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# Micronutrient intake and fundal height determine birth weight

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**ABSTRACT**

The birth weight (BW) is utilized as indicators of the healthy and term newborns. Factor that affects the weight of a newborn are micronutrient intake and fundal height. Folic acid and iron (Fe) were associated with newborn birth weight. Fundal height in centimeters (cm) is the same as the gestational age of the week, the fundal height that is not in accordance with the gestational age is leading to stunted fetal growth. The purpose of this study was to analyze the relationship between intake of folic acid, iron (Fe) and fundal height with newborn birth weight. This research method was an analytic observational using a Cross-sectional approach. The sample in this study was 114 pregnant women living in Yogyakarta. Statistical test results proved a significant relationship between the intake of folic acid ($p=0.030$) and iron ($p=0.003$) with the newborn birth weight. There was a significant relationship between the fundal height with the newborn birth weight ($p<0.001$). The concludes of this study, pregnant women with adequate folic acid intake, adequate iron intake and normal fundal height tended to give birth newborns with normal birth weight.



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## 1. INTRODUCTION

Birth weight (BW) is one indicator of mature healthy newborns. Newborns are newborn babies up to the age of four weeks. Also stated that newborns are organisms in the period of intrauterine life adaptation to extrauterine life with normal growth and development of the neonatal period is 28 days. In general, normal birth weight is 2,500 - 4,000 grams, below or less than 2,500 grams is said to be low birth weight (LBW). Low birth weight (LBW) is considered an indicator of public health status, which is related to mortality, infant illness, and the incidence of malnutrition at a later date in the toddler period [1]. According to the 2012 Indonesia Demographic and Health Survey, the Infant Mortality Rate (IMR) of 34 deaths/1,000 live births. From the results of Basic Health Research, the causes of infant mortality were sepsis 20.5%, congenital abnormalities 18.1%, pneumonia 15.4%, prematurity, and low birth weight (LBW) 12.8%, and respiratory disorder 12.8%. Low birth weight (LBW) is a direct cause of infant mortality [2].

Nutritional problems are still a major public health problem in developing countries including Indonesia. Nutritional problems indirectly cause maternal and child death, which can still be prevented. Low nutritional intake and nutritional status of pregnant women during pregnancy can result in various effects not good for the mother and baby. One of them is a baby born with low birth weight (LBW), which is birth weight below 2,500 grams. Babies born to low birth weight (LBW) have a chance of dying 35 times higher than the birth weight above 2,500 grams. Due to malnutrition begins with a slowing or retardation of fetal growth known as the Intra Uterine Growth Retardation (IUGR). In developing countries malnutrition in

pre-pregnancy and pregnant women affects the birth of intra uterine growth retardation (IUGR) and low birth weight (LBW). The condition of intra uterine growth retardation (IUGR) is almost half related to maternal nutritional status and hypertension in pregnancy [3].

Fetal growth depends on several genetic factors and environmental exposure from the mother. Factors before and during pregnancy that affect the success of pregnancy are the nutritional status of pregnant women. Adequate nutritional intake helps the growth of the mother and fetus. Maternal nutritional needs during pregnancy are influenced by the amount of macronutrient and micronutrient intake. There are several micronutrients that are related to the baby's birth weight such as folic acid and iron (Fe). Folic acid requirements for pregnant women are 600 mg every day. Consumption of folic acid is useful to prevent the occurrence of congenital defects in the fetus. During pregnancy, the need for folic acid increases due to bolus, fetal growth, and development. For this reason, Pregnant women with folate deficiency are at increased risk for various reproductive failures, including congenital defects and malformations [4, 5].

Another problem that often occurs during pregnancy is a decrease in hemoglobin levels due to an increase in plasma volume more than the volume of red blood cells. This decrease occurs at 8 to 32 weeks' gestation. Anemia can cause the transport of oxygen to be disrupted so that nutrients to the fetus are reduced. Anemia in pregnant women can occur due to lack of some micronutrients, one of which is iron (Fe). During pregnancy, an indication of anemia is if the hemoglobin concentration is less than 10.5 to 11.00 g/dl. The causes of anemia, in general, are lack of nutrition, iron deficiency, blood loss during past deliveries, and chronic diseases [6].

Fundal height measurement above the symphysis can provide useful information about the size of the baby in the womb. At the age between 20-21 weeks of pregnancy, the fundal height in *centimeters* (cm) is the same as the gestational age in weeks. The fundal height that is not suitable for gestational age is very leading to a condition of stunted fetal growth [7]. Appropriate fundal height measurements are carried out more objectively with a *centimeter* (cm) scale. Fundal height is related to the baby's body weight and reflects fetal growth and fetal size more accurately. There are several formulas to determine the estimated birth weight of babies including Johnson Toshack's formula, Dare's, simple method, Niswande, and others. Johnson Tohsach's formula uses a method to estimate fetal weight by fundal height measurement, which measures the distance between the upper edge of the symphysis pubis to the top of the uterine fundus by following the uterine arch, using a measuring tape and performing *vaginal toucher* (VT) to find the lowest decrease [8]. Fundal height and nutritional intake of pregnant women affect the birth weight and are closely related to the level of infant health and infant mortality.

Based on existing research, most of them only examined internal factors that focused on maternal age, parity, and macronutrient intake. There are still other internal factors that can affect the birth weight (BW) which are often overlooked, namely micronutrient intake, one of which is folic acid and iron, and fundal height in pregnant women. The purpose of this study was to determine the relationship of micronutrient intake (folic acid and iron) and fundal height with the weight of babies born.

## 2. RESEARCH METHOD

The method used in this study is analytic observational using a Cross-sectional study approach. The study was conducted for 2 months, starting from July to August 2018 in the Specialty Hospital Mother and Child in Yogyakarta City. The study population was pregnant women aged between 20-35 years as many as 141 pregnant women. The sampling method uses purposive sampling technique by selecting subjects based on specific criteria set by the researcher. Inclusion criteria include:Pregnant women who are willing to participate in the study, pregnant women entering the Estimated Day of Birth (±1 Week ), the age of the mother 20-35 years, the height of the mother>150 cm. Exclusion criteria include: the existence of multiple pregnancies, the presence of pregnancy co morbidities (diabetes mellitus, hypertension).

The data collected included: characteristics of the sample in the form of gestational age, maternal education, maternal work, family income with interviews using questionnaires. Intake of folic acid and iron (Fe) by using food recall (included supplementation of folic acid and iron), fundal height and birth weight were measured by experts. Folic acid and iron intake refers to the nutritional adequacy rate of third-trimester pregnant women. Fundal height is classified according to International Standard Reference (Intergrowth, 2016) and birth weight is classified based on the classification of the Ministry of Health RI (Normal=≥2500, Low=<2500) [9]. The data was then analyzed in stages, namely: univariate and bivariate analysis. The bivariate analysis used Fisher's exact test with p-value<0.05. Fundal height based on gestational age shown in Table 1.

Table 1. Fundal height based on gestational age

| Gestational Age (weeks) | Fundal Height (cm) |
|---|---|
| 33 | 29 |
| 34 | 29.5 |
| 35 | 30.5 |
| 36 | 31.5 |
| 37 | 32 |
| 38 | 33 |
| 39 | 33.5 |
| 40 | 34 |

Source: Intergrowth, 2016

## 3. RESULTS AND ANALYSIS

### 3.1. Subject characteristics

Subject characteristics shown in Table 2. This study included pregnant women aged between 20-35 years, who entered±1 week of the estimated day of birth. The gestational age of the study subjects was between 34-40 weeks, with the highest percentage at 38 weeks at 37.7%. Subjects in the study who had a higher education background were 112 (98.2%) and 2 (1.8%) had a low educational background. 88 (77.2%) subjects had jobs and 26 (22.8%) did not work. The average family income in this study was 108 (94.7%) had income≥Regional Minimum Wage (RMW) and 6 (5.3%)<Regional Minimum Wage (RMW).

Table 2. Subject characteristics

| Characteristics | Subject (n=114) | |
|---|---|---|
| | n | % |
| Gestational Age (weeks) | | |
| 34 | 2 | 1.8 |
| 36 | 5 | 4.4 |
| 37 | 4 | 3.5 |
| 38 | 43 | 37.7 |
| 39 | 35 | 30.7 |
| 40 | 25 | 21.9 |
| Maternal Education | | |
| High (High school/College) | 112 | 98.2 |
| Low (Do not pass elementary school/Elementary/Junior high school) | 2 | 1.8 |
| Maternal Work | | |
| Working | 88 | 77.2 |
| Not Working | 26 | 22.8 |
| Family Income | | |
| High (≥RMW ) | 108 | 94.7 |
| Low (<RMW) | 6 | 5.3 |
| Fundal Height | | |
| Normal | 96 | 84.2 |
| Abnormal | 18 | 15.8 |
| Birth Weight | | |
| Normal (≥2.500 gram) | 102 | 89.5 |
| Low (<2.500 gram) | 12 | 10.5 |
| Folic Acid Intake | | |
| Good | 72 | 63.2 |
| Poor | 42 | 36.8 |
| Iron (Fe) Intake | | |
| Good | 102 | 89.5 |
| Poor | 12 | 10.5 |

Source: Primary Data, 2018

Subjects in this study had a normal fundal height of 96 (84.2%) and abnormal fundal height of 18 (15.8%). The weight of babies born in this study, 102 (89.5%) had normal birth weight and 12 (10.5%) had low birth weight. Folic acid intake in 72 (63.2%) subjects was classified as sufficient and 42 (36.8%) were classified as lacking. Iron intake (Fe) in 102 (89.5%) subjects was sufficient and 12 (10.5%) subjects were classified as poor.

### 3.2. Bivariate Result

Bivariate result of folic acid, iron (Fe) and fundal height with birth weight shown in Table 3 as a result of this study, 68 (94.4%) subjects had sufficient folic acid intake, 95 (93.1%) had sufficient iron intake which gave birth to babies with normal birth weight. However, there were still 8 (19%) subjects who

had less folic acid intake and 5 (41.7%) less iron intake who gave birth to babies with low birth weight. Statistical test results prove that there is a significant relationship between folic acid and iron intake with birth weight (p<0.05).

Table 3. Bivariate result of folic acid, iron (Fe) and fundal height with birth weight

| Variable | | Birth Weight | | p |
|---|---|---|---|---|
| | | Normal | Low | |
| Folic Acid | Good | 68<br>94.4 % | 4<br>5.6 % | 0.030 |
| | Poor | 34<br>81.0 % | 8<br>19.0 % | |
| Iron (fe) | Good | 95<br>93.1 % | 7<br>6.9 % | 0.003 |
| | Poor | 7<br>58.3 % | 5<br>41.7 % | |
| Fundal Height | Normal | 94<br>97.9 % | 2<br>2.1% | <0.001 |
| | Abnormal | 8<br>44.4 % | 10<br>55.6 % | |

**Significant* p < 0.05

At fundal height, 94 (97.9%) of subjects had normal fundal height with the weight of babies born normally. However, 10 (55.6%) of subjects have abnormal fundal height and gave birth with low birth weight (LBW). Statistical test results prove that there is a significant relationship between the fundal height and the birth weight (p<0.001).

### 3.3. Discussions

Micronutrient intake (folic acid and iron) of pregnant women in this study showed that there was still a lack of micronutrient intake of pregnant women in the city of Yogyakarta. Such nutritional intake conditions can interfere with fetal growth and development. Poor nutritional intake can be a factor in the occurrence of low birth weight (LBW) in this region. The results of the study illustrate that pregnant women who have an adequate intake of folic acid and iron can give birth to babies with normal birth weight. Some studies found no relation between mean birth weight of infants and maternal energy and protein intake but instead demonstrated a stronger relationship with dietary intake of micronutrient rich foods or low positive correlation between the mean dietary iron, folic acid, carotene and vitamin B12 intake [10].

The results of this study are in line with Yusmardi's research, which states that in mothers who get enough folic acid supplementation will produce an increase in body weight and appearance scores, pulse, graphs, activity, respiration. In addition, it will reduce the incidence of mental retardation and maternal infection, on the contrary in mothers with blood folate levels of less than 240 µg/dl the risk of giving birth to low birth weight (LBW) and premature baby's increases by more than 200 percent [11]. A study conducted by Czeizel et al. In 2010 showed that there was a slight increase in the average baby's body weight at birth after administration of high doses of folic acid during pregnancy [12].

Folate required for growth reaches the maximal level in the last trimester, because of rapid growth of the fetus and the uteroplacental system and fetal accumulation of folate stores. Without sufficient folate intake, maternal plasma and Red Blood Cells (RBCs) folate decreases from the fifth month of pregnancy until several weeks after delivery [13]. A recent prospective study has also shown that low folate intake (<187 µg/day) and low RBC folate status in the late pregnancy increase the risk of small for gestational age (SGA) birth in an adolescent population. Other studies reported positive association between birth weight and maternal folate status [14].

Folic acid is a vitamin that needs twice as much for the mother and fetus. Many women in developing and developed countries have a lack of folic acid because the content of folic acid in their daily diet is not fulfilled. The fulfillment of folic acid needs varies for each person. During pregnancy, the need for folic acid will increase. Not only is it important for mothers who are pregnant, but it is also important for the growth and development of the fetus being conceived. In pregnant women, folic acid plays an important role in the formation of one-third of red blood cells. Folic acid functions as a coenzyme in reactions in the metabolism of nucleic and amino acids; therefore, in periods of enhanced anabolic activity, such as the one that occurs during pregnancy and lactation, folate requirements are increased. Less than optimal folate status has been associated with many negative reproductive outcomes such as an increased risk of neural tube defects, anemia in pregnancy, and low infant birth weight [15]. That is why pregnant women who experience folic acid deficiency generally also experience anemia, therefore folic acid is consumed from the beginning

of pregnancy until as much as 400µg / day during pregnancy. Anemia in pregnancy is caused because one of them is a lack of folic acid, with all the consequences, looks pale and easily tired, lethargic and Anemia in pregnant women will increase the risk of the mother to give birth to low birth weight (LBW) and the risk of bleeding at the time of delivery, even causing the death of the mother and her baby [16].

Anemia of pregnant women can result in reduced oxygen supply to the tissues and will interfere with fetal growth, so that it will strengthen the risk of premature labor and low birth weight babies. In addition, it was also strengthened by the results of other studies which explained that anemia in the third trimester of pregnancy had a 16 times greater risk of delivering low birth weight (LBW) [17]. Anemia of pregnant women is a risk factor for the incidence of severe infant birth. The link between hemoglobin (Hb) levels or anemia status of pregnant women with birth weight is due to anemia in pregnant women will cause nutritional disorders and oxygenation of utero placenta which results in the impaired growth of conception results, so that growth and development of the fetus is inhibited and fetuses born with low body weight [18].

The results of this study are also in line with previous studies that the intake of iron (Fe) in pregnant women affects the size of babies born both weight and length of babies born [19-20]. In Anand's study, conducted a systematic review and meta-analysis of several observational epidemiological studies to ensure an association between anemia in pregnancies with birth weight babies showed that from 17 studies found the incidence of anemia during pregnancy can cause mothers to give birth to low birth weight (LBW) twice as large compared with mothers who did not experience anemia during pregnancy [21]. Santha's research found that pregnant women with hemoglobin (Hb) levels<11 g/dl had a four times greater risk of giving birth to babies with Low Birth Weight (LBW) [22].

A few tested hypotheses showed that iron is necessary for hemoglobin synthesis and several other important functions in body. Iron deficiency can result not only in reduced oxygen carrying capacity due to lowered hemoglobin levels, but can also affect immunity and growth and of fetus [23]. Iron (Fe) requirements have increased for the formation of the placenta and red blood cells. Fulfillment of needs is obtained from both food and supplementation. Iron (Fe) requirements are higher than the average intake absorbed by the body. Iron (Fe) absorption depends on the source of food consumed. Rolfes's research found that 10.5% of pregnant women had less iron (Fe) intake, so two low birth weight (LBW) babies from pregnant women who lacked iron intake were born. There are still pregnant women who do not routinely consume Fe tablets and are often consumed along with drinking tea and milk. Tea contains tannin and milk containing calcium, can inhibit iron absorption [24].

Anemia in pregnancy is also affected by poverty, where nutritional intake is very poor, and can be caused by gender inequality, as well as ignorance about the right diet. Pregnant women need a lot of nutrients to meet the body's needs for themselves and their fetuses. For pregnant women, anemia contributes to an increase in the prevalence of maternal death and pain. For babies, it can increase the risk of infant morbidity and mortality, and low birth weight LBW [25].

There are several factors that influence the size of the baby at birth, including maternal nutritional intake during pregnancy and pregnancy diseases such as preeclampsia. There is a clear relationship between maternal nutritional intake in the last month of pregnancy and the size of the baby at birth. There is the worse the nutrition of the mother, the less birth weight and length of the baby. Micronutrient deficiency during pregnancy can cause the fetus to experience slower linear growth during the postnatal period [26]. Fetal growth is very dependent on the results of the body's metabolism transferred through the placenta to meet maternal needs during pregnancy and fetal nutrition to grow and develop so that babies born can be born normally [27].

Fundal height measurement above the pubic symphysis is used as an indicator to determine the progress of fetal growth, as well as predictions of gestational age. A stable (fixed) or decreased fundal height is an indication of fetal growth retardation. If the fundal height increases excessively identify more than one fetal number or possible hydramnios, one of the factors influencing fundal height measurement. Another theory states that the fundal height has a strong relationship with the baby's weight and is able to reflect fetal growth and fetal size [28-29].

The results of this study indicate that there is a fundal height relationship to the weight of newborns ($p<0.001$). The results of this study are similar to the Iranian study by Tabrizi, that there is a significant relationship between fundal height and the birth weight (0.001). Maryani's research found that there was a difference in the fundal height average of mothers with low birth weight [30-31].

Conceptually, fundal height increases according to gestational age and is directly proportional to the weight gain of the baby in the womb. The greater the gestational age, the more fundal height and the greater the weight of the fetus in the womb, a pregnant mother has an increase in BB≥8 kg at the end of pregnancy and fundal height rises 1-2 cm every month, so it can be assumed that the fetus in the increase in BB content is good [32].

Enaohwo study showed that prediction of low birth weight with fundal height had a low sensitivity but a high specificity, PPV and NPV. However, this is at variance with other studies that showed a high sensitivity for prediction of low birth weight [33]. This difference may also be due to differences in population, number of samples and duration of data collection. This showed that low birth weight infants can be predicted from fundal height and the sensitivity can be improved with larger sample sizes [34].

There are several other factors that affect the weight of a baby born, including maternal knowledge, environmental support and the number of maternal pregnancies. Lack of maternal knowledge about the danger signs of pregnancy, childbirth, and childbirth can cause mothers to be unable to identify visible signs so they cannot anticipate early [35]. Sumarni's research stated that there was a relationship between the knowledge of pregnant women about the danger signs of pregnancy, childbirth and postpartum on ANC behavior, meaning that the better the knowledge of pregnant women about the danger signs of pregnancy, childbirth and postpartum, the mother would be more willing to check her pregnancy regularly to health workers during the period of pregnancy. The knowledge possessed by the mother makes her want to know more about the condition of her pregnancy so that she visits ANC more often [36]. Fourianalistyawati's research states self-awareness and compassion around have a role to reduce depression in pregnant women. Depression experienced during pregnancy has an impact on labor, such as complications during childbirth, the appearance of symptoms during pregnancy and preterm birth [37].

The number of children born to mothers with multiparous or 3 to 6 people and grande multiparous (over 6 people), this condition can cause mothers to give birth to low birth weight babies. In Harini's study, most mothers who experienced preeclampsia were mothers who had previously given birth to either primipara or multipara [38]. This is consistent with studies that report that mothers who have given birth have a greater chance of developing preeclampsia. Preeclampsia is a health problem that affects infants including prematurity, low birth weight, inhibited fetal growth that contributes to the magnitude of perinatal morbidity and mortality [39].

## 4. CONCLUSION

Statistical test results prove that there is a significant relationship between the intake of folic acid ($p=0.030$), iron ($p=0.003$) and fundal height ($p<0.001$) with birth weight. Pregnant women with an adequate intake of folic acid, adequate intake of iron, and normal fundus tend to give birth to babies with normal birth weight. It is expected that health workers should provide health services for pregnant women since early to prevent the occurrence of low birth weight babies (LBW) accurately and conduct accurate anthrax measurements to monitor nutritional status. In addition, the family provides motivation for pregnant women to carry out regular prenatal care at least 4 times during pregnancy to the nearest service place and motivate them to consume nutritious and varied foods so that nutritional intake can be fulfilled properly.

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