SYSTEMATIC REVIEW

The Impact of Antenatal Care and Mother's Mid-upper Arm Circumference on Low Birth Weight Incidence: A Meta-analysis and Systematic Review

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ABSTRACT

Introduction: Low birth weight is a significant concern as it causes 60-80% of all neonatal deaths, with affected babies being 20 times more likely to die than those with normal weight. In this context, antenatal care and mid-upper arm circumference are two determinants of the incidence of low birth weight babies. This study aimed to conduct a systematic review and meta-analysis to identify the relationship between antenatal care and a mother's mid-upper arm circumference with low birth weight incidence. **Materials and methods:** The study employed a meta-analysis that followed the PRISMA 2020 guidelines. The articles were systematically searched in journal databases, such as PubMed, ScienceDirect, Springer, Google Scholar, and ProQuest. The data were then analyzed using Odds ratio (OR) with the Review Manager 5.4 to facilitate the systematic review analysis. **Results:** The search process finally generated nine studies, consisting of five articles on antenatal care and four articles on MUAC. The results revealed that antenatal care had a significant relationship with the incidence of low birth weight (OR 3.51; CI 95% 1.13 – 10.91; I2 93%; p = 0.03). Similarly, mid-upper arm circumference was also reported to play a significant role in the incidence of low birth weight (OR 6.06; CI 95% 2.25 – 16.31; I2 67%; p = 0.004). **Conclusion:** Mid-upper arm circumference of less than 23.5 cm and fewer than four ANC visits are at a higher risk of having low birth weight babies.
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Keywords: Antenatal care, MUAC, Low birth weight, Meta-analysis, Systematic review

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INTRODUCTION

One of the health indicators for a newborn baby is their weight. A baby's birth weight is related to the mother's nutritional intake during pregnancy (1). Pregnant women with a balanced nutritional intake will also have a normal nutritional status and give birth with normal birth weights (2). One of the factors that influence the nutritional status of pregnant women is the frequency of antenatal care visits (3).

Antenatal care (ANC) is a health service for pregnant women and babies. It aims to ensure they are offered regular check-ups, information, and support during pregnancy(4). In antenatal care, the nutritional status will be monitored regularly. Based on the World Health Organization (WHO), pregnant women are advised to make ANC visits four times. The new model 2016 recommends even more, with at least eight visits during pregnancy (5). One of the antenatal care services that must be obtained for pregnant women is mid-upper arm circumference (MUAC) measurement. This measurement serves as an indicator of energy and fat reserves and helps assess nutritional status (6).

Pregnant women are categorized as having a normal nutritional status if the MUAC measurement result is greater than 23.5 cm. Conversely, poor nutritional status is indicated by the upper arm circumference of less than 23.5 cm (7). Poor nutritional status affects chronic energy deficiency and the risk of giving birth with low birth weight (LBW) (8). Likewise, pregnant women with a low frequency of ANC will have babies with low birth weight, too, because monitoring of pregnant women and babies is not optimal(9).

According to WHO, low birth weight (LBW) babies are defined as those who are born with a bodyweight smaller than 2500 grams within 1 hour after birth (10). Low baby weight can increase the risk of infant mortality and morbidity in the future, such as delays in the growth of developed brain nerves and other degenerative diseases [10,11]. According to WHO (2019), babies with low birth weight contribute 60-80% of all neonatal deaths, with affected babies being 20 times more likely to die

than those with normal weight. WHO and UNICEF stated that 19.8 million newborns, or around 14.7% of babies, were born with low birth weight in 2020. From 2019-2013, the incidence of low birth weight babies increased from 15.5% to 16%, with 95.6% of these cases occurring in developing countries.

Up to the present, there has been no meta-analysis or systematic review in Indonesia that discusses the impact of antenatal care and maternal mid-upper arm circumference on the incidence of low birth weight. Indeed, in Africa, Engdaw et al. (2023) examined the effect of antenatal care on low birth weight using a systematic review and meta-analysis in 2022. Their research stated that everyone who had at least one ANC visit revealed a statistically significant association with low birth weight(9). However, this research was conducted in Africa and thus might be difficult to generalize. Therefore, research conducted in the Indonesian context is necessary.

The solution to preventing low birth weight is to ensure the micro and macro nutritional intake needed by pregnant women and babies during pregnancy(13). Thus, their nutritional status should be adequate. Pregnant women must regularly visit health service facilities for antenatal care so they can detect and prevent complications and health problems for themselves and their babies. Hence, the aim of this research is to analyze the relationship between antenatal care and a mother's mid-upper arm circumference and low birth weight incidence.

MATERIALS AND METHODS

Study Design

This study employed a meta-analysis design. This meta-analysis followed the PRISMA (Preferred Reporting Items for Systematic Review and Meta-Analysis) 2020 guidelines to ensure a systematic, transparent, and comprehensive review of the available evidence on the subject.

Eligibility Criteria

To ensure the relevance and quality of the studies included, the following inclusion and exclusion criteria were applied. Studies were selected if they met the following criteria: (1) published in English or Indonesian language; (2) from the years 2018 - 2023; (3) used keywords such as ANC, MUAC, and Low Birth Weight; and (4) classified as original research articles and demographic health surveys. The exclusion criteria were: (1) articles that are not editorial notes, systematic reviews, literature reviews, or meta-analyses; (2) articles consisting only of titles and abstracts; (3) articles published outside the years of 2018 to 2023.

Search Strategy and Selection of Studies

This meta-analysis involved a literature search using MeSH terminology (Supplementary Table) and was registered in the PROSPERO database. The articles were obtained from journal databases, including PubMed, ScienceDirect, Springer, Google Scholar, and Proquest. The search focused on articles discussing antenatal care, middle-upper arm circumference, and low birth weight. Databases were searched using terms (('antenatal care')) AND (('MUAC')) AND (('low birth weight')) in Januari, 2024. The quality of non-randomized studies included in systematic reviews and/or meta-analyses was assessed using the Newcastle-Ottawa Scale, which assesses bias through group selection, group comparability, and certainty of exposure or desired outcome. As argued earlier, the selection process followed the PRISMA flow diagram as shown in Figure 1.

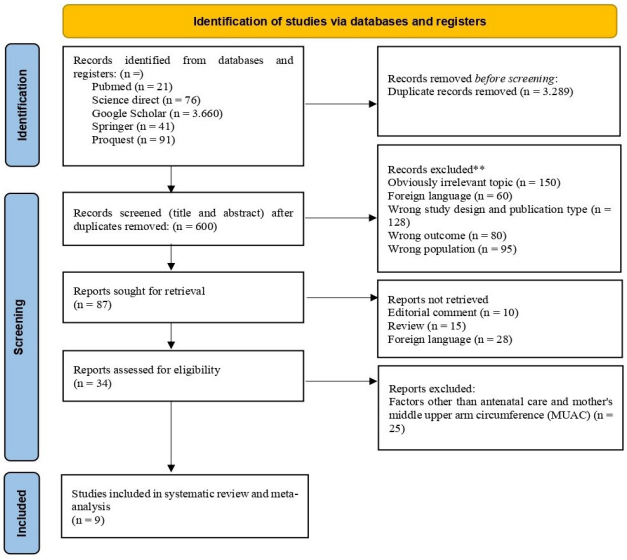

Figure 1: Preferred Reporting Items for Systematic Review and Meta Analyses (PRISMA) Flow Diagram of Study Selection

Quality Assessment and Risk of Bias (RoB)

In this study, the methodological quality was assessed using the National Institutes of Health (NIH) Quality Assessment Tool for Observational Cohort and Cross-sectional. The NIH quality tool consists of 14 questions with three options for answers: 1=yes, 0=no, and other (N/A=not applicable, N/R=not reported, CD=cannot determine). Quality of studies was graded as "good", "fair", or "poor" (3). The risk of bias in the selected studies was thought to be inversely related to the quality of the research. Good quality research is considered to have a low risk of bias (ROB). Meanwhile, a fair-quality study has a moderate ROB, and a poor-quality study has a high ROB (1). Table I shows the quality of the studies selected in this research.

Data Extraction

The following data: antenatal care, mother's middle upper arm circumference (MUAC), and low birth weight were collected and recorded in a formatted table. The data are summarized in Table II.

Statistical analysis

Review Manager 5.4 was used for statistical analyses,

with dichotomous data (risk ratio and odds ratio) analyzed using the Mantel-Haenszel statistical method for antenatal care and the mother's middle upper arm circumference (MUAC). Heterogeneity was assessed using the DerSimonian and Laird random-effect model. A leave-one-out sensitivity analysis was conducted to identify outliers and changes in heterogeneity (I^2), where I^2 values of 0-50% indicated low, 50-75% moderate, and 76-100% substantial heterogeneity. Data analysis used either fixed or random effect models; results with a p-value < 0.05 were considered statistically significant.

Table I: Quality Assessment and risk of bias for the selected Studies.

Study	National Institutes of Health Quality Assessment Tool for Observational Cohort and Cross-sectional questions														Quality scoring	Quality rating	Risk of bias (RoB)
Questions	**Q1**	**Q2**	**Q3**	**Q4**	**Q5**	**Q6**	**Q7**	**Q8**	**Q9**	**Q10**	**Q11**	**Q12**	**Q13**	**Q14**			
Antenatal Care																	
Asmare 2018 [19]	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	No	Yes	No	N/A	No	10	Good	Low
Bellizzi and Padrini, 2020 [12]	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	No	No	No	N/A	No	9	Fair	Moderate
Kujarinin-grum 2023 [18]	Yes	No	Yes	Yes	No	No	Yes	Yes	Yes	No	Yes	No	N/A	Yes	8	Poor	High
Sema 2019 [20]	Yes	Yes	Yes	Yes	Yes	Yes	No	Yes	N/A	No	Yes	No	Yes	Yes	10	Good	Low
Uwimana 2023 [13]	Yes	No	Yes	Yes	No	Yes	Yes	Yes	Yes	No	Yes	No	N/A	Yes	9	Fair	Moderate
Mid Upper Arm Circumference (MUAC)																	
Abera, 2019 [14]	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	No	Yes	No	N/A	No	10	Good	Low
Indriyani, 2023 [17]	Yes	No	Yes	Yes	Yes	No	No	No	Yes	No	Yes	No	Yes	Yes	8	Poor	High
Rahfiludin, 2018 [16]	Yes	No	Yes	Yes	Yes	Yes	N/A	Yes	N/A	No	No	No	Yes	Yes	8	Poor	High
Sahu, 2021 [15]	Yes	No	Yes	Yes	No	Yes	N/A	Yes	Yes	No	Yes	No	N/A	Yes	8	Poor	High

Table II: Systematic review of the quality of antenatal care and MUAC with the incidence of low birth weight (CONT.)

No	Name, Year	Title	Method	Result	Conclusion
Antenatal Care					
1.	Asmare 2018 [19]	Determi-nants of Low Birth Weight Among Ne-onates Born in Amhara Regional State Referral Hospi-tals of Ethiopia: Unmatched Case Control Study	All mothers who gave birth in Amha-ra Regional State Referral Hospitals were our source population. Mothers who gave live births weighed less than 2500g were considered as cases and those mothers with live births weighed 2500g and above were considered as controls. Data were entered into Epi-data Version 3.1 and exported to SPSS version 22 for further analysis. Multivariable binary logistic regres-sion analysis, adjusted odds ratio (AOR) with 95% CI and p-values were used to identify signifcant variables. Variables having p-value less than 0.05 were considered as signifcant de-terminants of low birth weight.	This study found that mothers who delivered female infants (AOR: 1.7, 95% CI 1.1, 2.6), occurrence of health problems during current pregnancy (AOR: 2.8, 95% CI 1.7,4.5), absence of antenatal care (AOR: 2.3,95% CI 1.3,4.0), lack of iron supple-mentation (AOR: 2.8, 95% CI 1.6,4.9), maternal MUAC be-low 23 cm (AOR: 1.7, 95% CI 1.0,2.7), and gestational age be-low 37 completed weeks (AOR: 3.3; 95% CI 1.9, 5.7) were found to be determinants of low birth weight.	Tis study found that infant sex being female, preterm, ab-sence of ANC visits, MUAC less than 23 cm, lack of iron or folic acid supplementation and complication during pregnan-cy the current pregnancy were found to be signifcant determi-nants of low birth weight.
2.	Saverio Bellizzi and Susan-na Padrini, 2020 [12]	Quality Utiliza-tion of Antenatal Care and Low Birth Weight: Evidence From 18 Demographic Health Surveys	Analysed data from 18 demograph-ic and health surveys, from 2005 to 2013, including 69 446 children. The main study outcome was birthweight < 2.5 kg, and access to and number of antemata care visits were exposure variables. Moreover, antenatal care attendants and time of visit (trimester) were considered. Multiple logistic re-gression adjusted for sampling at pri-mary and country level was utilized.	At least 1 and ≥ 4 antenatal care consultations were both associ-ated with decreased odds of low birth weight when compared to none and < 4 antenatal care consultations, respectively. Ad-ditional benefit stemmed from having skilled antenatal care attendants and the first antenatal care consultation during the first trimester.	Proper antenatal care coverage during pregnancy is beneficial for preventing low birth weight in low- and middle-income countries.

CONTINUE

Table II: Systematic review of the quality of antenatal care and MUAC with the incidence of low birth weight (CONT.)

No	Name, Year	Title	Method	Result	Conclusion
Antenatal Care					
3.	Kujaringrum 2023 [18]	Maternal Predisposing Factors with The Incidence of Low Birth Weight in Central Jawa	This study used a cross-sectional design and 2017 IDHS data. The study population consisted of 1205 babies born to WUS (Women of Childbearing Age) in 2012-2017 in Central Java. The bivariate analysis used was a statistical analysis of chi-square continuity correction. The independent variables included in the multivariate logistic regression method enter are the independent variables with p-value ≤ 0.25. The analysis used a significance level of 0.05 and a confidence level of 95%.	Pregnancy complications have been associated with incidences of LBW in Central Java (p-value = 0.0001). Iron supplementation (OR = 2.474) and pregnancy complications (OR = 4.869) affected the incidence of LBW in Central Java. Iron supplementation and pregnancy complications influenced the incidence of LBW in Central Java	There was a relationship between pregnancy complications and the incidences of LBW in Central Java. The quality of antenatal care, iron supplementation, and maternal smoking status were not related to the incidences of LBW. A pregnant woman who doesn't get iron supplementation (OR = 2.474) and complications of pregnancy (OR = 4.869) had a chance of 0.84 for having a baby with LBW.
4.	Sema 2019 [20]	Associated Factors with Low Birth Weight in Dire Dawa City, Eastern Ethiopia: A Cross-Sectional Study	A cross-sectional study designed was conducted, and using a systematic sampling technique, 431 mothers who gave birth in the public hospitals in Dire Dawa city from July 01 to August 30, 2018, were selected. The data were analyzed using SPSS Version 22.0. Adjusted Odds Ratio (AOR) with 95% confidence interval (CI) was applied in multivariate logistic regression models, and p value less than 0.05 was considered as statistical significant.	The prevalence of low birth weight was 21%. Not received nutritional counseling during antenatal care (AOR= 2.03, 95% CI: 1.01, 4.06), preterm birth (AOR= 18.48, 95% CI: 6.51, 52.42), maternal smoking (AOR= 3.97, 95% CI: 1.59, 9.88), and height of the mother less than 150 cm (AOR= 3.54, 95% CI:1.07, 11.76) were significantly associated with Low birth weight	There was a high prevalence of low birth weight in the study area. Effective dietary counseling and additional diet, implementing proven strategies to prevent preterm birth and avoid smoking during pregnancy might decrease the low birth weight and then enhance child survival.
5.	Uwimana 2023 [13]	Association between quality antenatal care and low birth weight in Rwanda: a cross-sectional study design using the Rwanda demographic and health surveys data	The Demographic and Health Surveys (DHS) are cross-sectional, nationally representative household surveys that collect population, health, and nutrition. A total of 16,144 women aged 15 to 49 years who had live births in the five years preceding each survey were included in this study. A survey adjusted for clusters at multiple level and a bivariate and multivariable logistic regression was used to estimate adjusted odds ratios(aOR) and 95% confdence intervals to assess the association between the outcome and independent variables.	Of 5,813 women; 201 (3.45%) had high-quality ANC in the 2010 survey, and of 5,813 newborns, 180 (3.10%) were LBW. Of 5404 women; 492 (9.11%) had high-quality ANC in 2015, and of 5404 newborns, 151 (2.79% were LBW). Of the 5,203 women, 776 (14.92%) had high-quality ANC in the 2020 survey year, and of the 5,206 newborns, 139 (2.67%) had LBW. In multivariable analysis, borderline high quality ANC was negatively associated with LBW.	Our fndings demonstrate that the use of high-quality ANC has gradually increased. However, the vast majority of the women are still receiving low-quality ANC. Te prevalence of LBW has decreased over the years of the surveys, however, it remains high. Addressing the coverage but also the quality of the content in ANC, especially to the poor and primiparous women results in the reduction of the prevalence of LBW. Te study revealed that the utilization of high-quality ANC can greatly contribute to lessening LBW and thus neonatal mortality and therefore achieving the SDGs.
Mid Upper Arm Circumference (MUAC)					
1.	Abera, 2019 [14]	Nutritional and non-nutritional factors associated with low birth weight in Sawula Town, Gamo Gofa Zone, Southern Ethiopia	Data were entered into Epi-info Version 3.5.3 and then exported to SPSS Version 20 for analysis. Bivariable and multivariable logistic regression were used to compare birth weight across categories of independent variables. The output of the analysis were presented using adjusted odd ratio (AOR) with the corresponding 95% confdence interval (CI).	A total of 358 mothers participated in the study. The mean (±standard deviation) birth weight of all term infants was 3304 (±684) gram. The prevalence of LBW was 17.3% (95% CI 13.7–21.2%). Mothers who had MUAC less than 23 cm [AOR=6.51 (95% CI 2.85–14.91)] and with hemoglobin	The signifcant predictors of LBW were maternal MUAC less than 23 cm, low hemoglobin level and frequency of daily intake of dairy products at third trimester. Strengthening quality nutrition education during ANC and improving the nutritional status of women particularly during pregnancy would reduce the occurrence of LBW.

CONTINUE

Table II: Systematic review of the quality of antenatal care and MUAC with the incidence of low birth weight (CONT.)

No	Name, Year	Title	Method	Result	Conclusion
Mid Upper Arm Circumference (MUAC)					
2.	Indriyani, 2023 [17]	Mid-Upper Arm Circumference in Pregnant Women and its Correlation to Birth Weight	The research methodology used analytical observational with a cross-sectional approach to the medical records of 104 mothers at the Taman Baca Health Center, Pembina Health Center, and Plaju Palembang Health Center. Data analysis on the variables of the Mid-Upper Arm Circumference of pregnant women and the body weight of the baby born was carried out using the SPSS-22 program computer software with the Fisher's Exact Test.	The results of this study showed that MUAC for pregnant women was more than equal to 23.5 cm as many as 86 (82,7%) respondents, while pregnant women of MUAC were less than 23.5 cm as many as 18 (17,3%) respondents. Analysis with Fisher's Exact Test with p-value=1,000.	There was no meaningful relationship between the MUAC of pregnant women and the body weight of babies.
3.	Rahfiludin, 2018 [16]	Risk Factors Associated with Low Birth Weight	This research is a cross-sectional study conducted at the Bulu Community Health Center, Temanggung, Central Java, Indonesia. The study population consisted of 114 second and third trimester pregnant women. The sample size required for this research is 69 samples based on the Slovin formula. The data analysis procedure was carried out using quantitative methods. Descriptive statistics were analyzed using mean and standard deviation. Categorical data were analyzed by cross tabulation. Inferential statistics use the chi-square test for bivariate analysis and binary logistic regression for multivariate analysis. Significant correlation between independent and dependent variables is shown at p value = 0.05.	The results of this study showed that mean infant birth weight was 2917.68 ± 374.673 kg. Inferential analysis showed that MUAC and pregnancy at a risky age were significant risk factors associated with LBW, while serum transferrin receptor levels, anemia, parity, energy and protein consumption levels, and systolic and diastolic blood pressure were nonsignificant risk factors. The probability of LBW in pregnant women with LILA under 23.5 cm and pregnancy at a risky age was 68.9%	It can be concluded that MUAC and age are risk factors associated with LBW in newborns, with a probability of 68.2%. It is suggested that public education on the importance of nutrition during pregnancy be increased to increase MUAC and avoid pregnancy under the age of 19 years or above the age of 35 years to reduce the incidence of infants with LBW.
4.	Sahu, 2021 [15]	Mid upper arm circumference in pregnant women and its relationship with birth weight	This cross sectional study was conducted in 240term pregnant women. MUAC was measured to the nearest millimeters using a non-stretchable tape at the midpoint between acromian process and olecranon process. Newborn baby weight was measured within 24 hrs of birth. The association between MUAC and birth weight was established by linear regression analysis	The mean of MUAC among pregnant women delivering LBW was 21.68±2.27 cm which was significantly low (p	Among the various maternal factors for the prediction of LBW, mid-upper arm circumference (MUAC) can be correlated with birth weight outcome effectively.

RESULTS

Study Selection

There were 9 cohort studies of antenatal care and mid-upper arm circumference (MUAC) of mothers with low birth weight. This study has conducted a thorough search for articles in 5 databases: Pubmed, Science Direct, Google Scholar, Springer, and Proquest. Then, the articles were selected based on their research topic and inclusion criteria. Table II shows the results of the review that has been conducted on the nine articles.

Antenatal Care

Of the nine articles above, five articles were included to specifically evaluate the relationship between antenatal care and the incidence of low birth weight. The results stated that antenatal care showed a significant relationship with the incidence of low birth weight (OR 3.51; CI 95% 1.13 – 10.91; I2 93%; p = 0.03). In this study, the results of the meta-analysis revealed that antenatal care had a 3.51 times greater risk of experiencing low birth weight. The complete results of the calculation are provided in Figure II.

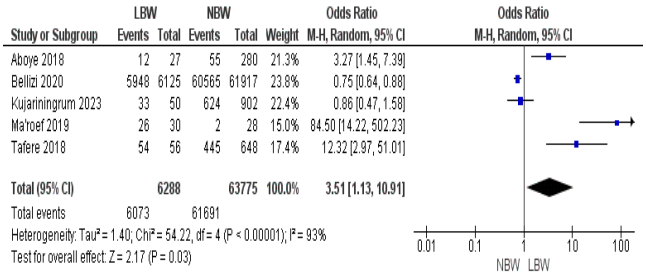

Figure 2: Meta – analysis of antenatal care and the incidence of low birth weight

Mid-Upper Arm Circumference (MUAC)

In addition to 4 antenatal care articles, there were four articles included to evaluate mid-upper arm circumference and the incidence of low birth weight. The results stated that mid-upper arm circumference showed a significant relationship with the incidence of low birth weight (OR 6.06; CI 95% 2.25 – 16.31; I2 67%;

p = 0.004). Similarly, the results of the meta-analysis showed that the upper middle arm circumference had a 6.06 times greater risk of low birth weight. The complete results of the calculation are provided in Figure III.

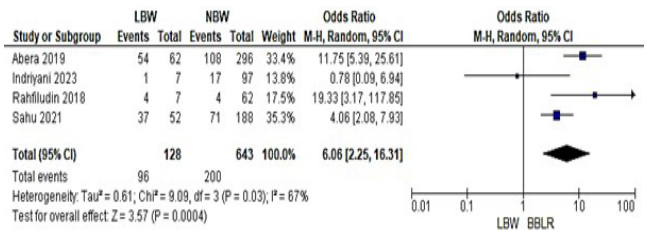

Figure 3: Meta – analysis of mid upper arm circumference and the incidence of low birth weight

DISCUSSION

This study aimed to determine the relationship between antenatal care and mid-upper arm circumference in pregnant women with the incidence of low birth weight. The study analyzed five articles that discussed antenatal care and four articles that discussed the mid-upper arm circumference of pregnant women in Africa and Asia. The results showed that both were associated with low birth weight. Based on the results of the meta-analysis, antenatal care and upper arm circumference of pregnant women had a significant association with the incidence of low birth weight. This finding supports earlier research proving the positive impact of antenatal care on the health of mothers and babies during pregnancy (14). Research by Tuncalp et al, the seven studies were conducted in countries on the continents of Africa and Asia, and the recommendations of the World Health Organization (WHO) were made as a reference in Antenatal Care. WHO recommendations on ANC cover aspects such as nutrition, maternal and fetal assessment, preventive measures, interventions for common physiological symptoms (e.g., nausea, heartburn, constipation), as well as health system interventions to improve ANC uptake, quality of care, and disease management for conditions like malaria, tuberculosis, and HIV (15).

The WHO recommends that a woman's 'contact' with a health care provider should be more than just a 'visit' but should be an opportunity to obtain high-quality services, timely medical care, support, and information during pregnancy. According to the WHO guidelines, pregnant women should have their first contact at 12 weeks' gestation, with subsequent visits at 20, 26, 30, 34, 36, 38, and 40 weeks' gestation(15). In this meta-analysis, at least 88242 newborns and pregnant women were included in birth weight measurements to see the effectiveness of ANC behavior. The analysis revealed that 1,923 babies with low birth weight were born to mothers who did not routinely perform antenatal care at health care centers [12,13,18,19,20].

Antenatal care (ANC) is essential for pregnant women to ensure the health of the mother and baby during pregnancy, childbirth, and the post-natal period (20). Antenatal care includes nutritional interventions, such as diet and key supplements, as well as assessment of maternal and fetal health, preventive measures, and strategies to improve healthcare quality (21). Performing routine ANC in accordance with WHO recommendations can reduce morbidity and mortality rates of mothers and babies (22). Previous studies have shown that compliance with ANC will have an impact on the health of the baby [12-15].

Attendance at ANC at least four times in African countries and six times in Indonesia has a positive impact on birth weight [12,22]. This study found that pregnant women in African countries who attended ANC fewer than four times had a 1.2 times higher risk (95% CI 1.0–1.4) of delivering LBW babies compared to those who attended ANC more than four times (16). Similar findings were reported in Eastern Ethiopia (Amhara and Dawa City), East Africa (Rwanda), and Southern Ethiopia. The Amhara and Dawa City regions had a higher Odd Ratio (OR: 2.3; 95% CI 1.3 – 4.0) rate than other African countries(17). As mentioned earlier, ANC is very influential in the incidence of low birth weight in these two countries. In Indonesia, pregnant women who attended ANC at least six times during pregnancy will have a healthier pregnancy and baby birth compared to those who do not routinely do ANC (24). At one Indonesia hospital, the risk of low birth weight was 4.50 times higher in mothers who do not routinely perform ANC (16). Overall, non-routine ANC behavior in African countries is associated with a higher incidence of low birth weight compared to Asia.

Mid-upper arm circumference (MUAC) during pregnancy is one of the indicators of nutritional status in pregnant women (25). MUAC is the measurement to identify chronic energy deficiency (CED), measured at the mid-point between the tip of the shoulder and the tip of the elbow. According to Indonesian Ministry of Health, MUAC values of below 23.5 cm were the cut-off point for CED (26). Socioeconomic factors such as occupation and income can affect upper arm circumference (27), with low socioeconomic status often leading to inadequate nutritional intake and an upper arm circumference of less than 23.5 cm (28). Pregnant women with a mid-upper arm circumference below 23.5 cm are more likely to have malnutrition, which can negatively affect the mother's condition as well as the baby's (25). Based on the analysis of the four journals above about mid-upper arm circumference, there were 771 pregnant women who experienced malnutrition. MUAC is a good indicator of nutritional status because it reflects the body's protein reserves; a thin MUAC can indicate that pregnant women are experiencing protein deficiency or nutritionally deficient (29). In fact, pregnant women with protein energy deficiency can endanger the health of the baby (30).

In addition to increasing infant mortality rates, pregnant women who lack protein energy also increase infant morbidity rates, for example, Intrauterine growth restriction (IUGR) or low birth weight babies (31). Babies with low birth weight are more susceptible to infections and have a higher risk of developing degenerative diseases(31). The meta-analysis showed that 164 babies weighing less than 2500 grams were born to mothers with a mid-upper arm circumference of less than 23.5 cm. Research on MUAC with low birth weight is mostly obtained from developing countries where inadequate nutritional intake during pregnancy is a common issue (32). The main nutrients needed by mothers during pregnancy include carbohydrates, fats, proteins, vitamins, and minerals (32). If the nutrition is adequate, the effect will be reflected in the nutrition of the pregnant woman and the weight of the baby in the womb. MUAC is closely related to antenatal care (ANC). Regular ANC visits provide opportunities for nutrition education and monitoring MUAC to track pregnancy progress (33).

Based on the meta-analysis, there is a significant relationship between mid-upper arm circumference and low birth weight. Pregnant women with a MUAC of less than 23.5 cm are 1.79 times more likely to deliver low birth weight babies compared to those with normal nutritional status. This finding is consistent with research conducted in five regions in Indonesia, one region in India, and one region in Africa, all of which reported that a low MUAC in pregnant women is associated with an increased risk of low birth weight babies [14,6,16, 15]. Notably, research conducted at a health center in Central Java, Indonesia, reported the highest odds ratio (OR:19.33; 95%CI 3.17 – 117.85), indicating that pregnant women in this region with a MUAC of less than 23.5 cm are more likely to have an LBW baby than those with normal MUAC (35). In India, pregnant women with protein energy deficiency have a 4.06 times higher risk (36), while in Africa, the risk is 11.75 times greater for those with a low MUAC (34).

Limitation

Limitations of this study include the presence of confounding factors, such as pre-pregnancy nutritional status, maternal age, and comorbidities, which were often poorly controlled, limiting the interpretation of causal relationships. Generalizability of the results may also be limited by differences in population, geographic location, and socioeconomic conditions among the studies reviewed. In addition, selection bias in the selection of studies and reliance on secondary data may affect the accuracy of the analysis.

CONCLUSION

In conclusion, antenatal care visits and upper arm circumference have a significant association with the incidence of low birth weight. Pregnant women with a MUAC of less than 23.5 cm and fewer than four ANC visits are at a higher risk of having low birth weight babies. To reduce the incidence of low birth weight, efforts should focus on improving communication, education, and information to pregnant women regarding adequate nutritional intake and comprehensive pregnancy care. Increasing these aspects can help reduce the frequency of LBW.

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