5)	>0.05	
	Teacher	3 (5.5)	7 (12.7)	>0.05	
	Private sector employee	1 (1.8)	1 (1.8)	>0.05	
	Entrepreneur	8 (14.5)	4 (7.3)	>0.05	
5	Other diagnosis				
	None	32 (58.2)	6 (10.9)	0.000	0.082 (0.03-0.2)
	Other diagnosis	4 (7.3)	17 (30.9)	0. 004	5.7 (1.77-18.3)
	PEB	18 (32.7)	32 (58.2)	0. 006	2.86 (1.3-6.2)
6	With infection diagnosis	14 (25.5)	30 (54.5)	0.000	7. 05 (2.8-17.6)
7	Obesity classification				
	Grade I		24 (43.6)		
	Grade II		15 (27.3)		
	Grade III		16 (29.1)		

*Estimated when the p-value is less than 0.05

3.2. Neonatal characteristics

Table 2 displays the characteristics of infants. In general, birth weight, birth length, and birth head circumference of infants in the obese group were higher than the control group with p-values close to significant. After being grouped according to birth weight and gestational age appropriateness (Lubchenco curve), there was a significant difference between groups (p-value 0.02), with findings of babies having EBW and large for gestational age (LGA) as much as 12.7% in the obese group, and 0% in the control group.

Well-known neonatal complications from maternal obesity are macrosomia and large for gestational age [16], [33]. The results of the intergroup Chi-square test comparing the incidence of macrosomia and gestational age (LGA) showed significant results. This result is consistent with a meta-analysis of maternal obesity and the incidence of macrosomia that showed obesity was associated with excessive fetal growth, birth weight ≥4,000 g (OR 2.17, 95% CI 1.92, 2.45), birth weight ≥4,500 g (OR 2.77.95% CI 2.22-2.96) and birth weight ≥90% lie for gestational age (OR 2.42, 95% CI 2.16-2.72) [34]. Another meta-analysis that consist of 46 articles in China demonstrated that obesity in pregnancy causes macrosomia (OR 1.91, 95% CI 1.75–2.09) and large for gestational age (OR 1.88, 95% CI 1.64–2.15) [35], [36]. A retrospective study involving 1,000 term infants also showed the same result, namely that macrosomia tended to be more common in the obese group [10].

Prematurity and respiratory distress are the other neonatal complications that are often mentioned as complications of neonates born to obese mothers [37]. In this study, prematurity has no significant difference between the two groups, whilst moderate-severe asphyxia was more common in babies born to obese mothers (OR 2.4 95% CI 1.0-6.1, p 0.04). A meta-analysis showed that obese mothers were 1.38 times more likely to have premature birth (95% CI 1.25–1.52; P<0.001; I2=74.8%), and babies born to obese mothers were 1.74 times more at risk of experiencing respiratory distress (95% CI 1.39–2.17; P<0.001; I2=0.0%) when compared to infants born to mothers with normal BMI [36]. Another study conducted by Anne-Frederique *et al* involving 38,675 births showed that babies born to obese mothers were 31% more likely to experience asphyxia at birth (APGAR scores min 1<7) [38].

Table 2. Neonatal characteristics of obese and control group

No	Variable	Group (Mean±SD or n (%))		p-value	OR (95%CI) *
		Non-Obese	Obese		
1	Birth weight (gram)	2841.7±516.2	3054.7±796.6	0.09	
2	Birth length (cm)	46.7±3.5	47.8±3.4	0.09	
3	Birth head circumference (cm)	32.6±2.8	33.2±2.1	0.07	
4	Sex				
	Male	27 (49.1)	29 (52.7)	0.4	
	Female	28 (50.9)	26 (47.3)		
5	Delivery method				
	Spontaneous	24 (43.6)	0		
	Vacuum extraction	3 (5.5)	0	0.000	
	C-section	28 (50.9)	55 (100)		
6	Birth weight classification				
	Excessive birth weight	0	7 (12.7)		
	Normal birth weight	44 (80)	37 (67.3)	0.02	
	Low birth weight	11 (20)	11 (20)		
7	Maturity				
	Postterm	0	1 (1.8)		
	Aterm	48 (87.3)	42 (76.4)	0.2	
	Preterm	7 (12.7)	12 (21.8)		
8	Lubchenco curve				
	Large for gestational age	0	7 (12.7)		
	Appropriate gestational age	48 (87.3)	44 (80)	0.01	
	Small for gestational age	7 (12.7)	4 (7.3)		
9	General condition				
	Unwell baby	19 (34.5)	30 (54.5)	0.035	2.27(1.05-4.9)
10	Birth asphyxia				
	Moderate-Severe	9 (16.4)	18 (32.7)	0.04	2.4(1.0-6.1)
11	Birth trauma	0	0		
12	Other diagnoses				
	Neonatal Infection	9 (16.4)	18 (32.7)	0.04	2.8(1.1-7.2)
	Clinical sepsis	7 (12.7)	10 (18.2)	0.29	
	Respiratory distress	9 (16.4)	10 (18.2)	0.5	
	Anemia	7 (12.7)	9 (16.4)	0.5	
	Jaundice	15 (27.3)	9 (16.4)	0.12	

*Estimated when the p-value is less than 0.05.

Unwell babies were more commonly to be found in the obese group (OR2.27 95% CI 1.05-4.9, p=0.035). Another diagnosis with significantly different incidence rates between groups was a neonatal infection (OR 2.8 95% CI 1.1-7.2, p0.04). Rastogi *et al.* studied the neonatal outcome morbidity of 109,488 women showing that infants born to obese mothers were 1.91 more at risk of developing sepsis [39]. Other conditions such as respiratory distress, sepsis, and anemia were also more commonly found in the obese group, but the difference in numbers was not significant. Birth trauma was zero in this study, this finding can be explained by 100% C-section the delivery method in the case group.

The condition of babies at birth is influenced by many factors, but the mother's condition is one of the determining factors. The possible mechanisms that explain the relationship between maternal obesity and neonatal condition are not yet clear. Some of the literature describes the relationship associated with an increase in pelvic fat tissue, difficulty monitoring the condition and weight of the baby due to too thick maternal fat tissue, a maternal cardiovascular function that does not provide adequate supply to the fetus due to complications from obesity, and vulnerable infection transfer due to the dysfunction of mother's immune system [38].

3.3. Neonatal outcomes

Neonatal outcomes are shown in Table 3. In this study, it was found that the length of stay was longer in the case group (4.5±3.6 vs. 3.2±4.4). The need for NICU admission was also found to be more common in the case group (20% vs 12.7%), but the difference was not statistically significant. Two death cases were found in the obese group. The cause of death in both cases was early-onset sepsis with multiple organ failure (MOFs).

The research of Yang *et al.* also showed the same result, namely that one of the neonatal complications born to obese mothers was a longer length of stay (21.6%) and the need for NICU care (6.5%) [17]. The limitation of this study is a small number of samples and is conducted in a referral hospital so the sample population tends to be heterogeneous with other health conditions that may be the reason for referral (besides obesity). This is minimized by selecting samples based on inclusion criteria and a description of the characteristics of the mother and baby, including the co-morbidities they have.

Table 3. Neonatal outcomes of the obese and control group

No	Variable	Group (Mean±SD or n (%))		p-value
		Non-Obese	Obese	
1	Length of stay	3.2±4.4	4.5±3.6	0.01
2	Survival			
	Survived	55 (100)	53 (96.4)	0.25
	Death	0	2 (3.6)	
3	NICU Admission	7 (12.7)	11 (20)	0.22

4. CONCLUSION

Compelling maternal characteristics of the obese mother were having higher education, working as a housewife, being diagnosed with severe preeclampsia, and having infection risk. Characteristics and outcomes of babies born to obese mothers with significant value were delivered by C-section, had excessive birth weight, large for gestational age, unwell babies, and led to a longer hospital stay. Any other morbidities like prematurity, rate of neonatal sepsis, anemia, and respiratory distress were also more common to be found in the obese group, but the number was not statistically significant. Suggestions for further research should be done on a larger population and samples. In addition, a deeper analysis can also be carried out regarding the magnitude of the influence of obesity status on maternal and neonatal outcomes.

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BIOGRAPHIES OF AUTHORS

Ari Yunanto is a Full Professor of Neonatology and Master of Law at Lambung Mangkurat University in Banjarmasin. He has published dozens of peer-reviewed scientific articles in the major journal on subjects of biomedicine, clinical medicine, and pediatrics. He also actively writes and publishes books about clinical practice in neonatology and law in medicine. Ari is also well known for his innovation in making the Continuous Positive Airway Pressure - Babies Respiratory Distress Recovery Device (CPAP-BiRD), which brings him the TOP 99 Public Service Innovation award. He can be contacted at email: ariefkaunlam@gmail.com.

Pudji Andayani is a Senior Consultant in Neonatology at a Teaching Hospital, Ulin General Hospital, Banjarmasin associated with Lambung Mangkurat University. She is involved in several research and has published papers in a major journal of pediatrics. She is also an active senior member of the Indonesian pediatrician association at South Kalimantan. She can be contacted at email: pudji.andayani@yahoo.id.

Pricilia Gunawan Halim is a Pediatrician at Teaching Hospital, Ulin General Hospital, Banjarmasin associated with Lambung Mangkurat University. Currently, she is continuing her education as a consultant in Neonatology at the University of Indonesia. She is involved in many studies and has published papers in major journals of medicine. She can be contacted at email: pricilia.gh@gmail.com.

Julia Kasab is a Fresh General Practitioner at Ulin General Hospital. Besides practicing in general medicine, she also has a great interest in sciences and research. Has graduated from Lambung Mangkurat University and finished an internship at Badaruddin Hospital, Tabalong in 2020. She is involved in some studies about bio and clinical medicine. She can be contacted at email: juliakasab@gmail.com.