

First trimester maternal upper arm circumference correlated to placental size and neonatal anthropometry

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pISSN: 0853-1773 • eISSN: 2252-8083
<https://doi.org/10.13181/mji.oa.192950>
Med J Indones. 2020;29:38–41

Received: June 19, 2018

Accepted: December 10, 2019

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ABSTRACT

BACKGROUND First maternal nutrition, represented by anthropometrics, is an important factor for fetal growth. This study aimed to determine the correlation between maternal nutritional status of first trimester pregnant women with placental size and neonatal anthropometry.

METHODS A retrospective cohort study (N = 134) was conducted in Jakarta and Riau during August–September 2017. Correlation between first trimester maternal nutritional status, placental size (placental weight and volume), and neonatal anthropometry (birth weight, birth length, head circumference, and abdominal circumference) were examined using Spearman's correlation test.

RESULTS High maternal body mass index and upper arm circumference (UAC) are weakly correlated with high birth weight ($r = 0.281, p < 0.001$ and $r = 0.271, p < 0.001$), birth length ($r = 0.176, p = 0.022$ and $r = 0.238, p = 0.002$), head circumference ($r = 0.251, p = 0.001$ and $r = 0.297, p < 0.001$), abdominal circumference ($r = 0.227, p = 0.003$ and $r = 0.226, p = 0.003$), placental weight ($r = 0.198, p = 0.01$ and $r = 0.228, p < 0.001$), and placental volume ($r = 0.194, p = 0.01$ and $r = 0.203, p = 0.008$). In addition, high maternal height is also weakly correlated with high birth weight ($r = 0.157, p = 0.043$) and birth length ($r = 0.158, p = 0.041$).

CONCLUSIONS UAC can be reliably used to assess the nutritional status of pregnant women and to predict placental and newborn sizes.

KEYWORDS birth weight, maternal nutrition, pregnancy outcome

Maternal undernutrition remains a major health concern in developing countries. It may lead to increased risk of low birth weight and many other pregnancy complications.^{1,2}

Anthropometric measurements can be performed to determine the nutritional status of pregnant women by measuring their body weight before pregnancy, body height, body mass index (BMI), and upper arm circumference (UAC). This technique is an easy, low-cost, and noninvasive method for determining nutritional status.^{3–5} In resource-poor settings, where

the availability of well-calibrated equipment for body weight and height measurement is limited, UAC can be a useful substitute to assess maternal nutritional status because this parameter reflects muscle and subcutaneous fat mass. Individuals with a high risk of undernutrition tend to have less subcutaneous fat. Therefore, UAC is a reliable factor to reflect changes in muscle mass and determine whether a woman is undernourished. Early detection of maternal undernutrition may allow prompt treatment to improve maternal and neonatal outcome.

Conditions such as preeclampsia, spontaneous preterm labor, low birth weight, fetal growth restriction, and stillbirth are linked to not only maternal nutritional status but also placental condition.⁶ Placental weight throughout pregnancy is an important determinant of fetal growth and birth weight because it reflects the placental capacity to transfer nutrients and oxygen to the growing fetus.⁷ This study was aimed to determine the correlation of maternal nutritional status, placental size, and neonatal anthropometry in the first trimester of pregnant women.

METHODS

This cohort retrospective study included 134 term pregnant women who delivered in Budi Kemuliaan Hospital, Jakarta and Arifin Achmad Hospital, Riau from August to September 2017. Subjects were recruited via consecutive sampling with the following inclusion criteria: normal delivery with complete data about maternal characteristics (age, gravida, parity, abortion, gestational age, body weight, body height, UAC), placental weight, placental volume, and neonatal anthropometry (birth weight, birth length, head circumference, abdominal circumference) and informed consent given to participate in the study. Exclusion criteria were as follows: pregnant women with chronic disease, preeclampsia, and gestational diabetes mellitus, and subjects with incomplete data. This study was approved by the Ethics Committee of Universitas Indonesia (No: 715/UN2.F1/ETIK/2017).

Retrospective data of maternal first trimester weight, height, and UAC were obtained from medical records. Maternal BMI was calculated based on maternal weight and height. UAC was defined as the circumference of the nondominant arm and measured at the midpoint between the acromion and olecranon processes. Infant birth weight, birth length, head circumference, abdominal circumference, placental weight, and placental volume were measured by the attending midwife within an hour after delivery. Data were analyzed using SPSS, version 20.0 (IBM Corp, USA). Descriptive statistics were presented as mean and standard deviation for data with normal distribution, and data without normal distribution were presented as median and minimum–maximum range. Spearman’s correlation and linear regression were performed to analyze bivariate and multivariate data.

RESULTS

There were 168 subjects having normal delivery in Budi Kemuliaan Hospital and Arifin Achmad Hospital, 34 of which were excluded due to incomplete data. A total of 134 subjects were included in this study.

Maternal characteristics and first trimester anthropometry are presented in Table 1. Maternal

Table 1. Maternal, infant, placental characteristics and maternal anthropometry in the first trimester

Characteristics	Median (min–max), N = 134
Age (years)	28 (18–42)
Gravida, n (%)	
Primi	48 (35.8)
Multi	86 (64.2)
Parity, n (%)	
Nulli	58 (43.3)
Multi	76 (56.7)
History of abortus, n (%)	
None	111 (82.8)
Present	23 (17.2)
Gestational age (weeks)	39 (38–41)
Mother	
Body weight (kg)	58.5 (48–97)
Body height (cm)	156 (142–176)
BMI (kg/m ²)	24 (18.1–39.9)
BMI group, n (%)	
Underweight (<18.5)	5 (3.7)
Normal (18.5–24.9)	75 (56.0)
Overweight (25–29.9)	43 (32.1)
Obesity (>30)	11 (8.2)
UAC group, n (%)	
Low (<23.5)	18 (13.4)
High (≥23.5)	116 (86.6)
Infant	
Birth weight (g)	3,200 (2,500–4,550)
Birth weight group, n (%)	
Normal (2,500–4,000)	130 (97.0)
High (>4,000)	4 (3.0)
Birth length (cm)	48 (45–52)
Head circumference (cm)	34 (32–38)
Abdominal circumference (cm)	33 (31–35)
Placental weight (g)	550 (459–599)
Placental volume (cm ³)	756 (720–924)

BMI=body mass index; UAC=upper arm circumference

Table 2. Correlation of maternal BMI, body height, and UAC with birth characteristics

Characteristics	Maternal BMI		Body height		UAC	
	<i>r</i>	<i>p</i>	<i>r</i>	<i>p</i>	<i>r</i>	<i>p</i>
Birth weight	0.281	<0.001	0.157	0.043	0.271	<0.001
Birth length	0.176	0.022	0.158	0.041	0.238	0.002
Head circumference	0.251	0.001	0.117	0.131	0.297	<0.001
Abdominal circumference	0.227	0.003	-0.025	0.745	0.226	0.003
Placental weight	0.198	0.01	0.043	0.581	0.228	<0.001
Placental volume	0.194	0.01	0.027	0.724	0.203	0.008

BMI=body mass index; UAC=upper arm circumference

median BMI, body height, and UAC were 24 kg/m², 156 cm, and 25 cm. Only 3.7% of the mothers were underweight during the first trimester, whereas 32% were overweight.

The results of Spearman's correlation between variables were presented in Table 2. High maternal BMI and UAC were weakly correlated with high birth weight, birth length, head circumference, abdominal circumference, placental weight, and placental volume. In addition, high maternal height was also correlated with high birth weight and birth length, although it showed weak correlation.

DISCUSSION

Maternal nutritional intake during preconception and pregnancy affects fetal growth and placental metabolism, which can be reflected by the measured maternal BMI, body height, and UAC during the first trimester.^{8,9} This study showed that high maternal BMI and UAC were associated with high infant birth weight, birth length, head circumference, abdominal circumference, placental weight, and placental volume. High maternal body height was related to high infant birth weight and birth length. The correlation of these characteristics with UAC was more significant than that with BMI, implying that UAC was a reliable parameter for assessing the nutritional status of pregnant women and could be used to predict placental and infant sizes.

UAC is used as a screening tool to assess malnutrition in children and adults. A low UAC (<23.5 cm) among pregnant women is associated with pregnancy complications such as low birth weight and preterm labor.¹⁰ Studies have stated that maternal UAC has a sensitivity of 92.1% and a sensitivity of 88.3% for the detection of maternal protein-energy

malnutrition.¹¹ UAC can be used to examine the maternal nutritional status, which significantly affects fetal and placental growth, during preconception and pregnancy.⁹ Placental growth can be evaluated by measuring placental weight, which is a strong predictor of birth weight. Placental weight may indicate the placental capacity to transfer oxygen and nutrients to the fetus.¹²

UAC measurement is an easy and cheap modality that has been described since 1994 in several studies reporting the increased risk of preterm labor in pregnant women with a low UAC.¹⁰ Other studies have also shown that measured UAC is a predictor in assessing the nutritional deficiency and clinical condition of pregnant women.¹³ In Bangladesh, Gernand et al⁹ reported that maternal factors, including UAC are positively correlated with birth weight and placental mass. A similar result was observed in our study, which revealed that UAC was also positively correlated with neonatal anthropometry. This finding suggested that UAC might be used to assess nutritional status during pregnancy and predict placental and fetal sizes. However, the correlation between variables found in this study was weak, so other modalities should be considered to examine maternal nutritional status and newborn condition. The measurement of maternal plasma nutrient level is the most objective method to evaluate maternal macro- and micronutrient adequacy, but this method is costly and inaccessible nationwide. As such, it cannot be applied to a national level. The nature of UAC reflecting muscle mass is hindered in the presence of subcutaneous mass, whose distribution varies with genetics and age.¹⁴ This condition might explain the low correlation found in this study because only 3.7% of the subjects were underweight.

This study had several limitations, including bias attributed to secondary data and the absence of data

about pregnancy-related maternal weight gain and maternal intake, which also affected placental and neonatal outcome. In conclusion, UAC can be reliably used to assess the nutritional status of pregnant women and to predict placental and newborn sizes.

Conflict of Interest

The authors affirm no conflict of interest in this study.

Acknowledgment

None.

Funding Sources

None.

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