Original Research Report

MATERNAL MID-UPPER ARM CIRCUMFERENCE AS A SCREENING TOOL TO PREDICT INFANT BIRTH WEIGHT

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ABSTRACT

Mid-upper arm circumference (MUAC) is commonly used for assessing chronic energy deficiency in women of childbearing age. The measurement of MUAC during pregnancy mainly serves as early detection of potential low birth weight. However, certain studies have indicated no significant correlation between maternal MUAC and birth weight. Therefore, this study aimed to determine the relationship between maternal nutritional status and infant birth weight. The study used an analytical observational method with a cross-sectional approach, involving a sample of 86 mothers who delivered at Jagir Primary Healthcare Center in Surabaya, Indonesia, between July and December 2019. The participants were selected based on certain inclusion and exclusion criteria. The data were obtained from secondary sources, specifically the medical records of Jagir Primary Healthcare Center. The data were analyzed using the Spearman test, with a 95% confidence interval and a 5% margin of error. Most mothers (86.05%) had good nutritional status, as indicated by a MUAC measurement of ≥23.5 cm. Only 3.49% of infants were born with a low birth weight (<2,500 g), while 1.16% of infants were considered macrosomia (>4,000 g). Although most mothers exhibiting low MUAC did not give birth to infants with low birth weights, the analysis revealed a significant relationship (p=0.035) between maternal MUAC and infant birth weight. In conclusion, maternal MUAC can be utilized as a screening tool to predict infant birth weight because it indicates the condition of muscle tissue and subcutaneous fat, which serve as the mother's energy reserves. However, several variables can also impact infant birth weight, including maternal nutrient intake.

Keywords: Nutritional status; mid-upper arm circumference; birth weight; malnutrition

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Highlights:
1. This study investigated the correlation between maternal mid-upper arm circumference and infant birth weight, aiming to present a different outcome compared to previous research.
2. The study's findings offer data suggesting that mid-upper arm circumference can serve as a screening tool for predicting infant birth weight.

INTRODUCTION

Chronic energy deficiency is a prolonged condition in which an individual's nutritional intake fails to adequately meet their body's energy requirements, resulting in adverse effects on their overall health. In adults, chronic energy deficiency leads to detrimental changes in bodily functions, increased risks of morbidity and mortality, and impaired mental and cognitive development, which eventually contribute to decreased productivity. Inadequate food intake, socio-economic status, and infectious diseases are the primary factors that contribute to the occurrence of chronic energy deficiency in adults. Chronic energy deficiency can be assessed by analyzing nutritional status through

the utilization of body mass index (BMI) measures (Tejayanti 2020, Dagne et al. 2021).

Maternal nutritional status can be assessed using MUAC as an alternative to BMI. MUAC measurements are typically carried out on women within the reproductive age range of 15–49 years to assess their nutritional status and identify the presence of chronic energy deficiency (Das et al. 2020, Shifraw et al. 2021). According to the 2018 Basic Health Research, the occurrence of chronic energy deficiency among women of reproductive age in Indonesia was recorded at 14.5% for non-pregnant women and 17.3% for pregnant women. The prevalence rates exhibited a decline in comparison to the rates recorded in 2013, which reached 20.8% for non-pregnant women and 24.2% for pregnant women. However, the prevalence rate of chronic energy deficiency among women aged 15–45 years in 2007 was recorded at 13.6%, a number that was lower than the prevalence observed in 2018 (Minister of Health of the Republic of Indonesia 2013, 2018).

Chronic energy deficiency in pregnant women leads to the delivery of infants with low birth weight. Infants with a low birth weight are susceptible to various disorders, such as stunting. They also have a higher risk of mortality compared to infants with a normal birth weight (Muliawati 2013; Kusumawati et al. 2015). According to data from the World Health Organization (2020), Indonesia ranked 7th in terms of infant mortality. Nevertheless, statistical data demonstrate a consistent downward trend in the infant mortality rate over the years.

The measurement of maternal MUAC has been acknowledged as an effective screening tool for evaluating nutritional status. Furthermore, it has been linked to the weight of newborn infants (Kpewou et al. 2020). However, a previous study conducted by Babu et al. (2021) demonstrated the absence of a relationship between maternal nutrition and infant birth weight. Therefore, this study aimed to ascertain the relationship between the nutritional status of mothers and the birth weight of their infants.

MATERIALS AND METHODS

This study examined the relationship between maternal nutritional status and infant birth weight. Therefore, the research used an analytical observational design with a cross-sectional approach. The data analyzed in this study were acquired from medical records provided by Jagir Primary Healthcare Center, Surabaya, Indonesia. The medical records contained information regarding mothers who delivered their newborns at the health center throughout the period of July to December 2019 (Indriyani et al. 2023).

The subjects were determined using simple random sampling, while the sample size was calculated using Slovin's formula. A total of 86 medical records were obtained from Jagir Primary Healthcare Center. The inclusion criteria for the subjects were mothers aged 15–49 years who had no pregnancy complications or a history of infectious disease. Twin pregnancies were excluded from this study (Minister of Health of the Republic of Indonesia 2018, Isip 2019).

The assessment of maternal nutritional status was conducted by measuring the MUAC. A maternal MUAC measurement below 23.5 cm was deemed indicative of a chronic energy deficit. Infants with a birth weight below 2,500 g were classified as having a low birth weight, whereas those with a birth weight above 4,000 g were defined as having macrosomia (Thamaria et al. 2017, Minister of Health of the Republic of Indonesia 2018).

This study received ethical clearance from the Health Research Ethics Committee of the Faculty of Medicine, Universitas Airlangga, Surabaya, Indonesia (No. 161/EC/KEPK/FKUA/2023 dated 26/6/2024). Data obtained from the subjects were processed using IBM SPSS Statistics for Windows, version 26.0 (IBM Corp., Armonk, N.Y., USA). The Spearman's correlation test was employed to analyze the correlation between maternal nutritional status and infant birth weight. The correlation was assessed using a 95% confidence interval and a 5% margin of error. A correlation analysis result with a value less than 0.05 ($p<0.05$) signified a significant correlation, whereas a result greater than 0.05 ($p>0.05$) indicated a lack of statistical significance. The correlation coefficient (Rs) was calculated to determine the strength of the relationship between variables. A higher R-value indicated a stronger correlation, while a lower R-value indicated a weaker correlation ($0 \leq R \leq 1$) (Sangi et al. 2021, Barcelona Field Studies Centre 2024).

RESULTS

This study acquired data from the medical records of 86 mothers who delivered their babies at Jagir Primary Healthcare Center over the period of July to December 2019. Table 1 shows the characteristics of the mothers and their infants. The majority of the mothers (86.1%) delivered their babies at the ideal age, with an average age of 27.01 years. In addition, most of the mothers (96.5%) gave birth at full term, with an average gestational age of 39.54 weeks. A total of 13.9% of the mothers were identified as being susceptible to chronic energy deficiency.

According to the data collected from the subjects, there was a higher prevalence of female infants compared to male infants. Only a small number of infants were born with a low birth weight, while the majority were born with an ideal birth weight. The average birth weight of the infants was 3,110.76 g.

Table 1. Characteristics of the mothers and their infants.

Characteristics			n	%	Total
Mothers	Age	<20 years	8	9.3	86 (100%)
		20–35 years	74	86.1	
		>35 years	4	4.6	
	MUAC	<23.5 cm	12	13.9	
		≥23.5 cm	74	86.1	
	GA	<37 weeks	2	2.3	
		37–41 weeks	83	96.5	
		>41 weeks	1	1.2	
Infants	Sex	Male	41	47.7	
		Female	45	52.3	
	BW	<2,500g	3	3.5	
		2,500–4,000g	82	95.3	
		>4,000g	1	1.2	

Notes: MUAC=mid-upper arm circumference; GA=gestational age; BW=birth weight.

Table 2 demonstrates that only three infants (3.5%) had a low birth weight. These infants were not born from mothers at risk of chronic energy deficiency but from mothers with a normal nutritional status instead. Mothers who were at risk of chronic energy deficiency delivered babies with a birth weight within the normal range.

Table 2. Distribution of the maternal mid-upper arm circumference and infant birth weight.

Characteristics		MUAC				Total
		<23.5 cm		≥23.5 cm		
		n	%	n	%	
BW	<2,500g	0	0.0	3	3.5	86 (100%)
	2,500 – 4,000g	12	14.0	70	81.4	
	>4,000g	0	0.0	1	1.1	

Notes: MUAC=mid-upper arm circumference; BW=birth weight.

The statistical analysis using the Spearman's correlation test revealed a significant correlation between maternal nutritional status and infant birth weight, with p=0.035. However, the correlation between maternal MUAC and infant birth weight was found to be weak, with R=0.227 (Table 3).

Table 3. Correlation analysis of maternal mid-upper arm circumference and infant birth weight.

		MUAC	BW
MUAC	Spearman's correlation	1	0.227
	Significance (two-tailed)		0.035
BW	Spearman's correlation	0.227	1
	Significance (two-tailed)	0.035	

Notes: MUAC=mid-upper arm circumference; BW=birth weight.

DISCUSSION

In this study, the majority of the mothers (86.05%) had an MUAC of ≥23.5 cm. Meanwhile, 4.65% of the young mothers had a smaller MUAC. This finding aligns with previous research conducted by Ariendha et al. (2020). The research revealed a higher prevalence of young pregnant women with an MUAC of ≥23.5 cm (79.7%) compared to those with a smaller MUAC (66.67%). The 2018 data on the East Java region of Indonesia showed a high prevalence of pregnant women, including teenage mothers, with an average MUAC of ≥23.5 cm (Minister of Health of the Republic of Indonesia 2018). Nevertheless, female adolescents are more likely to experience chronic energy deficiencies. This is due to their high nutrient requirements for supporting optimal body growth. In addition, female adolescents often limit their food intake to maintain their body weight. Consequently, their MUAC, as represented in numerous studies, becomes smaller than the expected measurements (Retni et al. 2016, Paramata & Sandalayuk 2019).

All of the young mothers in this study delivered their babies at the expected gestational age, which was considered full term. Likewise, the majority of the older mothers gave birth to their babies at full term, while only a small percentage of them (1.16%) delivered their babies after the expected date (post-term). Conversely, those who gave birth at a lower gestational age (pre-term) were mothers of ideal age. In a prior investigation conducted by Zulaikha & Minata (2021), it was discovered that 40 mothers (59.7%) with a risky age delivered their babies prematurely. The study highlighted that a mother of a risky age has a 2.781 times higher likelihood of experiencing preterm birth compared to a mother within the ideal age range. This statement has been supported by several other studies (Wahyuni & Rohani 2017, Drastita et al. 2022).

Out of the total number of babies examined in this study, only three infants (3.49%) were born with a low birth weight, and two of them were female. The

current data is comparable to the 2018 data, which indicated a higher incidence of low body weight in female infants compared to male infants in East Java (Minister of Health of the Republic of Indonesia 2018). A prior study conducted by Iltaf et al. (2017) corroborated this finding. Nevertheless, the sex of the infant is not a definitive determinant of the occurrence of low birth weight. The child's weight during growth is not influenced by sex (Thamaria et al. 2017).

This study found that mothers with a small MUAC did not deliver babies with a low birth weight. They gave birth to babies with a birth weight within the normal range instead. In a recent study conducted by Sangi et al. (2021), it was found that only 26.3% of infants born to mothers with nutritional problems had a low birth weight. However, there is an opposing notion suggesting a correlation between maternal MUAC and infant birth weight. Mothers with a small MUAC were found to have a higher likelihood of giving birth to infants with a low birth weight. Furthermore, mothers with chronic energy deficiency exhibited a fourfold higher risk of low birth weight, even if their MUAC was greater than 22 cm (Kusparlina 2016, Puspitaningrum 2018).

The statistical analysis of this study revealed a significant relationship (p=0.035) between maternal MUAC and infant birth weight, but with a weak correlation coefficient (R=0.227). Similarly, several studies have demonstrated a significant relationship between the two variables, corroborating the results of this study (Rani et al. 2017, Puspitaningrum 2018, Siyoum & Melese 2019). In contrast, a study conducted by Sangi et al. (2021) revealed that there was no statistically significant relationship between maternal MUAC and infant birth weight (p=0.145). However, there was a moderate correlation (R=0.117) observed between the variables. Maternal MUAC indicates the measurement of muscle and subcutaneous fat in the arms, which is one of the areas where fat is stored in the mother's body. However, other factors may affect the birth weight of a baby, including the mother's nutritional intake. While in the womb, the fetus mostly relies on maternal nutrition, particularly for the essential intake of protein and fat. These nutrients are crucial for fetal development and have an immediate impact on the baby's weight (Cohen & Spiegelman 2016, Woldeamanuel et al. 2019).

Strength and limitations

This study offers additional evidence on the advantages of using MUAC measurement as a screening tool to identify the early onset of low birth weight. However, this study primarily relied on MUAC data taken in the first trimester of pregnancy. This imposed a limitation on the quantity of data that could be acquired. Additional research is advised to take into account this factor in order to achieve improved outcomes.

CONCLUSION

Maternal mid-upper arm circumference (MUAC) has an impact on infant birth weight, suggesting its potential as a screening tool for predicting birth weight. Pregnant women must maintain a nutritious diet and meet their nutritional needs to prevent low birth weight. Future research is required to establish the correlation between maternal MUAC and birth weight by examining MUAC measurements immediately after childbirth.

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Conflict of interest

None.

Ethical consideration

The Health Research Ethics Committee of the Faculty of Medicine, Universitas Airlangga, Surabaya, Indonesia, issued the ethical approval for this study (No. 161/EC/KEPK/FKUA/2023 dated 26/6/2024).

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Author contribution

MRF contributed to the conception and design, analysis and interpretation of the data, drafting of the article, and collection and assembly of the data. SU was responsible for the analysis and interpretation of the data, critical revision of the article for important intellectual content, final approval of the article, and statistical expertise. EMK and BS contributed to the critical revision of the article for important intellectual content and final approval of the article.

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