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# Pre-Pregnancy Body Mass Index and Gestational Weight Gain as Risk Factors for Low Birth Weight

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A B S T R A C T

Low weight (LBW) is one of the perinatal complications with high infant mortality and morbidity. At Wonosamodro District in 2018, 4.8% of babies were born with LBW. One of the risk factors for LBW is maternal nutritional factors. This study aims to analyze the correlation between pre-pregnancy body mass index (BMI) and gestational weight gain with the incidence of low birth weight. This study was an analytic observational study using a case-control design. The population was all infants and toddlers with a history of LBW in the case group and normal birth weight (NBW) in the control group in Wonosamodro Sub-District, Boyolali District, born from September 2015 to September 2020. There were 102 samples with consecutive and matching sampling. The characteristics of respondents, BMI, and gestational weight gain processing were done by editing, coding, entry, cleaning, and tabulating. Then, the data analysis used the chi-square test. The study's results at 5% alpha showed that gestational weight gain significantly correlated with LBW incidence (p=0.000). Meanwhile, pre-pregnancy BMI did not significantly correlate with LBW (p=0.096). Mothers with less gestational weight were 5.3 times at risk of delivering LBW babies than mothers with normal gestational weight gain (OR =5.318 95% CI 2.122-13.326). Maternal weight gain during pregnancy is a risk factor for LBW in Wonosamodro Subdistrict, Boyolali District, while pre-pregnancy BMI is not. Further research should use the primary data collection method, a cohort design, a more significant number of samples, and random sampling and examine other variables.

## INTRODUCTION

Low birth weight (LBW) is one of the perinatal complications with high infant mortality and morbidity. The causes of low birth weight are high parity, poor mother's nutritional status during pregnancy, anemia, maternal age, infectious diseases, pregnancy complications, very short interpregnancy interval, maternal chronic disease, gender of the baby, multiple pregnancies, congenital malformations and low economic status (Bian *et al*., 2013; WHO, 2014; Pramono and Paramita, 2015; Endalamaw *et al*., 2018). In addition, risk factors for low birth weight are maternal nutritional factors, including low body mass index and inappropriate weight gain during pregnancy (Tabrizi and Saraswathi, 2012; Bian *et al*., 2013; Endalamaw *et al*., 2018).

Several studies have concluded that the nutritional status of pregnant women before and during pregnancy affects the newborn's weight. Pregnant women with poor nutrition or low body mass index (BMI) potentially harm pregnancy outcomes, such as babies with low birth weight and premature birth (Bhowmik *et al*., 2019). Various factors influence gestational weight gain and directly affect pregnancy outcomes. Low gestational weight gain is associated with an increased risk of stunted fetal growth.



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Monitoring nutritional status needs to be carried out by mothers from the beginning of pregnancy. If mothers with gestational weight gain of fewer than nine kilograms continue until delivery, it will increase at risk of giving birth to LBW babies (Yongky *et al*., 2009; Ayensu and Reginald Adjetey Annan, 2016). Pre-pregnancy body mass index and gestational weight gain are modifiable risk factors for adverse pregnancy outcomes (Frederick *et al*., 2008). Based on research from (Yu *et al*., 2013), underweight pregnant mothers increased the risk of small fetuses by 1.81 times and LBW by 1.47 times. Thus, women with low gestational weight gain potentially had a baby with a low birth weight (Tabrizi and Saraswathi, 2012). On the other side, (Bhaskar *et al*., 2015), in their investigation, stated that pre-pregnancy body mass index had no significant effect on the incidence of LBW in babies.

The number of LBW babies in 2015, based on United Nations International Children's Emergency Fund (UNICEF) and World Health Organization (WHO) data, was 20.5 million (UNICEF and WHO, 2019). From 2000 to 2015, the LBW birth rate in the world decreased slowly by 2.9%. In addition, the number of babies born with LBW in the ASEAN region decreased by 1.4%. Furthermore, Based on Basic Health Research, the incidence of LBW in Indonesia fell to 9% in 2019. At Wonosamodro District in 2018, 4.8% of babies were born with low weight, and then its number decreased by 0.5% to 4.3% in 2019. Meanwhile, from January to March 2020, LBW at Wonosamodro Sub-district was 6.3%. Its number was still higher than the Boyolali District prevalence rate of 4.5% in the same period. This study aims to determine the correlation between pre-pregnancy body mass index (BMI) and gestational weight gain with LBW incidence in Wonosamodro Sub-district, Boyolali District (Dinkes Boyolali, 2019).

## METHOD

This study was an analytic observational study using a case-control design. The population was all infants and toddlers with a history of LBW in the case group and normal birth weight (NBW) in the control group in Wonosamodro Sub-District, Boyolali District, born from September 2015 to September 2020. There were 102 samples with consecutive and matching sampling. The sample size was calculated using the case-control study sample size formula with 51 respondents. Then, the sample size of the control group used a ratio of 1: 1, namely 51 samples, so that the total number of respondents in this study was 102. In this study, the researchers applied for research permits to The National Unity and Political Agency of Boyolali District also the Boyolali District Department of Health Office. In addition, this paper has obtained ethical approval. Data collection was carried out from September to October 2020, starting with determining the samples in the case and control groups. The collected data was secondary data obtained from registers, medical records, and MCH books. The characteristics of respondents, BMI, and gestational weight gain processing were done by editing, coding, entry, cleaning, and tabulating. Then, the data analysis used the chi-square test with the SPSS computer program.



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## RESULT

Most respondents' mothers were 20-35 years or non-risky age (79.4%), had education below senior high school or equivalent (75.5%), unemployment (71,6 %), gestational age at term (87.3%), and had normal height (91.2%) (Table 1).

Table 1. The Characteristics of Samples

| Characteristics | LBW | | NBW | | Total | |
|---|---|---|---|---|---|---|
| | n | % | n | % | n | % |
| Maternal age (Years) | | | | | | |
| < 20 or > 35 | 10 | 19.6 | 11 | 21.6 | 21 | 20.6 |
| 20 - 35 | 41 | 80.4 | 40 | 78.4 | 81 | 79.4 |
| Maternal education | | | | | | |
| < Senior high school | 42 | 82.4 | 35 | 68.6 | 77 | 75.5 |
| ≥ Senior high school | 9 | 17.6 | 16 | 31.4 | 25 | 24.5 |
| Maternal occupation | | | | | | |
| employee | 14 | 27.5 | 15 | 29.4 | 29 | 28.4 |
| unemployed | 37 | 72.5 | 36 | 70.6 | 73 | 71.6 |
| Maternal gestational age (Weeks) | | | | | | |
| < 37 | 13 | 25.5 | 0 | 0 | 13 | 12.7 |
| ≥ 37 | 38 | 74.5 | 51 | 100 | 89 | 87.3 |
| Maternal height (cm) | | | | | | |
| ≤ 145 | 6 | 11.8 | 3 | 5.9 | 9 | 8.8 |
| > 145 | 45 | 88.2 | 48 | 94.1 | 93 | 91.2 |

The results showed that mothers with underweight and normal pre-pregnancy BMI gave birth to more babies with LBW than overweight pre-pregnancy BMI mothers. Thirteen of 22 mothers with underweight pre-pregnancy BMI gave birth to LBW babies. In addition, 60.8% of mothers with normal pre-pregnancy BMI delivered LBW babies. Meanwhile, 25.5% of overweight pre-pregnancy BMI mothers gave birth to babies with normal birth weight (Table 2).

In addition, thirty-six of 52 mothers with less weight gain during pregnancy delivered babies with low birth weight. The incidence of low birth weight was more common in mothers with less gestational weight gain. In contrast, babies with normal birth weight mainly were in mothers with normal weight gain during pregnancy, namely 26. In addition, 17.6% of mothers who were overweight during pregnancy also delivered babies with normal birth weights (Table 2).

Table 2. The correlation between maternal pre-pregnancy BMI and gestational weight gain during pregnancy with the incidence of LBW in Wonosamodro Sub-district, Boyolali District

| Variable | LBW | | NBW | | Total | | *p* | OR 95%CI |
|---|---|---|---|---|---|---|---|---|
| | n | % | n | % | n | % | | |
| Maternal pre-pregnancy BMI | | | | | | | | |
| Underweight | 13 | 25.5 | 9 | 17.6 | 22 | 21.6 | | - |
| Normal | 31 | 60.8 | 26 | 51 | 57 | 55.9 | 0.096 | |
| Overweight | 7 | 7.8 | 16 | 25.5 | 23 | 22.5 | | |
| Gestational Weight Gain | | | | | | | | |
| Less | 36 | 70.6 | 16 | 31.4 | 52 | 51.0 | | 5.318 (2.122-13.326) |
| Normal | 11 | 21.6 | 26 | 51 | 37 | 36.3 | 0.000 | |
| Over | 4 | 7.8 | 9 | 17.6 | 13 | 12.7 | | |



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Furthermore, the chi-square test in the gestational weight gain variable obtained $p$=0.000, indicating a significant correlation between maternal weight gain during pregnancy and the incidence of low birth weight. Mothers who experienced less weight gain were at 5.3 times the risk of giving birth to LBW babies compared to mothers with normal gestational weight gain. Meanwhile, the chi-square test in the maternal pre-pregnancy BMI variable obtained $p$=0.096, indicating no association between maternal BMI and the incidence of low birth weight.

## DISCUSSION

In this study, most mothers were housewives, and their recent educational history was junior high school or equivalent (Table 1). This condition can affect the mother's economic status and knowledge level, which also impacts the nutritional needs during pregnancy. One factor that affects the mother's nutritional status during conception is the social and economic condition before pregnancy and maternal health and nutrition (Mardalena and Suyani, 2016). Low socioeconomic levels do not directly impact the pregnancy outcome but rather a harmful condition for pregnancy, including issues of maternal anthropometrics and nutrition (Abu-Saad and Fraser, 2010). Maternal nutritional intake is fulfilled to meet the required energy, such as activity and metabolism (Nirbita, 2012), and for the fetus's and placenta's growth. So, unmet maternal nutritional needs during pregnancy can lead to less weight gain and the risk of low birth weight. This paper showed no significant correlation between maternal pre-pregnancy BMI and the incidence of LBW (Table 2). It is in line with a study by Bhaskar *et al*. (2015), with the same research design and analysis (chi-square) to determine the risk factors for LBW. The study was conducted at two hospitals with a larger sample size of 159 in each case and a control group. Data was collected using interviews and secondary data. The study revealed that most respondents had a normal BMI. In addition, most of the mothers who gave birth to LBW babies had a normal BMI in the case group. Furthermore, there was no significant relationship between maternal BMI and low birth weight ($p$=0.12). Moreover, the study revealed that maternal height, first ANC visit, number of ANC visits, Fe and calcium supplementation, maternal education, disease during pregnancy, and hypertension were essential predictors of LBW. Meanwhile, maternal blood type AB and BMI were protective factors against the incidence of LBW.

A prior study by Ojha and Malla (2007) also found that maternal BMI did not correlate statistically with LBW ($p$=0.28). That study analyzed the correlation between anthropometry of pregnant women and the incidence of LBW using 154 samples in each case and a control group. Based on logistic regression analysis, only the maternal weight variable significantly affected the incidence of LBW. Mothers with low anthropometry (especially maternal weight and upper arm circumference) tended to have LBW babies. Among various risk factors in that study, low maternal anthropometric significantly influenced the incidence of LBW babies.



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A normal pre-pregnancy BMI should reduce the risk of LBW compared to mothers with a low pre-pregnancy BMI (Tabrizi and Saraswathi, 2012). However, BMI was not associated with the incidence of LBW in this research because most of the mothers who give birth to LBW babies had a normal BMI. In this study, most mothers with normal pre-pregnancy BMI were 20-35 years old (Table.1). At that age, a lot of energy is essential for activity and metabolism. Maternal nutritional intake during pregnancy is vital to supply maternal needs and the growth and development of the fetus. So, even though the mother has a normal pre-pregnancy BMI, if the nutritional intake is unmet, she can experience less gestational weight gain and still be at risk of giving birth to an LBW baby.

Ronnenberg *et al*. (2003) mention in their research that maternal weight gain during pregnancy could affect the relationship between BMI before pregnancy and pregnancy outcome. Women with less pre-pregnancy BMI who experienced enough gestational weight gain potentially delivered babies with normal or near-normal weight. Good gestational weight gain might compensate for the adverse effects on fetal growth associated with low maternal BMI during early pregnancy (Abu-Saad and Fraser, 2010; Ludwig and Currie, 2010; Nnam, 2015).

On the other hand, several studies have concluded that the nutritional status of pregnant women before and during pregnancy affects low birth weight. Good nutritional status before pregnancy illustrates the availability of nutrient reserves in the body that is ready to support fetal growth during pregnancy. Based on a study by Sutan *et al*. (2014), there was a significant association between body mass index in early pregnancy and the incidence of low birth weight ($p$=0.002). That study used matching sampling on the sex of the baby. In addition, it used a case-control design and a sample of 180 samples in each group. It showed that younger maternal age, lower BMI, prematurity, history of LBW infants, cesarean delivery, and gestational hypertension were significantly associated with LBW incidence. Younger maternal age, history of LBW infants, prematurity, and hypertension have been widely recognized as predictors of LBW infants.

Endalamaw *et al*. (2018) did a systematic review and meta-analysis of several studies conducted in Ethiopia examining LBW risk factors. The studies in that systematic review used cross-sectional, case-control, and cohort designs. That meta-analysis estimated LBW Ethiopia's national prevalence and its risk factors. It used 30 studies with 55,085 participants. Furthermore, it revealed that mothers with normal pre-pregnancy BMI had a lower risk of 5.6 times giving birth to LBW babies. Moreover, maternal age <20 years, interval pregnancy <24 months, BMI <18.5 kg/m2, and gestational age <37 weeks were LBW risk factors (Endalamaw *et al*., 2018).

Total weight gain during pregnancy is the difference between pre-delivery and body weight before conception (Karima, 2012). A significant correlation between maternal weight gain during pregnancy and the incidence of low birth weight was found in this paper ($p$=0.000). In addition, a previous study by

Nirbita (2012) also revealed an association between gestational weight gain and LBW incidence. The study used a case-control design with a 73-sample size for each case and the control group. However, the characteristics of that study were in contrast with this study. That study showed that most mothers had a high school education, so the respondent's education level was higher. In data analysis, the value of x2 did not match the requirements, so it used a correlation coefficient to determine the association between gestational weight gain (nutritional status) and LBW incidence. The correlation coefficient was 0.809 with a significance value of <0.0001 ($p < \alpha$), indicating a significant relationship between both variables with a very strong correlation.

A previous study by Anil *et al*.(2020) also indicated that mothers with less gestational weight gain had three times the risk of giving birth to LBW babies ($p$=0.0001, OR = 3; 95%, CI 1.9-4.8). The study used a case-control approach with a sample size of 123 in the case group and 246 in the control group. Cases and controls were randomly selected using a ratio of 1: 2. Its collecting data utilized interview and medical record data. Its population was mothers who delivered at a government health facility consisting of 28 maternity clinics and three hospitals. So, its sample, collecting data method, and population are more significant than this study.

Our findings showed that low weight gain during pregnancy increased the risk of low-birth-weight babies (Table 2). The Odds Ratio (OR) was 5.318 (95% CI 2,122-13,326), indicating mothers with less weight gain were 5.3 times at the risk of delivering LBW babies. Monitoring the maternal nutritional status is essential from the beginning of pregnancy. Mothers with a low nutritional status in early pregnancy are at risk of giving birth to small babies. Moreover, when it continues until delivery, which indicates by weight gain of fewer than 9 kilograms, the mother is more at risk of giving birth to an LBW baby (Yongky *et al*., 2009; Ayensu and Reginald Adjetey Annan, 2016).

## CONCLUSION

In conclusion, maternal weight gain during pregnancy is a risk factor for LBW in Wonosamodro Subdistrict, Boyolali District, while pre-pregnancy BMI is not. Further research should use the primary data collection method, a cohort design, a more significant number of samples, and random sampling and examine other variables. Health workers, especially midwives, could use this study's results as information to prevent LBW incidence. Midwives should improve midwifery care for pregnant women, especially those related to nutrition for pregnant women, such as providing counseling on pre-conception nutrition, nutrition for pregnant women, nutritional intake, and supplements for pregnant women. Furthermore, it can be a recommendation for health program planning and implementation, especially for women of childbearing age and pregnant women, to reduce the incidence of LBW.


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