# MATERNAL SHORT STATURE AND NEONATAL STUNTING: AN INTER-GENERATIONAL CYCLE OF MALNUTRITION

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**Abstract**

Maternal body size before pregnancy as a predictor of pregnancy outcome has been investigated in several publications. Most of the stunted children were delivered by stunted mother. This research was aimed to analyze whether maternal body size before pregnancy has an important contribution to neonatal stunting. A prospective cohort study was conducted in Probolinggo Regency, East Java. A number of 420 women were enrolled in this study. Among those women, 194 women were pregnant and 107 newborns were completely observed. Maternal body size was measured before pregnancy including body weight, height, and Mid-*Upper Arm Circumference* (MUAC). Newborn's birth length was measured less than 24 hours after birth. Short stature is defined as an height less than 145 cm, low body weight is defined as a body weight less than 40 kg, neonatal stunting is defined as a birth length less than 48 cm. Result indicated that 12.9% of women had short stature (<145 cm), 16.2% had low body weight (< 40 kg), and 25% had MUAC of <23.5 cm. Data was statistically analyzed by using independent t test. Among the observed pregnant women (107 women), 16.8% had short stature and 19.6% had low body weight. Maternal short stature, but not maternal low body weight and chronic energy deficiency, was correlated with birth length (p= 0.03 and 0.119; 0.653 respectively). Mothers with short stature (height < 145 cm) had a propensity to deliver low birth length babies, but there was insignificant correlation between the birth length and the maternal body weight. The result indicated that a stunted mother would likely to bring forth a stunted baby which reflected the inter-generation malnutrition from mothers to their babies.

**Keywords: stunting, short stature, neonatal, maternal body size.**

**Presenting Author's Biography**

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## INTRODUCTION

Maternal and child undernutrition is one of global problems with various consequences of survival, incidence of acute and chronic diseases, healthy development, and economic productivity of individual and society [1]. However, the highly prevalence of the case in low-income and middle-income countries results in substantial increase of mortality and global burden of diseases. It is estimated that a number of 178 million children aged younger than 5 years old are stunted children and 90% of them live in 36 countries which make up 46% of children in those countries [2]. Recently, stunting phenomenon among under five years old children has gained the international attention for two reasons, *First*, it affects a large number of children globally and *Second*, it has severe short- and long-term health consequences [3]. Furthermore, WHO has determined six global targets to reduce the high burden of diseases associated with malnutrition with stunting as the first target. The target is to reduce the total number of stunted children under 5 years old by 40% by 2025 [4].

Stunting is define as having a height-for-age Z score less than -2, or two standard deviations below the age-sex median for a well-nourished reference population [5]. Stunting, as well as other anthropometric measurements, is one of important public health indicators. The Lancet series on maternal and child undernutrition promoted the use of stunting and wasting in assessing nutritional status, designing programs, and assessing impacts [2,6]. It also emphasized the long-term consequences of stunting for adult health and human capital [7].

The etiology of stunting is vast. Recognizing the causal factors in prenatal period including maternal height, weight gain, anemia and infection, as well as postnatal period such as infant and children's feeding and infections, becomes a vital. Stunting is perceived to be closely tied to poverty and access to health services [6]. Mother with low weight is associated with greater risk of stunting and wasting which highlights the role of maternal body composition on pregnancy outcomes. Mother's early age at first delivery also increases the risk of stunting [8].

Maternal stature (height) is an important determinant of intrauterine growth restriction and low birth weight, meanwhile, birth weight and intrauterine growth restriction are predictors of subsequent mortality and growth failure [2]. Maternal short stature, a proxy for generational influences, had an important relationship with child stunting [8]. Several studies revealed that maternal stature significantly affected the neonates' size and child stunting [9,10,11]. It is also evidence that it can predict the offspring outcomes before or immediately after birth. It is a simple, stable, and useful marker for assessing intergenerational linkages in health and malnutrition [12]. Regarding with this, this study was undertaken to analyze the association between maternal body size and neonatal stunting.

## METHODS

A prospective cohort was conducted in Probolinggo Regency, East Java, Indonesia, as a part of a study [13]. A cohort of 420 newly married women from 9 (nine) selected sub-districts were enrolled in this study. Among those women, 194 women were pregnant and 115 of them were intensively observed until the delivery. It was recorded that 4 (four) of them had miscarriage and 4 (four) women moved out from the study areas, which made up a final total of 107 pairs of maternal and neonatal data.

The examined variable was preconception body size which included body weight, height, body mass index, and mid upper arms circumference. The outcome variable was length of birth. Socio-economic characteristics such as age, education, and income, were obtained by carrying out an interview equipped with structured questionnaires. Body mass index (BMI) was expressed in weight (kg) and divided by the square of height (m). Body weight was measured by using digital body scale Seca® type 803, with an increment of 100 g. Height or stature was measured by using microtoise with 0.1 cm increment. Body weight was categorized in single cut of point < 40 kg as low body weight and height was classified in single cut of point < 145 cm as short stature. Mid-upper arm circumference (MUAC) was measured by using fiber tape (Unicef) with an increment of 0.1 cm. Data of MUAC was categorized as risk of chronic energy malnutrition if it was < 23.5 cm and normal if it was ≥ 23.5 cm. Length of birth was measured using recumbent length meter Seca® for newborn babies, with single cut off point < 48 cm as neonatal stunting.

Data was statistically analyzed by Man-Whitney test to detect the mean differentiation of length of birth between short stature mother and normal stature mother. The study protocol had been approved by Ethical Committee Faculty of Medicine Gadjah Mada University with register No. KE/FK/202/EC.

## RESULTS

Table 1 shows the characteristic of socio-economy and body size prior to pregnancy. In overall, the sample population was categorized as young women with average age of 21.8 ± 3.7 years with more than 40% of these women had low educational background. Percentage of underweight (23.4%) was greater compared to the percentage of overweight (10.3%) and obesity (2.7%).

**Table 1.** Characteristic of study sample (n=107).

| **Variables** | **n (%)** | **Mean ± SD** |
|---|---|---|
| Age (years) | | |
| < 20 | 36 (33.6%) | 21.8 ± 3.7 |
| 20 ≤ age < 25 | 51 (47.7%) | |
| > 25 | 20 (18.7%) | |
| Education background | | |
| Junior high school or less | 43 (40.1%) | - |
| High school | 45 (42.1%) | |
| College or above | 19 (17.8%) | |
| Income level (Rupiahs) | | |
| < 1000 000 | 59 (55.2%) | 723.648 ± 1.264.784 |
| 1000 000 – 2000 000 | 47 (43.9%) | |
| > 2000 000 | 1 (0.9%) | |

| | | |
|---|---|---|
| BMI | | |
| <18.5 (underweight) | 25 (23.4%) | |
| 18.5-25 (normal) | 68 (63.6%) | 20.9 ± 3.7 |
| > 25-30 (overweight) | 11 (10.3%) | |
| > 25 (obese) | 3 (2.7%) | |
| Body weight (kg) | | |
| < 40 | 21 (19.6%) | 47.1 ± 8.7 |
| ≥ 40 | 86 (80.4%) | |
| Stature (cm) | | |
| < 145 cm | 18 (16.8%) | 150.2 ± 5.7 |
| ≥ 145 cm | 89 (83.2%) | |
| MUAC (cm) | | |
| < 23.5 | 35 (32.7%) | 25.2 ± 3.6 |
| ≥ 23.5 | 72 (67.3%) | |

BMI = Body Mass Index
MUAC = Mid Upper Arms Circumference

The result of the study demonstrated the average value of BMI was 20.9 ± 3.7, body weight was 47.1 ± 8.7 kg, height was 150.2 ± 5.7 cm, and MUAC was 25.2 ± 3.6 cm. The majority of the subjects had normal BMI (63.6%), body weight ≥ 40 kg (80.4%), MUAC ≥ 23.5 cm (67.3%). Additionally, the proportion of the subjects who were underweight and having chronic energy deficiency (CED) were, respectively, 23.4% and 32.7%.

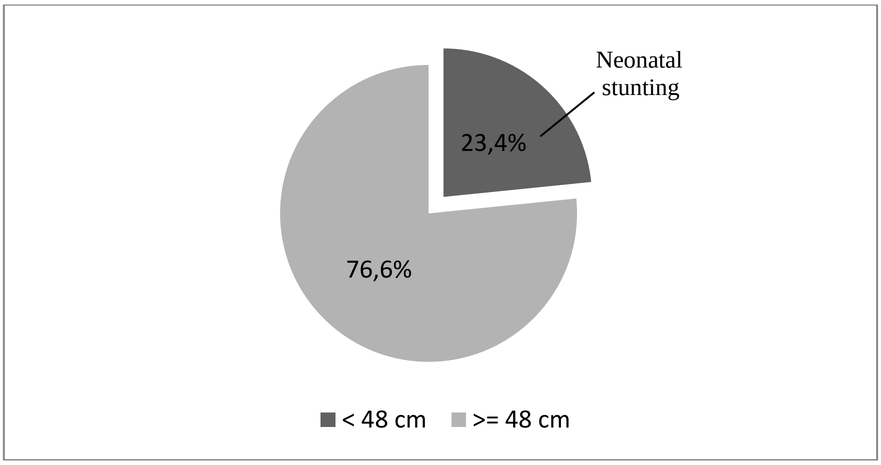


**Figure 1.** Percentage of neonatal stunting.

**Table 2.** The mean value of neonatal length birth with different parameters of maternal preconception body size.

| Maternal body size | Neonatal length birth (cm) | p |
|---|---|---|
| Height (cm) | | |
| < 145 | 47.7 ± 2.3 | 0.033* |
| ≥ 145 | 48.9 ± 2.2 | |
| Weight (kg) | | |
| < 40 | 48.1 ± 2.1 | 0,119 |
| ≥ 40 | 48.9 ± 2.3 | |
| MUAC (cm) | | |
| < 23.5 | 48.6 ± 2.1 | 0.653 |
| ≥ 23.5 | 48.8 ± 2.3 | |

* significant at $\alpha < 0.05$; $\alpha$=0.05).

Figure 1 depicts the percentage of neonatal stunting was 23.4%, meanwhile, the percentage of babies with normal length birth was 76.6%. Table 2 shows the comparison of babies' length at birth in different maternal body sizes prior to pregnancy. The data consisted of 107 pairs of maternal and neonatal data with complete observation. Women with short stature tended to deliver stunted babies compared with normal height women (p=0.033). The mean values of babies' birth length delivered by stunted mothers and normal size mother were, respectively, 47.7 cm and 48.9 cm. However, there was insignificant difference of birth length between babies delivered mothers with low body weight (body weight less than 40 kg) and mothers with body weight ≥40 kg. Additionally, there was insignificant difference of birth length between babies delivered by mothers with chronic energy deficiency (MUAC <23.5 cm) and mother with MUAC ≥23.5 cm (p=0.653). Independent t-test revealed a significant difference of mean birth length between babied delivered by women with short stature compare to those with normal stature, on the contrary, there was no correlation between women with body weight less than 40 kg and women with body weight ≥ 40 kg. Similarly, mid-upper arms circumference also has no effect on neonatal stunting (Table 2).

## DISCUSSION

Stunting indicates a failure to achieve one's genetic potential for height [7]. A child is considered 'stunted' if his or her height is more than two standard deviations below the World Health Organization standard [5]. The main causes of stunting include intrauterine growth restriction, inadequate nutrition to support the rapid growth and development of infants and young children, and frequent infections during early life [6]. Although a child may not be classified as 'stunted' until she/he reaches 2–3 years of age, the process of becoming stunted typically begins *in utero*. The result –a very short height– usually reflects the persistent and cumulative effects of poor nutrition and other deficits that often span across several generations [7].

Based on Table 2, it is clearly shown that women with short stature are more likely to deliver stunted babies compared to women with normal stature. The possibility to deliver stunted babies is also higher in women with body weight less than 40 kg prior to pregnancy. However, this phenomenon infrequently occurs among women with MUAC less than 23.5 cm. This evidence indicates that there is intergenerational linkage of linear growth between mothers and their babies. According to Ramakrishnan *et al.*, growth failure includes underweight, wasting, and stunting [9,10,12].

The intergenerational cycle of growth failure was firstly exposed in 1992 on the second report of the world nutrition situation. The intergenerational cycle of growth failure typically is found out in many developing countries where young women growing up in poverty become stunted women and are more likely to give birth to low birth weight babies. In the case the newborn is a girl, they are likely to continue the cycle by being stunted in adulthood [9]. Theoretically, maternal short stature are more likely to have low birth weight babies due to maternal size has an important influence on birth weight. Children born with low birth weight have a propensity to endure growth failure during childhood. Thus, girls born with low birth weight are more likely to become stunted adults. The cycle is accentuated by high rates of teenage pregnancy, as adolescent girls are even more likely to have low birth weight babies [12].

According to UNS/SCN (2013), growth failure is transmitted across generations through the mother. Because maternal size has a strong influence on birth weight, where teenage pregnancy rate is high especially among the upper class, the lost growth attributable to adolescent pregnancy must make an important contribution to the intergenerational cycle of growth failure and the perpetuation of maternal short stature. It surely represents an important window of opportunity for breaking the intergenerational cycle of growth failure. Renewed and redoubled efforts are most urgently needed to enforce existing legislation on age of marriage [12].

Our findings revealed that 33.6% of respondents were categorized as young women (less than 20 years old) and some of them were adolescents (< 18 years old). Furthermore, it seemed that the higher prevalence of growth failure is apparently more frequent in low- and middle-income countries compared to the developed countries [2]. In accordance to the analysis of Black *et al*. (2008), the socio-economic characteristic of our samples was classified as low socio-economic status reflected by low education and low income level (Table 1). Therefore, our respondents might have double risk factors that they were still young and from low income group. This situation led them being vulnerable to have intergenerational cycle of growth failure.

## CONCLUSION

Mothers with short stature of approximately < 145 cm in height or mothers with low pre-pregnancy of < 40 kg in body weight, have a propensity to deliver low birth length babies. It indicates that neonatal stunting reflects an inter-generational of malnutrition inherited from mothers to their babies.

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