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Association Between Maternal Mid-Upper Arm Circumference and Baby's Birth Weight

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Abstract

Birth weight can be a potential predictor for short-term and long-term health outcomes. Low birth weight can be an output from maternal malnutrition. Mothers' chronic energy malnutrition risk is detected by measuring maternal mid-upper arm circumference (MUAC). This study aimed to analyze the correlation of maternal MUAC with a baby's birth weight. This study was an analytic observational study that used secondary data from October 2021 to January 2022. Data were obtained from Tanjungsari Intergenerational Study Nutrition Working Group from 2014 to 2016. Subjects were 124 pairs of mother and baby who were recruited using total sampling. Data were analyzed using t-test and logistic regression. A significant association of maternal MUAC and the baby's birth weight (t (122) = 3.75, 95% CI 174.5, 564.0, p=0.000) was detected. Underweight (OR 23.3, 95% CI 2.6, 209.0, p=0.005), overweight, and obese (OR 0.05, 95% CI 0.01, 0.42, p=0.006) status was shown to have an association with MUAC. Education level and occupation status had no associations with MUAC. In conclusion, maternal MUAC is associated with baby's birth weight. The determinant factors of maternal MUAC were underweight, overweight, and obese status.

Keywords: Birth weight, chronic energy malnutrition, MUAC, Tanjungsari

Introduction

Birth weight is a potential indicator of maternal and infant health. In 2015 globally, it is estimated that 20.5 million newborns had low birth weight (LBW) and more than half were born in Asia.[1] According to Basic Health Research 2018 in Indonesia, the prevalence of LBW babies was about 6.2%. Meanwhile, West Java became one of the top fifteen highest rates of LBW in Indonesia, reaching 6.3%.[2]

A baby with LBW has a higher risk of morbidity and mortality. In 2020, LBW was the leading cause of infant death in Indonesia.[2] Baby who survives is at risk of developing intraventricular hemorrhage, respiratory distress syndrome, eye disorders, and hearing impairment.[3] Later in life, they are more likely to have decreased motor and cognitive function, type 2 diabetes mellitus, and cardiovascular diseases.[4,5]

Nutritional status assessment during pregnancy can be a tool for predicting birth weight.[6] One method is an anthropometric measurement of mid-upper arm circumference (MUAC). It is faster, practical, non-invasive, and requires less expertise than other screening tools.[7] Maternal MUAC can be influenced by maternal factors such as socioeconomic and body mass index (BMI). Low education levels, working mothers, and underweight mothers have a relationship with low MUAC that can impact maternal health.[8–10]

In Indonesia, the MUAC cut-off <23.5 cm indicated a risk of chronic energy deficiency (CED).[11] 17.3% of Indonesian pregnant women suffered from CED. While in Sumedang, 10% of women of childbearing age had CED.[2] This can occur if pregnant women experienced energy deprivation over a long period and may decrease nutrient delivery to the fetus. Research showed that pregnant women with lower MUAC or below the cut-off are at risk of having an LBW baby.[6] Nevertheless, if detected early, prevention and improvement of maternal nutrition during pregnancy can be made immediately.

Therefore, this study aims to analyze the association of maternal MUAC with a baby's birth weight and determine the factors associated with

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Methods

The study was an analytic observational study that used secondary data from October 2021 to January 2022. Data was obtained from Tanjungsari Intergenerational Study Nutrition Working Group (NWG) from 2014 to 2016, with 141 pregnant women. They then excluded those who had twin pregnancy (n=3), pre-eclampsia (n=1), miscarriage or stillbirth (n=6), who did not continue the study (n=2) and did not complete the assessment procedure (n=5). The sample size was calculated using two population proportions formula by assuming =5%, power = 80%, and anticipated proportion of P1=0.8 and P2=0.4.[12] Thus, the minimum sample size for normal and LBW babies was 23 samples each. The final sample included 124 pairs of mothers and babies selected by the total sampling technique. This study has received ethical approval from the Health Research Ethics Committee Universitas Padjadjaran with No. 977/UN6.KEP/EC/2021.

Maternal MUAC was measured at the midpoint between acromion and olecranon processes using nonstretchable tape, which has an accuracy of 0.1 cm in the first trimester. We classified MUAC into normal (≥23.5 cm) and risk of CED (<23.5 cm).[11] Height was measured barefoot using a stadiometer. Weight was measured using a standardized weighing scale that is accurate to 0.1 kg. Mothers were barefoot and wore light clothing. The height and weight were conducted in the first trimester. Then, BMI was calculated by dividing weight (kg) by height (m) squared. According to Asia-Pacific criteria, BMI was categorized into underweight (<18.5 kg/m^2), normal (18.5–22.9 kg/m^2), overweight (23–24.9 kg/m^2), obese I (25–29.9 kg/m^2), and obese II (≥30 kg/m^2). Education level was categorized into primary school and below, secondary school, tertiary school, and above. Occupation status became unemployed (as a housewife) and employed. The babies were measured within 1 hour after delivery. Birth weight was classified into normal (≥2.500 g) and LBW (<2.500 g).[1]

The collected data were analyzed using Stata version 14.2. Significant level was p<0.05 and 95% confidence interval. Variables were checked for normality with histograms. Maternal and baby characteristics were reported as frequency and percentage for categorical variables. In contrast, continuous variables were reported as mean estimates and standard deviations. An independent t-test was used to analyze the effect of maternal MUAC on a baby's birth weight. Binary logistic regression was used to determine the determinant factor of maternal MUAC.

Results

The study conducted in *Tanjungsari* Subdistrict had 124 pairs of mothers and babies. Study participants' characteristics were shown in Table 1, where most of the babies were 58.1% male, and the frequency of LBW was 20.2%. All mothers were at optimal reproductive age between 25 and 30 years old. A total of 46.8% of maternal were in secondary school, and 67.7% were unemployed or housewives. In an anthropometric measurement in the first trimester of pregnancy, the frequency of MUAC with risk of CED and underweight were 16.1% and 6.5%, respectively.

In Table 2, it can be seen that there was a mean difference in the birth weight of a newborn whose mother with normal and MUAC <23.5 cm (p=0.000). Table 2 shows that mothers with MUAC <23.5 cm had a newborn weighing 369.2 g less on average 95% CI (174.50, 563.95).

The results of the bivariate analysis are shown in Table 3. Underweight had a significant association (p=0.005), while overweight and obese had a negative association (p = 0.006) to predict MUAC with risk of CED.

Discussion

This study demonstrates the relationship between maternal MUAC and a baby's birth weight in Tanjungsari Subdistrict. In this study, there was a statistical difference between birth weight means in mothers with normal and low MUAC (p=0.000). Mothers with MUAC <23.5 cm were 3.7 times more likely to have a baby with a lower weight. This result was similar to a study done by Fajriana et al., which showed that mothers with MUAC <23.5 cm were 6.6 times more likely to have a baby with LBW (p=0.018).[11] A study in India found that MUAC below the cut-off was 3.4 times higher odds of having LBW (p=0.006).[6]

Mid-upper arm circumference is an index of muscle tissue, subcutaneous fat, protein, and energy reserve that can indicate the risk of CED in pregnancy.[7] Low maternal MUAC indicates

Table 1 Characteristics of the Study Participants

Variable (n=124)	n (%)	Mean ± SD
Baby		
Gender		
Male	72 (58.1)	
Female	52 (41.9)	
Birth weight (g)		2887.18 ± 423.76
Normal, ≥2,500 g	99 (79.8)	
LBW, <2,500 g	25 (20.2)	
Maternal		
Age (years)		
25	25 (20.2)	
26	34 (27.4)	
27	49 (39.5)	
28	11 (8.9)	
29	3 (2.4)	
30	2 (1.6)	
Education level		
Primary school and below	32 (25.8)	
Secondary school	58 (46.8)	
Tertiary school	26 (21.0)	
Above	8 (6.5)	
Occupation status		
Unemployed	84 (67.7)	
Employed	40 (32.3)	
MUAC (cm)		27.19 ± 3.77
Normal, ≥23.5 cm	104 (83.9)	
Risk of CED, <23.5 cm	20 (16.1)	
BMI		
Underweight	8 (6.5)	
Normal	52 (41.9)	
Overweight	22 (17.7)	
Obese 1	33 (26.6)	
Obese 2	9 (7.3)	

LBW=low birth weight, MUAC=mid upper arm circumference, CED=chronic energy deficiency, BMI=body mass index, sd=standard deviation

inadequate protein availability, resulting in the limitation of nutrient delivery to the fetus. These can affect fetal growth and development, such as impaired brain development, fewer beta cells in the pancreas, limited liver growth, and lipid metabolism.[13] Consequently, mothers with low MUAC may have a higher risk of LBW baby that may carry risks of a decreased probability of achieving a higher education level, lower employment rate, acquired type 2 diabetes, and

Table 2 Comparison of Birth Weight in Normal Maternal MUAC with Low Maternal MUAC

Birth Weight (g)	Mean	t	md	95% CI	p
MUAC					
Normal	2946.73	3.75	369.2	174.5–564.0	0.000*
Risk of CED	2577.50				

MUAC=mid-upper arm circumference; CED=chronic energy deficiency; md=mean difference; CI=confidence interval; *significant, $p < 0.05$ with independent samples t-test

Table 3 Association between Maternal Variables with MUAC

Variables	Category	OR	z	95% CI	p
Education level	Primary school and below	1	1	1	1
	Secondary school	1.12	0.17	0.31–4.05	0.863
	Tertiary school	2.1	1.05	0.52–8.43	0.295
	Above	2.33	0.87	0.35–15.80	0.385
Occupation status	Unemployed	1	1	1	1
	Employed	0.88	-0.24	0.31 – 2.50	0.814
BMI	Underweight	23.33	2.82	2.61–208.98	0.005*
	Normal	1	1	1	1
	Overweight and above	0.05	-2.77	0.01–0.42	0.006*

BMI=body mass index; OR=odds ratio; CI=confidence interval; *significant, p<0.05 with binary logistic regression.

cardiovascular disease as an adult.[5,1]Hence, this also explains mother with normal MUAC has a heavier baby shown in the current study.

Afterward, this study intended to identify which maternal characteristics that act as determinant factors for maternal MUAC. In this study, no significant association was found between education level and MUAC. The finding was in line with a study done by Hess et al. (p=0.08).[15] In contrast, a study conducted in India showed that maternal education was associated with MUAC (p=0.014).[8]particularly during critical periods of life. This study aimed to assess the nutritional and weight status of women and their children who had experienced cyclone Aila prenatally and postnatally in comparison with a non-affected neighbouring group. The study sample involved N=597 dyads consisting of mothers and their prepubertal children prenatally or postnatally (during infancy People with higher education levels may have the ability to choose healthy food compared to lower education levels. However, besides formal education, there is also non-formal education such as pregnancy classes and community-based health promotion. Mothers who regularly participate in these activities will gain good nutritional knowledge, even though they have a low level of education.[16]

Occupation is related to income, affecting their ability to fulfill nutritional intake for themselves and their families.[17] Earlier studies in Ethiopia showed a significant association between maternal occupation and low MUAC in pregnancy (p≤0.001).[9] They stated that working mothers would have more time to work than take care of themselves, so they were more prone to undernutrition. However, this study showed that maternal occupation status was not associated with low MUAC. A similar finding was also observed in another study conducted by Yuliastuti (p=0.551).[18] The result in the current study could be due to most mothers being unemployed. Furthermore, a study in Pakistan found that working mothers had healthier dietary habits such as more fruits, fish/poultry, and water intake than housewives.[19] Insufficient protein intake in pregnancy can lead to the risk of CED.[2] In addition, housewives had sedentary lifestyles and were overweight.[19] Mothers with overweight were less likely to have low MUAC, as discussed later in this study.

In this study, underweight mothers had odds 23 times higher of having low MUAC than those with normal BMI. However, this finding had a wide confidence interval, which described high variability. Overweight and obese mothers were 95% less likely to have low MUAC than those with normal BMI. Our findings were in line with the study done by Suresh et al. that showed a significant association between MUAC and BMI (p=0.000) and MUAC and weight (p=0.000) in pregnancy.[12] If there is a heavier maternal weight, MUAC would also increase. An underweight mother, particularly malnourished or had gestational weight gain below the recommendation, has a high risk of having LBW baby.[6,20]

The limitation of this study is that the researcher did not directly interview the participants. Thus, the participant's background, such as dietary habits or activities during pregnancy, was not obtained thoroughly. Observation of other factors associated with MUAC and birth weight are recommended for further related studies.

In conclusion, maternal MUAC in the first trimester significantly affected the baby's birth weight. When it is not possible to measure weight, MUAC can be used to detect the risk of CED in pregnancy and predict LBW babies. Determinant factors of maternal MUAC were underweight, overweight, and obese. This study findings provide vital information for pregnant women or those planning to become pregnant to monitor nutritional status, including MUAC. Thus, health professionals and the local government can promote optimal nutrition during pregnancy to reduce having a CED or LBW baby.

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