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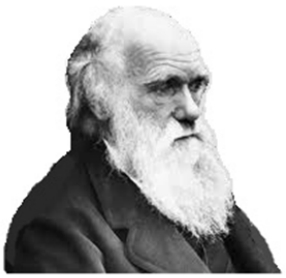

World News of Natural Sciences

An International Scientific Journal

WNOFNS 22 (2019) 159-167 EISSN 2543-5426

# Pre-pregnancy weight as a dominant factor of Infant birth length

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**ABSTRACT**

Birth length is one of a factor of stunting in toddler. Maternal nutritional status have an association with growth and development of fetus which is represented by birth size. The objective of this research is to find the association of maternal anthropometry; as a representation of maternal nutritional status before and during pregnancy; with birth length in Kabupaten Garut, West Java, Indonesia. This descriptive analytic research was done by cross sectional design, using independent t-test and multiple linear regression as statistical analysis. Results showed that mean birth length is 48.72 ±1.39 cm. There is significant association between maternal pre-pregnancy weight and infant sex with birth length ($p<0.05$). Pre-pregnancy weight is a dominant factor of birth length ($p<0.001$). This result showed that maternal pre-pregnancy nutritional status is very important for fetal growth. Nutrition and health programs and education is needed, not only during pregnancy, but also before pregnancy; with teenager and women in reproductive age as main a target.

***Keywords*:** Birth length, maternal nutritional status, pre-pregnancy weight, gestational weight gain, stunting

## 1. INTRODUCTION

Stunting is the highest nutritional problem in the world. In developing countries, more than one third (37%) of children under 5 years experience stunting and causes 14% of mortality

( Received 15 December 2018; Accepted 31 December 2018; Date of Publication 01 January 2019)

in children. In addition to increasing the risk of mortality, stunting also adversely affects cognitive and motoric development, decreases learning ability, increases the risk of obesity and non-communicable diseases, and reduces productivity in adulthood. This accumulative effect eroded costs by 11% of national income in Asian and African countries[1,2].

The birth size is one of the risk factors for stunting in infants. Infants born with small sizes indicate the growth and development of the fetus is not optimal. Study shows that Small for Gestational Age (SGA) contribute to 20% of stunting cases worldwide. Aside from being a representation of fetal health status, the birth size is also an important predictor of infants growth and development. Small births are associated with an increased risk of child mortality and morbidity[1,3]. In time of adulthood, infants born with small sizes are more risk for having non-communicable diseases[4]. Therefore, observation of the birth size is important thing.

Maternal nutritional status before and during pregnancy plays an important role in fetal growth and development. Study in Vietnam shows that mothers who experience malnutrition before and during pregnancy have a high risk for small for Gestational Age (SGA)[5]. In addition, children born of mathers who experience malnutrition have more risk of stunting when they are 2 years old[3].

During pregnancy extra energy is needed for growth and development of the fetus, placenta and various maternal tissues, such as the uterus, breast and fat store. The ideal condition for a woman is to enter pregnancy with a normal weight and good nutritional status. Pre-pregnancy weight is a strong predictor for low birth weight babies (LBW). The main determinants for LBW in low and middle income countries are poor maternal nutritional status (low body mass index) at conception, inadequate weight gain during pregnancy due to lack of food intake, and short maternal stature due to malnutrition in childhood[6].

Availability and supply of nutrients for a developing fetus depends on the maternal nutritional status. Some studies show that the importance of nutrition during pregnancy, especially in the second and / or third trimester where organogenesis occurs. Various nutrients play a role during pregnancy and affect the metabolism of the maternal and fetus through their role in modulating oxidative stress, enzyme function, signal transduction and transcription pathways that occur during the critical period of preconception, conception, implantation, placentation and embryo/organogenesis.

Nutrients such as vitamin A, B-6, B-12, folic acid and zinc affect embryogenesis that occurs early in pregnancy. These nutrients are also involved in the process of methylation which in turn affects cell replication and differentiation. Vitamins C, E, B-6, B-12 and folic acid can reduce oxidative stress in the placenta, while iron, zinc, iodine and long chain n-3 polyunsaturated fatty acids (LCPUFA) have important roles in brain development and nervous system[7].

Several observational studies have examined the relationship between maternal nutritional status based on anthropometric measurements such as body weight and height and use of vitamin supplements during the periconseption period with birth size. Studies shows that there is a close relationship between maternal body mass index before pregnancy and infant birth weight. In addition, it was also found that maternal iron status before pregnancy, especially iron deficiency anemia, was associated with low birth weight[3,7] Anthropometric measurement is one way to determine the nutritional status of pregnant women.

The maternal anthropometric characteristics before and during pregnancy have been shown to be related to fetal growth and development[5,8].

## 2. THE OBJECTIVE OF THE STUDY

The study aims to determine the relationship between maternal anthropometric characteristics before and during pregnancy with the birth length.

## 3. MATERIAL AND METHODS

This is a cross-sectional descriptive analytic study with a quantitative approach to determine the relationship between maternal anthropometric size before and during pregnancy with the birth length. The study population was all pregnant and maternal childbirth in Kabupaten Garut, West Java, Indonesia. The subject of the study is all pregnant and maternal childbirth who examined themselves at one of the health centers in Tarogong area of Kabupaten Garut in 2011-2012. The data used are secondary data obtained from the data of pregnant women who examined themselves and gave birth at the public health services in Tarogong area, Kabupaten Garut, in 2011-2012.

The method used is the total sampling method, all data from the maternal childbirth in 2011-2012 were collected and then selected based on inclusion and exclusion criteria. Data taken for analysis come from mothers' cards who had checked themselves from the first trimester to the final trimester, were over 18 years of age, gave birth to a single, normal, and pregnancy age at delivery ≥37 weeks. Womens with a history of chronic diseases and infants with morphological abnormalities was excluded from this study.

Variables observed included maternal anthropometry (pre-pregnancy weight, maternal height, gestational weight gain) and infants characteristics (birth length and sex). Measurement of maternal weight and height was carried out by a trained midwife at Puskesmas when the mother first examined her pregnancy. Pre-pregnancy weight was obtained based on measurements of maternal weight at <13 weeks' gestation. Gestational weight gain was calculated based on the last weight before give birth (3rd trimester) minus pre-pregnancy weight. The measurement of the birth length is done shortly after the baby is born.

Univariate analysis is by looking at the frequency distribution and population average value for each variable. Bivariate analysis between maternal anthropometry and the infant sex with birth length was carried out using an independent t-test. Multiple linear regression will be used to perform multivariate analysis for variables with independent t-test results <0.25.

## 4. RESULTS

The final sample obtained was 375 data of maternal and their infants. The majority of maternal height were ≥150 cm (88.8%), gestational weight gain ≥9 kg (72.35%), and slightly more than half had pre-pregnancy weight ≥50 kg (57.3%). The average birth length of infant was 48.72 cm and half sample were male (53.6%) (Table 1).

The results of mean birth length based on variables observed showed that infants born from mothers with pre-pregnancy weight of ≥50 kg had higher birth length compared with infants born from mothers with pre-pregnancy weight <50 kg. Mothers with height <150 cm gave birth to infants shorter than infants from mothers with height ≥150cm. Based on gestational weight gain, infants birth length from mother with weight gain ≥9 kg higher than

infant birth length from mother with gestational weight gain <9 kg. Based on the infant characteristic, the birth length of the male infant was higher than female (Figure 1).

**Table 1.** Maternal and infants characteristics

| Variable | Label | n/ Mean ±SD | % |
|---|---|---|---|
| Birth length (cm) | | 48.72±1.39 | |
| Pre-pregnancy weight | < 50 kg | 160 | 42.7 |
| | ≥ 50 kg | 215 | 57.3 |
| Maternal height | < 150 cm | 42 | 11.2 |
| | ≥ 150 cm | 333 | 88.8 |
| Gestational weight gain | < 9 kg | 104 | 27.7 |
| | ≥ 9 kg | 271 | 72.3 |
| Infant sex | Female | 174 | 46.4 |
| | Male | 201 | 53.6 |

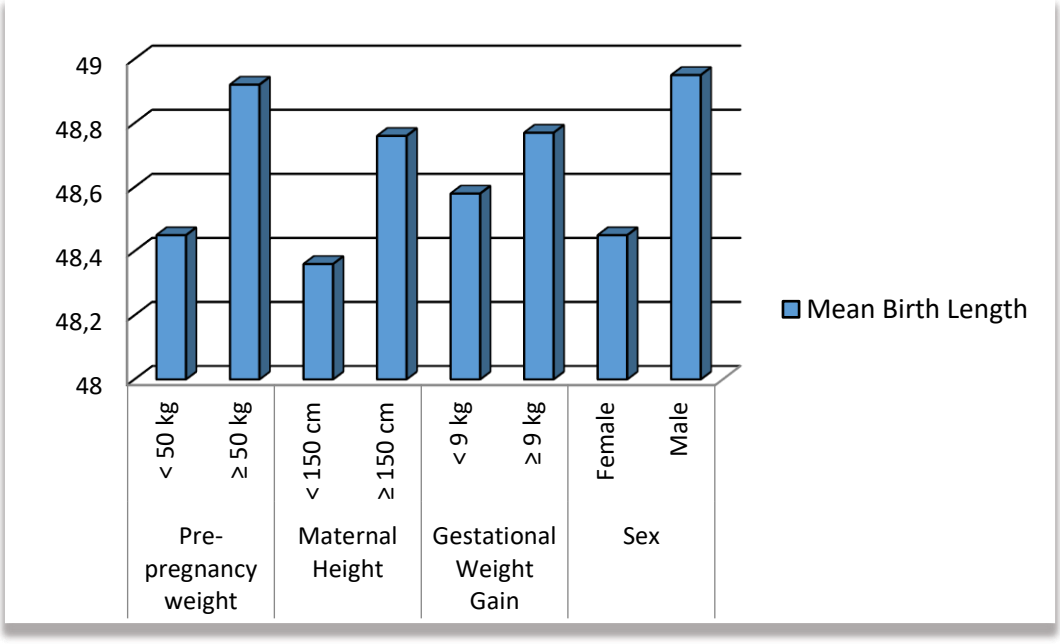


**Figure 1.** Mean birth length based on variables observed

From bivariate analysis we found that infants born from mothers with pre-pregnancy weight of ≥50 kg significantly had higher birth length (0.47 cm) compared with infants born from mothers with pre-pregnancy weight <50 kg (p = 0.001). Mothers with height <150 cm gave birth to infants who tended to be 0.4 cm shorter than infants from mothers with height ≥150 cm (p = 0.074). Based on weight gain experienced during pregnancy, birth length from mother with gestational weight gain ≥9 kg tends to 0.19 cm higher than birth length from mother with gestational weight gain <9 kg (p = 0.225). Based on the infant characteristic, the birth length of the male infant was 0.5 cm higher than female (p = 0.01) (Table 2).

**Table 2.** Analysis between maternal anthropometry characteristics and the infant's sex with birth length

| Variable | Label | Birth Length | | N | *P*-value |
|---|---|---|---|---|---|
| | | X | SD | | |
| Pre-pregnancy weight | < 50 kg | 48.45 | 1.39 | 160 | 0.001* |
| | ≥ 50 kg | 48.92 | 1.36 | 215 | |
| Maternal height | < 150 cm | 48.36 | 1.48 | 42 | 0.074 |
| | ≥ 150 cm | 48.76 | 1.37 | 333 | |
| Gestational weight gain | < 9 kg | 48.58 | 1.35 | 104 | 0.225 |
| | ≥ 9 kg | 48.77 | 1.40 | 271 | |
| Infant sex | Female | 48.45 | 1.39 | 174 | 0.001* |
| | Male | 48.95 | 1.35 | 201 | |

All of maternal and infants characteristic were included in multivariate analysis. However, maternal height and gestational weight gain showed no significant differences in determining birth length. The final results of multivariate analysis showed that only maternal pre-pregnancy weight and infant sex were related to infant birth length (p = 0.001).

**Table 3.** Multivariate analysis

| Variable | B | β | Sig. |
|---|---|---|---|
| Pre-pregnancy weight | 0.504 | 0.180 | 0.001 |
| Gestational weight gain | 0.307 | 0.099 | 0.055 |
| Infant's sex | 0.460 | 0.165 | 0.001 |

In multivariable model, standardized coefficients (β) explain variation of birth length. Table 3 showed that pre-pregnancy weight explains as much as 18% of variation in birth length (p = 0.001) and infants sex explains 16.5% of the variation in birth length (p = 0.001). Among the variables analyzed, the pre-pregnancy weight was the most dominant factor for infant's birth length.

## 5. DISCUSSION

Birth size is a representation of fetus growth and development rate. Maternal nutritional status is one of the most important factor that can influence infant's birth size and it can be assessed by anthropometric indicator. Previous studies cite that several maternal anthropometric are have an association with birth length: pre-pregnancy weight, height, and gestational weight gain. Infant's gestational age and gender are also factors that can influence birth length. To investigate association between maternal anthropometric and infant's birth length, we only obtained a single birth, full term (>37 weeks) infants from mother without chronically illness history to eliminate confounding effects of multiple birth, short gestational period, and maternal health status during pregnancy.

The average birth length of infants in this study was 48.72 cm. This average is lower than results of research in Vietnam which has an average birth length of 49.0 cm[5], as same as Benin (48.7 cm)[9], and higher than study in India (45.8 cm)[10]. The difference birth length can be caused by various factors, including maternal nutritional status which can be observed through anthropometric characteristics.

Pre-pregnancy weight were obtained before pregnancy or when pregnancy is under 12 weeks. It is representative enough to see pre pregnancy weight because majority of women doesn't have a significant weight gain in this period. Maternal weight before pregnancy greatly affects birth size because it is related to the nutrient reserves that will be given to the fetus in the early days of pregnancy. Fulfillment of nutrition in the early stages of pregnancy is very important because at this period there is a cell hyperplasia process and a critical period of rapid growth which is will not be repeated in the next trimester. But, nutritional needs at this time often cannot be fulfilled through adequate weight gain due to morning sickness or unaware of the pregnancy status[7]. This study proves there is a relationship between maternal weight before pregnancy and infant's birth length. These results are in line with the study in Jamaica which showed that the weight of a woman before pregnancy had a significant relationship with fetal growth and infant's birth length[4].

In contrast to pre-pregnancy weight, the relationship between maternal height and birth length was not significant. This is in line with study conducted in Iran which showed no significant correlation between maternal height and birth length[12], but it different with study in Benin, West Africa, which shows a significant correlation between maternal height and birth length[9]. This correlation is an implication of genetic factors, where maternal height is thought to help determine bone mass which will affect the size of the infant's bones[13]. The difference in these results can be caused by the influence of other factors, including the maternal intake factor. An adequate and high-quality diet is the main determinant of a nutritional status of women during conception. Systematic review of 45 articles show that supplement intake of vitamins and minerals can reduce the risk of preterm birth and SGA.

Besides availability quality of food, there is 2 other factors indirectly affect maternal nutritional status. Those factors are the age of the woman and the length of time between pregnancies. Young woman (≤14 years) are 82% more likely to have LBW babies than the older woman. Low maternal age also increases the risk of premature births (<37 weeks' gestation)[11]. In addition, differences in results of this research can be caused by the homogenity of maternal height in this study so that maternal body weight becomes the most decisive factor for infant's birth length.

Similar to maternal height, this study shows that gestational weight gain did not have a significant relationship with infant's birth length. This results are different from the results of a study in Vietnam that showed that weight gain during pregnancy is closely related to fetal growth and infant birth size. This difference can be caused by the difference method in calculating maternal weight gain. This study calculated weight gain totally from the first trimester to the last trimester, not per trimester. The method really can give an impact because fetus has a different growth pattern every trimester so that the pattern of weight gain per trimester can represent infant's growth and development. It proved in the same study in Vietnam that maternal weight gain at <20 weeks' gestation was strongly associated with fetal size and birth size when compared with maternal weight gain at 21-29 weeks of gestation[14].

A study in America found that women with normal weight who had inadequate gestational weight gain were associated with a threefold increase in risk for delivery SGA infants and twice the risk of preterm birth compared with women who experience adequate weight gain. Similarly, obese women who get inadequate gestational weight gain, it is almost tripled the risk for giving SGA infants suggesting that obese women must also meet minimum weight requirements to prevent having SGA infants. The standard used for gestational weight gain in this study adapted from Institute of Medicine where woman with normal weight are recommended for have total gestational weight gain in range 11.3-15.9 kg and for obese women 5-9 kg[15].

In addition to maternal characteristics, fetal characteristics can also affect infant's birth length independently. This study found that male infant have a higher birth length than female. Gender influences baby's size through its relation to hormone function. Human placenta produces Insulin-like growth factor IGF-1 and IGF-2 which can act as growth regulators where IGF-2 is more expressed. The mechanisms that contribute to differences in growth between male and female fetuses are still unclear, but the influence of sex in the regulation of growth by the IGF pathway may be involved. One study found that growth hormone concentrations were higher in men than in women[16]. This result also in line with research in Spain which showed that male infant were significantly 0.87 cm longer than female[17].

## 6. CONCLUSIONS

The average birth length in this study is 48.72 cm. Pre-pregnancy weight is the most associated factor of infant's birth length. Therefore, it means that pregnancy is a process that must be prepared early. Nutritional status and health of women in childbearing age must be made as a first priority to be watched and protected; given the magnitude of the influence of it on fetus's growth and development. For this reason, efforts such as the provision of iron tablets, nutrition and health education, and reproductive health checks must begin to focus on women

of childbearing age. Not only for pregnant women, but also for teenager and women who is planning to pregnant.

Gestational wight gain also needs special attention to the maternal and fetus healths. Weight gain must be adjusted to the maternal nutritional status before pregnancy so that fetal growth and development can be optimal and avoid complications that can be endanger the maternal and fetus healths. It is important to know the maternal nutritional status before pregnancy to recommend optimal gestational weight gain.

Further research with a prospective cohort method is needed to see directly the effect of nutritional status and maternal intake before and during pregnancy on fetal growth, infant birth size, and growth in infancy. Based on this thorough research, it is expected that there are more comprehensive conclusions to find a solution in accordance with the nutritional problems faced.

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