

ORIGINAL RESEARCH

Constructing Sustainable Maternal and Child Health Strategies: Analyzing Factors Associated with Low-Birth-Weight Incidence in Indonesia



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Abstract

Background: Maternal and child health (MCH) is crucial for public health, especially in low- and middle-income countries like Indonesia. Despite improvements in healthcare infrastructure, challenges remain in reducing maternal and neonatal mortality rates, with low birth weight (LBW) posing a significant concern. Previous research has largely examined individual factors, such as maternal age, parity, or nutritional status, in isolation. To date, there has been no comprehensive analysis integrating the various determinants of LBW within the Indonesian context.

Purpose: This study aimed to comprehensively analyze factors associated with LBW incidence in Indonesia to inform sustainable MCH strategies.

Methods: A cross-sectional study design was used to analyze data from 420 newborns and their mothers. A structured questionnaire and medical record reviews were used to collect data on maternal characteristics, antenatal care attendance, birth outcomes, and infant characteristics. Data were obtained from maternal and child health reports collected by primary health centers and hospitals under the Ministry of Health between 2021 and 2023. Statistical analyses, including bivariate Chi-square tests and multivariable logistic regression, were conducted to identify factors associated with LBW incidence.

Results: The prevalence of LBW among newborns was 34.3%. Significant associations were found between LBW and maternal anemia (OR = 1.53; 95% CI = 1.16–2.03), irregular antenatal care attendance (OR 11.9; 95% CI 8.17–17.32), multiparity (OR = 0.61; 95% CI = 0.43–0.88), and preterm birth (OR = 11.22; 95% CI = 7.55–16.68). Primiparous mothers and full-term infants were less likely to experience LBW. Among the associated factors, irregular antenatal care visits and preterm birth emerged as the most dominant risk factors. No significant associations were observed with maternal complications, chronic diseases, infant gender, mode of delivery, or maternal age.

Conclusion: Targeted interventions addressing maternal anemia, improving access to and adherence with antenatal care, and preventing preterm births are critical strategies for reducing LBW in Indonesia. The findings in this study underscore the need to improve maternal nutrition and encourage pregnant women to attend regular antenatal care visits.

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1. Introduction

Maternal and child health (MCH) is a critical issue in global health, particularly in low- and middle-income countries (LMIC) such as Indonesia (WHO, 2025; WHO et al., 2025). Despite the global decline in mother and child mortality rates, disparities in access to and quality of healthcare services continue to be a significant problem. In Indonesia, disparities in antenatal care, a high prevalence of anemia among pregnant women, and ongoing nutritional challenges remain critical issues in MCH, underscoring the need for comprehensive interventions to improve these indicators (Ministry of Health, Republic of Indonesia [MoHRI], 2023; MoHRI, 2024).

The prevalence of low birth weight (LBW), defined as a birth weight below 2,500 grams, serves as an important indicator of MCH quality (Mingude et al., 2020). The WHO reports that

roughly 19.8 million infants (15%) globally are born with LBW, primarily in LMIC (Okwaraji et al., 2024). In 2023, Indonesia recorded a prevalence of LBW of around 6.1%, indicating that approximately 23.6% of infants born with LBW did not receive the necessary medical care, despite LBW being a significant contributor to neonatal mortality (MoHRI, 2023). Recent data from various sources suggest that LBW remains a pressing issue in Indonesia, with approximately 6.9% of infants born with LBW annually (MoHRI, 2024). This high prevalence underscores the urgent need for targeted interventions and policies to address the underlying determinants of LBW and improve MCH outcomes in the country. The absence of therapy for this infant demonstrates the inadequacy of the infant care system and underscores the necessity to enhance postnatal care and targeted healthcare interventions. Consequently, maternal and child health care must prioritize LBW management to prevent avoidable infant mortality. This high prevalence underscores the urgent need for targeted interventions and policies to address the underlying determinants of LBW and improve MCH outcomes in the country (MoHRI, 2024).

In Indonesia, LBW prevalence remains a significant challenge, driven by factors such as socioeconomic disparities, limited access to quality healthcare services, and cultural practices (MoHRI, 2023). LBW not only indicates maternal and infant health issues but also reflects broader social determinants like poverty, education, and healthcare access (MoHRI, 2023). Although various studies have investigated single risk factors, a comprehensive analysis of multiple determinants of LBW in the Indonesian context remains limited. Previous investigations often lacked integration of maternal characteristics, antenatal care practices, and neonatal factors in one model, highlighting the need for a more holistic approach (Okwaraji et al., 2024; Arsyi, 2021).

Maternal health during pregnancy plays a crucial role in fetal growth outcomes, with anemia being one of the significant maternal conditions influencing LBW. Anemia during pregnancy is recognized as a significant contributor to LBW in Indonesia. Recent studies indicate that anemia prevalence among pregnant women in Indonesia is approximately 27.7%-37% (MoHRI, 2023; Sungkar et al., 2022). Anemia, characterized by insufficient red blood cells or hemoglobin levels, is often attributed to poor nutrition, iron deficiency, parasitic infections, and limited access to healthcare services. During pregnancy, anemia can lead to intrauterine growth restriction (IUGR) and subsequently, LBW (Liu et al., 2022). Addressing anemia among pregnant women requires comprehensive strategies that focus on nutrition education, iron supplementation, deworming programs, and improvements in antenatal care services.

Similarly, suboptimal antenatal care utilization, characterized by irregular attendance and inadequate quality of care, hampers the timely detection and management of maternal and fetal health issues, including those related to LBW risk factors (Mingude et al., 2020; Oulay et al., 2018). Antenatal care plays a crucial role in promoting maternal and child health by providing essential services, including screening for complications, monitoring fetal growth, and counseling on healthy behaviors (Yasin et al., 2024). However, barriers such as geographical distance, transportation costs, cultural beliefs, and healthcare provider attitudes often deter pregnant women from seeking timely and adequate antenatal care (Engdaw et al., 2023).

Without prompt and appropriate medical intervention, low birth weight is associated with heightened risks of neonatal morbidity and mortality, such as an increased risk of infections, as well as long-term health complications, such as impaired growth and cognitive development (Mingude et al., 2020). LBW is also closely correlated with stunting, a condition characterized by impaired linear growth in children. Stunting often results from chronic malnutrition, inadequate access to healthcare, and poor sanitation (Ramlan et al., 2025). LBW infants are at increased risk of stunting due to their compromised nutritional status and susceptibility to infections, which further hinder their growth and development (UNICEF, 2023).

The simultaneous incidence of LBW and stunting highlights the necessity of an integrated approach to maternal and child health, extending from the prenatal stage to early childhood, to reduce the long-term consequences of malnutrition and adverse health outcomes. Furthermore, given persistent challenges in maternal and child health outcomes, supported by evidence, research is essential to guide specific interventions and policies to reduce LBW in Indonesia (Wulandari et al., 2023). However, there has been no comprehensive analysis integrating the various determinants of LBW within the Indonesian context. This study aimed to examine the demographic and health-related profile of respondents and identify characteristics associated with LBW in infants in the study group. Specifically, this study explored factors associated with

the occurrence of LBW, including maternal age, parity, maternal anemia, utilization of antenatal care services, gestational age, pregnancy complications, infant gender, and the method of delivery.

2. Methods

2.1. Research design

This study used secondary data and a cross-sectional design to examine the demographic and health-related characteristics of mothers and newborns and to identify factors associated with LBW incidence in the study population. A cross-sectional approach allowed simultaneous collection of data on multiple variables of interest at a single point in time, providing a snapshot of the study population's characteristics and enabling exploration of associations among variables (Rothman, 2021).

2.2. Setting and samples

The study was based on data from Primary Health Services and Provincial Hospitals in Jakarta, which showed a prevalence of LBW of 6.7% (MoHRI, 2024). All newborns and their mothers who attended newborn visits between 2021 and 2023 were randomly selected. Newborns with congenital anomalies or medical conditions affecting birth weight, those born to mothers with a history of chronic illnesses that could impact fetal growth, those from multiple gestations (e.g., twins or triplets), and those whose mothers did not provide consent to participate were excluded from the study. The sample size for this study was determined based on the anticipated prevalence of LBW in the study population and the desired level of precision for estimating this prevalence. Given the lack of recent local data on LBW prevalence in the study area, we conservatively estimated it at 50%, which provided the maximum variability and ensured the required sample size. Using a 95% confidence level and a 5% margin of error, the minimum required sample size was calculated using the formula for estimating proportions in cross-sectional studies (Rothman, 2021). This calculation yielded a minimum sample size of 384 participants, and the final sample included 420 newborns and their mothers.

2.3. Measurement and data collection

Data were collected by professional midwives working at the study sites, who were trained in advance to ensure the proper use of the secondary data collection. All procedures adhered to ethical standards for research involving human subjects. The data used in this study were obtained from primary health services and hospitals that maintained medical record databases.

This study used secondary data from maternal-child health reports recorded in primary health services under the Ministry of Health and from hospitals between 2021 and 2023. Data collection was conducted using structured questionnaires and maternal and child health handbooks. The questionnaire included sections on demographic characteristics (e.g., maternal age, parity), health-related factors (antenatal care utilization, presence of complications or chronic diseases during pregnancy), and birth outcomes (birth weight, gestational age, and method of delivery). Additionally, maternal anemia data were obtained from medical records documenting maternal status during pregnancy.

The primary outcome variable was LBW, defined as birth weight less than 2,500 grams. Independent variables of interest included maternal anemia status, antenatal care patterns (regular vs. irregular visits), gestational age at birth (<37 weeks vs. term), presence of complications or chronic diseases during pregnancy, infant gender, method of delivery, and maternal age. Maternal anemia status was based on hemoglobin test results obtained during pregnancy, with a value <11 g/dL indicating anemia.

2.4. Data analysis

Descriptive statistics were used to summarize the demographic and health-related characteristics of the study population. The prevalence of LBW and other variables of interest was calculated. Bivariate analyses using Chi-square tests were conducted to examine associations between independent variables (anemia status, antenatal visit, parity, gestational age, complications or chronic diseases, infant gender, method of delivery, and maternal age) and LBW incidence. Variables with a p-value <0.05 in the bivariate analysis were subsequently included in multivariable logistic regression models to identify factors independently associated with LBW.

The multivariate logistic regression analysis was performed utilizing the Enter approach to control for all independent variables.

2.5. Ethical considerations

Ethical approval for this study was obtained from the Ethics Committee of Universitas Respati Indonesia (Approval number 1625/KEP/UR/3/2023). All procedures adhered to ethical standards for research involving human subjects. Confidentiality and anonymity of participants' information were strictly maintained. As the study utilized secondary data, direct contact with participants was not required; however, initial consent for the use of personal health information had been obtained at the point of care.

3. Results

3.1. Characteristics of participants

The results of this study present a comprehensive overview of the demographic and health-related characteristics of the respondents. As shown in Table 1, despite the predominance of term births, the substantial prevalence of low birth weight (34.3%) and preterm (31.9%) may negatively impact newborn outcomes. The statistics also reveal that a substantial proportion of mothers had irregular antenatal care visits (71.4%), suggesting possible inadequacies in maternal health services and surveillance during pregnancy. Most respondents were aged 20-35 (70.7%), the typical reproductive age range. Approximately one-fifth of the sample (17.9%) experienced anemia during pregnancy, indicating that maternal health and nutrition remain significant concerns.

Table 1. Characteristics of the participants

Variables	Frequency (f)	Percentage (%)
Birth weight (gram)		
Normal weight (>2500)	276	65.71
Low weight (<2500)	144	34.29
Parity		
1	111	26.43
≥2	309	73.57
Antenatal visit		
Regular	120	28.57
Irregular	300	71.43
Gestational age		
<37 weeks	134	31.90
A term	286	68.10
Complications/chronic diseases		
Yes	66	15.71
No	354	84.29
Infant gender		
Male	217	51.67
Female	203	48.33
Method of delivery		
Cesarean section/ Vacuum-Forceps	252	60.00
Spontaneous delivery	168	40.00
Maternal age		
<20, >35	123	29.29
20-35	297	70.71
Status of anemia		
Anemia	75	17.86
No	345	82.14

3.2. Bivariate analyses of factors associated with LBW

Table 2 presents the bivariate analysis results examining the association between various maternal and neonatal factors and LBW incidence. All odds ratios (ORs) were calculated through Chi-square analyses, comparing the LBW group to the normal birth weight group, which served as the reference category.

According to Table 2, maternal anemia during pregnancy was significantly associated with an increased likelihood of LBW, with infants born to anemic mothers exhibiting a 1.53-fold higher odds of LBW compared to those born to non-anemic mothers (95%CI = 1.16-2.03, $p=0.005$). Moreover, irregular antenatal care attendance emerged as a significant risk factor for LBW, with infants born to mothers with irregular antenatal care visits demonstrating a nearly 12-fold higher odds of LBW compared to those with regular attendance (OR = 11.9, 95%CI = 8.17-17.32, $p<0.001$). Additionally, parity was found to influence the incidence of LBW, with primiparous mothers exhibiting lower odds of delivering LBW infants compared to multiparous mothers (OR = 0.61, 95%CI = 0.43-0.88, $p=0.007$). Gestational age emerged as a significant determinant of LBW in our study, with preterm infants showing a markedly higher risk of LBW compared to term infants. Infants born before 37 weeks of gestation had substantially higher odds of LBW (OR = 11.22, 95% CI = 7.55-16.68) compared to those born at term.

Conversely, the result did not reveal statistically significant associations between LBW and several other variables examined, including complications/chronic diseases ($p=0.20$), infant gender ($p=0.11$), method of delivery ($p=0.34$), and maternal age ($p=1.00$). While these factors are known to influence maternal and infant health outcomes, our findings suggest they may not exert a significant independent effect on LBW risk in this study population.

Table 2. Odds ratios (OR) and 95% confidence intervals (CI) of factors associated with the incidence of LBW

Factors	Birth weight						<i>p</i> -value*
	Low birth weight (144)			Normal weight (276)			
	f	%	OR (95% CI)	f	%	OR (95% CI)	
Status of anemia							
Anemia	36	25.00	1.53 (1.16-2.03)	39	14.13	1.00 (reference)	0.005
Normal	108	75.00	0.76 (0.60-0.95)	237	85.87	1.00 (reference)	
Antenatal visit							
Irregular	119	82.60	11.90 (8.17-17.32)	1	0.36	1.00 (reference)	<0.001
Regular	25	17.40	0.009 (0.001-0.06)	275	99.64	1.00 (reference)	
Parity							
1	26	18.10	0.61 (0.43-0.88)	85	30.80	1.00 (reference)	0.007
≥2	118	81.90	1.23 (1.08-1.41)	191	69.20	1.00 (reference)	
Gestational age							
<37 weeks	121	84.10	11.22 (7.55-16.68)	13	14.49	1.00 (reference)	<0.001
A term	23	15.90	0.10 (0.06-0.17)	263	85.51	1.00 (reference)	
Complications/chronic diseases							
Yes	26	18.06	1.18 (0.84-1.65)	40	14.49	1.00 (reference)	0.20
No	118	81.94	0.90 (0.73-1.11)	236	85.51	1.00 (reference)	
Infant sex							
Male	68	47.20	0.83 (0.64-1.09)	149	53.99	1.00 (reference)	0.11
Female	76	52.80	1.09 (0.95-1.26)	127	46.02	1.00 (reference)	
Method of delivery							
Cesarean section/ Vacuum-Forceps	84	58.30	0.93 (0.71-1.22)	168	60.87	1.00 (reference)	0.34
Spontaneous delivery	60	41.70	1.03 (0.89-1.19)	108	39.13	1.00 (reference)	
Maternal age							
<20, >35	44	30.60	1.02 (0.73-1.35)	79	28.62	1.00 (reference)	1.00
20-35	100	69.40	1.04 (0.85-1.17)	197	71.38	1.00 (reference)	

Notes. *Chi-square test

3.3. Multivariate logistic regression analysis of factors associated with LBW

Table 3 shows that, after controlling for factors associated with LBW, the most dominant factors were antenatal visits (OR = 9.8, 95% CI = 6.12 – 15.64) and gestational age (OR = 10.5, 95% CI = 6.72 – 16.23), both with p -values <0.001. In contrast, maternal anemia status and parity were no longer associated with LBW after adjusting for other related variables.

Table 3. Multivariate logistic regression analysis of factors associated with LBW

Variable	OR	95% CI (Lower–Upper)	p-value*
Status of anemia	1.19	0.48 – 2.92	0.711
Antenatal visits	9.80	6.12 – 15.64	<0.001
Parity	0.80	0.33 – 1.91	0.613
Gestational age	10.50	6.72 – 16.23	<0.001

Notes. *Logistic regression using the enter method

4. Discussion

This study aimed to examine the factors associated with the incidence of LBW by examining demographic factors, as well as maternal and infant-related factors, which are key determinants of maternal and child health and serve as contributing causes of LBW. This study revealed that 34.3% of infants were born with LBW, indicating a high prevalence of LBW in Indonesia. This underscores the urgent need for high-impact, targeted interventions to reduce the incidence of such cases. Identifying the key contributing factors is crucial for informing and guiding effective prevention strategies.

Among the identified risk factors, maternal anemia during pregnancy showed a significant association with LBW, with affected mothers having a 1.53 times higher risk. However, this relationship became less pronounced after controlling for other influencing variables. Infants born to anemic mothers exhibited significantly higher odds of LBW compared to those born to non-anemic mothers. This finding aligns with previous research highlighting the detrimental effects of maternal anemia on fetal growth and development (Bodeau-Livinec et al., 2011). Maternal anemia during pregnancy is recognized as a significant contributor to the risk of LBW in newborns (Wirawan et al., 2023). Anemia, characterized by a deficiency of hemoglobin or red blood cells in the bloodstream, compromises the delivery of oxygen and nutrients to the developing fetus (Garzon et al., 2020). This oxygen and nutrient deprivation can impair fetal growth and development, leading to intrauterine growth restriction (IUGR) and ultimately resulting in LBW at birth (Khan et al., 2016). The inadequate oxygen supply associated with maternal anemia can also lead to placental insufficiency, reducing the transfer of essential nutrients and oxygen to the fetus (Garzon et al., 2020). Additionally, anemia-related hypoxia may trigger compensatory mechanisms in the fetus, such as increased erythropoiesis and alterations in metabolic pathways, which can further disrupt normal fetal development and contribute to LBW. Furthermore, maternal anemia is associated with other adverse pregnancy outcomes, such as preterm birth and intrauterine fetal demise, which further increase the risk of LBW (Bodeau-Livinec et al., 2011). Therefore, addressing maternal anemia through nutritional interventions and iron supplementation programs is crucial for reducing the risk of LBW and improving maternal and neonatal health outcomes in Indonesia (Sungkar et al., 2022).

Another factor associated with LBW in this study was antenatal care attendance. Irregular antenatal visits were significantly associated with a higher risk of LBW, with mothers who had irregular visits being 12 times more likely to deliver LBW infants compared to those with regular antenatal care. Antenatal care plays a crucial role in reducing the incidence of LBW by promoting maternal and fetal health throughout pregnancy (Engdaw et al., 2023). Regular antenatal visits enable healthcare providers to monitor maternal health, detect and manage pregnancy complications, and provide essential interventions to optimize fetal growth and development (Oulay et al., 2018). The findings of our study underscore the importance of adequate, timely antenatal care in reducing the risk of LBW among newborns. Regular antenatal visits facilitate early identification and management of maternal health conditions that may compromise fetal growth, such as maternal anemia, hypertension, and gestational diabetes (Tunçalp et al., 2017; Wulandari et al., 2021). Moreover, antenatal care visits provide opportunities for healthcare providers to educate pregnant women about healthy lifestyle behaviors, including proper nutrition, adequate rest, and avoidance of harmful substances such as tobacco and alcohol, which are essential for supporting optimal fetal growth and development (Mbuagbaw et al., 2016; Yasin et al., 2024).

This study highlighted that primiparous mothers had a lower likelihood of delivering LBW infants compared to multiparous mothers, suggesting a potential protective effect of primiparity

against LBW. This finding aligns with previous research highlighting primiparity's protective effect against LBW. Studies have suggested that primiparous mothers may benefit from physiological adaptations and enhanced maternal-fetal interactions during their first pregnancy, leading to better fetal growth and development (Shirvani & Tayebi, 2021). Additionally, primigravida mothers often receive heightened attention and support from healthcare providers, leading to improved prenatal care utilization and adherence to healthy behaviors during pregnancy (Ahrens et al., 2017).

Another factor strongly associated with LBW in this study was gestational age. Gestational age emerged as a significant determinant of LBW, with preterm infants showing a markedly higher risk of LBW compared to term infants. Infants born before 37 weeks of gestation had substantially higher odds of LBW, highlighting the critical role of gestational age in determining birth weight outcomes. This finding is consistent with previous research indicating that preterm birth is a major risk factor for LBW (Blencowe et al., 2019). Preterm infants often experience intrauterine growth restriction and inadequate fetal development due to shortened gestational duration, leading to lower birth weights (Maheshwari et al., 2022). Additionally, preterm birth is associated with various complications, including respiratory distress syndrome, necrotizing enterocolitis, and intraventricular hemorrhage, further exacerbating the risk of adverse outcomes such as LBW (Morgan et al., 2022). The association between gestational age and LBW underscores the importance of efforts to prevent preterm births and promote optimal fetal development through early identification and management of high-risk pregnancies.

Multivariable analysis in this study confirmed the persistent significance of key determinants of LBW, underscoring the need for targeted interventions focused on these variables (antenatal visits and gestational age) to reduce LBW prevalence in Indonesia effectively. Meanwhile, factors such as maternal complications or chronic illnesses, infant gender, mode of delivery, and maternal age were not significantly associated with LBW. This may be due to the confounding or modifying influence of more dominant factors, particularly gestational age and maternal anemia.

5. Implications and limitations

This study highlights the pivotal role of health workers in improving antenatal care services to reduce the risk of LBW, calling for enhanced access and culturally sensitive approaches. We recommend policies that expand antenatal care services with adequate resources. Health workers such as midwives and nurses should actively prioritize early detection and management of maternal anemia and educate mothers and families to ensure they do the routine antenatal check-up, and collaborate across sectors to prevent preterm births. Furthermore, we urge policymakers to implement comprehensive maternal and neonatal health initiatives that address the underlying determinants of LBW.

This study has several limitations that should be considered for future improvements. The use of secondary data may result in limited information, as certain relevant variables may not be captured. Additionally, the cross-sectional design provides only a snapshot at a single point in time and does not allow for the assessment of causal relationships, which could be better explored using more complex study designs such as cohort studies.

6. Conclusion

In conclusion, this study identified several key factors associated with LBW. Maternal anemia, irregular antenatal care attendance, preterm delivery, and multiparity were found to increase the risk of delivering LBW infants. Among these, irregular antenatal care visits and gestational age emerged as the most dominant risk factors. In contrast, other variables such as pregnancy complications, infant gender, mode of delivery, and maternal age were not significantly associated with the risk of LBW. These findings underscore the need for greater attention to improving maternal nutrition and encouraging pregnant women to attend regular antenatal care visits, both to prevent maternal and neonatal complications and to reduce the prevalence of LBW in Indonesia.

For future research, it is recommended to conduct a more in-depth examination of other potential contributing factors to LBW, such as nutritional intake, environmental influences, and psychological stress related to maternal mental health. In addition, longitudinal or cohort studies are needed to better understand causal relationships and identify pathways that can support the development of effective prevention systems.

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Authors Contribution

GNS contributed as the principal investigator, overseeing the study design, data collection, analysis, and interpretation. DNS, YF, and SM served as co-authors, contributing to the study design, data analysis, and interpretation. All authors critically reviewed and approved the final manuscript for publication.

Conflict of Interest

All of the authors have no financial relationships relevant to this article to declare. All authors have no conflicts of interest to disclose.

References

- Ahrens, K. A., Thoma, M. A., & Rossen, L. M. (2017). Interpregnancy interval and adverse pregnancy outcome; An analysis of successive pregnancies. *Obstetrics Gynecology*, 130(2), 464. <https://doi.org/10.1097/aog.0000000000002173>
- Arsyi, M. (2021). Maternal factors affecting the incidence of low birth weight (LBW) in Indonesia. *International Journal of Pharmaceutical Research*, 13(1), 4197–4203. <https://doi.org/10.31838/ijpr/2021.13.01.557>
- Blencowe, H., Krasevec, J., de Onis, M., Black, R. E., An, X., Stevens, G. A., Borghi, E., Hayashi, C., Estevez, D., Cegolon, L., Shiekh, S., Ponce Hardy, V., Lawn, J. E., & Cousens, S. (2019). National, regional, and worldwide estimates of low birthweight in 2015, with trends from 2000: A systematic analysis. *The Lancet Global Health*, 7(7), e849–e860. [https://doi.org/10.1016/S2214-109X\(18\)30565-5](https://doi.org/10.1016/S2214-109X(18)30565-5)
- Bodeau-Livinec, F., Briand, V., Berger, J., Xiong, X., Massougbdji, A., Day, K. P., & Cot, M. (2011). Maternal anemia in Benin: Prevalence, risk factors, and association with low birth weight. *American Journal of Tropical Medicine and Hygiene*, 85(3), 414–420. <https://doi.org/10.4269/ajtmh.2011.10-0599>
- Engdaw, G. T., Tesfaye, A. H., Feleke, M., Negash, A., Yeshiwas, A., Addis, W., Angaw, D. A., & Engidaw, M. T. (2023). Effect of antenatal care on low birth weight: A systematic review and meta-analysis in Africa, 2022. *Frontiers in Public Health*, 11, 1158809. <https://doi.org/10.3389/fpubh.2023.1158809>
- Garzon, S., Cacciato, P. M., Certelli, C., Salvaggio, C., Magliarditi, M., & Rizzo, G. (2020). Iron deficiency anemia in pregnancy: Novel approaches for an old problem. *Oman Medical Journal*, 35(5), e166. <https://doi.org/10.5001/omj.2020.108>
- Khan, A., Nasrullah, F. D., & Jaleel, R. (2016). Frequency and risk factors of low birth weight in term pregnancy. *Pakistan Journal of Medical Sciences*, 32(1), 138–142. <https://doi.org/10.12669/pjms.321.8120>
- Liu, D., Li, S., Zhang, B., Kang, Y., Cheng, Y., Zeng, L., Chen, F., Mi, B., Qu, P., Zhao, D., Zhu, Z., Yan, H., Wang, D., & Dang, S. (2022). Maternal hemoglobin concentrations and birth weight, low birth weight (LBW), and small for gestational age (SGA): Findings from a prospective study in Northwest China. *Nutrients*, 14(4), 858. <https://doi.org/10.3390/nu14040858>
- Maheshwari, A., Bagga, N., & Panigrahy, N. (2022). Extra-uterine growth restriction in preterm infants. *Newborn*, 1(1), 67–73. <https://doi.org/10.5005/jp-journals-11002-0019>
- Mbuagbaw, L., Habiba Garga, K., & Ongolo-Zogo, P. (2016). Health system and community level interventions for improving antenatal care coverage and health outcomes. *Cochrane Database of Systematic Reviews*, 2016(2), CD010994. <https://doi.org/10.1002/14651858.CD010994>
- Mingude, A. B., Gebretsadik, W., Misker, D., & Woldeamanuel, G. G. (2020). Determinants of low birth weight among live birth newborns delivered at public hospitals in Gamo Gofa zone, South Ethiopia: Unmatched case control study. *SAGE Open Medicine*, 8, 2050312120940544. <https://doi.org/10.1177/2050312120940544>

- Ministry of Health Republic of Indonesia. (2023). *Indonesian health survey 2023*. <https://www.badankebijakan.kemkes.go.id/en/hasil-ski-2023/>
- Ministry of Health Republic of Indonesia. (2024). *Laporan tematik survey kesehatan Indonesia tahun 2023* [Thematic report of the 2023 Indonesian health survey: A portrait of Indonesia's Health]. <https://repository.badankebijakan.kemkes.go.id/id/eprint/5537>
- Morgan, A. S., Mendonça, M., Thiele, N., & David, A. L. (2022). Management and outcomes of extreme preterm birth. *The BMJ*, 376, e055924. <https://doi.org/10.1136/bmj-2021-055924>
- Okwaraji, Y. B., Krasevec, J., Bradley, E., Conkle, J., Stevens, G. A., Gatica-Domínguez, G., Ohuma, E. O., Coffey, C., Estevez Fernandez, D. G., Blencowe, H., Kimathi, B., Moller, A. B., Lewin, A., Hussain-Alkhateeb, L., Dalmiya, N., Lawn, J. E., Borghi, E., & Hayashi, C. (2024). National, regional, and global estimates of low birthweight in 2020, with trends from 2000: a systematic analysis. *The Lancet*, 403(10431), 1071–1080. [https://doi.org/10.1016/S0140-6736\(23\)01198-4](https://doi.org/10.1016/S0140-6736(23)01198-4)
- Oulay, L., Laohasiriwong, W., Phajan, T., Assana, S., & Suwannaphant, K. (2018). Effect of antenatal care on low birth weight prevention in Lao PDR: A case control study. *F1000Research*, 7, 1138. <https://doi.org/10.12688/f1000research.15295.1>
- Ramlan, P., Sukri, P., Abdullah, M. T., Ibrahim, M. A., Hardianti, & Cahyani, A. (2025). Poverty and stunting: A socioeconomic analysis of vulnerable communities; a systematic literature review. *IOP Conference Series: Earth and Environmental Science*, 1475, 012026. <https://doi.org/10.1088/1755-1315/1475/1/012026>
- Rothman, K. J. (2021). The origin of Modern Epidemiology, the book. *European Journal of Epidemiology*, 36(8), 763-765. <https://doi.org/10.1007/s10654-021-00790-0>
- Shirvani, M. A., & Tayebi, T. (2021). Importance of childbirth preparation classes in improving childbirth self-efficacy and reducing worry in primigravidas. *Perinatology*, 22(1), 8–14.
- Sungkar, A., Badosono, S., Irwinda, R., Manikam, N. R. M., Sekartini, R., Medise, B. E., & Nasar, S. S. (2022). A life course approach to the prevention of iron deficiency anemia in Indonesia. *Nutrients*, 14, 277. <https://doi.org/10.3390/nu14020277>
- Tunçalp, Pena-Rosas, J. P., Lawrie, T., Bucagu, M., Oladapo, O. T., Portela, A., & Metin Gülmezoglu, A. (2017). WHO recommendations on antenatal care for a positive pregnancy experience—going beyond survival. *BJOG: An International Journal of Obstetrics and Gynaecology*, 124(6), 860–862. <https://doi.org/10.1111/1471-0528.14599>
- UNICEF. (2023). *Low birthweight*. UNICEF. <https://data.unicef.org/topic/nutrition/low-birthweight/>
- WHO. (2025). *WHO recommendations on maternal health: Guidelines approved by the WHO guidelines review committee*. World Health Organization. <https://www.who.int/publications/i/item/WHO-MCA-17.10>
- WHO, UNICEF, & UNFPA. (2025). *Trends in maternal mortality 2000 to 2020: Estimates*. World Health Organization. <https://www.who.int/reproductivehealth/publications/maternal-mortality-2000-2017/en/>
- Wirawan, F., Yudhantari, D. G. A., & Gayatri, A. (2023). Pre-pregnancy diet to maternal and child health outcome: A scoping review of current evidence. *Journal of Preventive Medicine and Public Health*, 56(2), 110–127. <https://doi.org/10.3961/jpmph.22.472>
- Wulandari, R. D., Laksono, A. D., & Matahari, R. (2023). Policy to decrease low birth weight in Indonesia: Who should be the target? *Nutrients*, 15(2), 456. <https://doi.org/10.3390/nu15020465>
- Wulandari, R. D., Laksono, A. D., & Rohmah, N. (2021). Urban-rural disparities of antenatal care in South East Asia: A case study in the Philippines and Indonesia. *BMC Public Health*, 21, 1221. <https://doi.org/10.1186/s12889-021-11318-2>
- Yasin, R., Azhar, M., Allahuddin, Z., Das, J. K., & Bhutta, Z. A. (2024). Antenatal care strategies to improve perinatal and newborn outcomes. *Neonatology*, 122(Suppl 1), 13–31. <https://doi.org/10.1159/000542702>