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A Systematic Review of Maternal and Sociodemographic Risk Factors for Low Birth Weight in Developing Countries

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ABSTRACT

Low birthweight (LBW) is a global health problem, and its incidence is increasing, especially in developing countries such as Indonesia. Despite its significant impact, systematic reviews on risk factors for low birth weight are scarce, highlighting the need for further research to inform efficacy. This study aimed to conduct a systematic review of maternal and sociodemographic factors in developing countries. This study was a systematic review and used the PRISMA flow diagram to search for eligible articles using the keywords "LBW OR low birthweight" AND "risk factors OR associated factors" AND "LBW in developing countries OR low birthweight in developing countries". CEBMA's critical appraisal was used to select eligible data. The total number of articles included in the study was 15, and the number of participants in the 15 articles was 6057. Based on the description of the primary studies, the most influence factors on the incidence of LBW in developing countries were ANC visits (aOR=172,79), nutrition counseling (aOR=4,05), iron and folic acid intake (aOR= 5,02), anemia during pregnancy (aOR= 3,54), MUAC (aOR= 5,62), maternal height (aOR=20,38), number of deliveries (aOR= 2,28), complications during pregnancy (aOR= 5,70), gestational age (aOR=14,28), and maternal age at conception (aOR= 6,42), maternal education (aOR= 4,19), region of residence (aOR= 3,12), and smoking status (aOR= 1,4). The most influential factors in the incidence of LBW in developing countries were ANC Visit (aOR = 172.79; p-value <0.001), maternal height (aOR 20.38; p-value <0.001), and gestational age (preterm birth) (aOR 14.28; p-value <0.001). Recommendations for future research are to examine risk factors for LBW more comprehensively using meta-analysis and to allow meta-analysis studies to determine the impact of all risk factors on the incidence of LBW.

KEYWORDS: LBW, Low Birthweight, Pregnancy, Pregnant Women, Risk Factors.

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INTRODUCTION

Low birthweight (LBW), classified as weighing less than 2500 grams at birth, is a significant health problem worldwide (WHO, 2014). Babies born with LBW are at increased risk for complications such as breathing difficulties, growth and developmental problems, and increased mortality. The increasing incidence of LBW in many countries underscores significant health challenges that require immediate attention. These challenges include inadequate access to proper healthcare services, insufficient prenatal monitoring, and negative environmental factors affecting both maternal and infant health.

The latest data from UNICEF & WHO (2023) estimates that LBW causes up to 20% of all births worldwide, and the prevalence increases to around 95% in low-income countries. There are large regional differences in the prevalence of LBW, ranging from about 6% in East Asia and the Asia Pacific to13% in sub-Saharan Africa, with the highest rate of about 28% in South Asia. In Indonesia, the neonatal mortality rate in 2020 is reported to be 16.85 per 1,000 live births (BPS, 2020).

Each year, approximately twenty million infants are born with LBW worldwide, accounting for 15.5% of all live births (Devaguru et al., 2023). This figure is reported to be 7% in developed countries, 16.5% in developing countries, and 18.6% in less developed regions (Khazaei et al., 2017). Most LBW births are concentrated in developing regions, particularly Asia (72%) and Africa (22%) (Devaguru et al., 2023). LBW infants are at higher risk of childhood mortality than infants with normal birth weights and are also more vulnerable to infection, disease, and long-term physical, behavioral, learning, and psychosocial difficulties (Mahumud et al., 2017). In developing countries, demographic changes, such as increased life expectancy, have made low birthweight a significant economic burden and a cause of high disease prevalence. Consequently, LBW becomes a crucial problem hindering children's growth and development.

Effective prevention strategies are essential to address LBW. Identifying key risk factors is crucial. Significant factors associated with LBW include maternal age, occupational status, maternal weight, parity, smoking history, multiple pregnancies, poor nutrition during pregnancy, inadequate prenatal supplementation, antenatal care (ANC) visits, and maternal anemia. Despite efforts to manage LBW, the mortality rate of LBW children remains quite high, approximately 20 times that of normal-weight children, including cognitive and neurological impairments, chronic diseases such as hypertension and high cholesterol, and physical and developmental delays (Khazaei et al., 2017).

Research by Sema et al. (2019) and Diabelková et al. (2022) have identified additional risk factors for LBW, including younger

maternal age, shorter birth intervals, family economic status, maternal malnutrition, chronic energy deficiency (CED), pregnancy complications, preterm delivery, maternal chronic disease history, multiple pregnancies, previous history of LBW births, inadequate antenatal care, and active maternal smoking have been identified.

Understanding the risk factors for LBW is critical for governments to develop effective policies to reduce the incidence of LBW. However, systematic reviews on LBW, particularly in countries with high incidence, are lacking. Existing reviews often focus on developed countries or specific factors such as maternal nutrition or socioeconomic status, without a comprehensive view of the various determinants. Furthermore, much of the existing literature does not incorporate the latest data or consider regional variations in LBW prevalence determinants. This review aims to address these gaps by integrating current data and providing a comprehensive analysis of LBW risk factors in developing countries. The novelty of this review lies in its holistic and comprehensive approach, focusing on regional differences to provide deeper insights for developing more effective interventions.

LITERATURE REVIEW

Low Birth Weight (LBW)

Birth weight is an important measurement determined by weighing a baby in the first hour after birth. Based on these measurements, babies can be classified into several categories based on their birth weight: low birth weight babies weighing less than 2500 grams, normal birth weight babies weighing between 2500 and 4000 grams, and overweight babies weighing more than 4000 grams. This classification plays a crucial role in health care because birth weight is often an early indicator of a baby's health, nutritional status, and risk of various health problems in early life (Gladstone et al., 2021).

In addition to weight classification, births can also be differentiated based on the relationship between birth time and gestational age. In this case, a baby is categorized as preterm if born at less than 37 weeks' gestation. A baby is considered full-term if born between 37 and 42 weeks' gestation, while a baby born at more than 42 weeks' gestation is classified as postterm. This categorization is important for understanding differences in physical characteristics and potential health risks (Kuo et al., 2025). Low Birth Weight (LBW) specifically refers to babies born weighing less than 2,500 grams, regardless of gestational age. Since 1961, the WHO has replaced the term "prematurity" with "LBW," as not all babies weighing less than 2,500 grams are considered premature. Some babies are born full-term or even later but still have a low birth weight, so the term LBW is considered to better reflect the actual clinical condition (Krasevec et al., 2022).

LBW classification can be viewed from two main aspects: birth weight and gestational age. With advances in medical technology and increasingly effective neonatal care, birth weight classification has become more detailed, providing a clearer picture of the baby's condition. Based on birth weight, babies born weighing between 1,500 and 2,500 grams are classified as low birth weight (LBW) (Alabbad et al., 2024). Babies with a lower birth weight, between 1,000 and 1,500 grams, are classified as very low birth weight (VLBW). Meanwhile, a more extreme category is extremely low birth weight (VLBW), meaning babies born weighing less than 1,000 grams. This classification is important because the lower the baby's birth weight, the higher the risk of health complications and the more intensive care required to support the baby's survival (AlQurashi, 2021).

In addition to weight, LBW classification can also be based on gestational age, or the length of pregnancy at birth. In this category, the term "pure prematurity" is used, which refers to babies born at less than 37 weeks' gestation but with a birth weight appropriate for their gestational age. This condition indicates that even though the baby was born prematurely, their intrauterine growth remained within normal limits. Conversely, there is also the category of "dysmaturity," which refers to babies born with a lower birth weight than expected for their gestational age (Roggero et al., 2024). Babies in this "dysmaturity" group experience intrauterine growth retardation and are often classified as small for gestational age (SGA). This classification based on gestational age is crucial because it helps medical personnel determine a treatment approach, considering that pure premature babies require different treatment than dysmature babies, even though both are classified as LBW (Damhuis et al., 2021).

The characteristics of low birth weight (LBW) babies can be identified by a number of physical signs and distinctive physiological conditions. In general, LBW babies weigh less than 2,500 grams, have a body length that usually does not reach 45 cm, a head circumference of less than 33 cm, and a chest circumference smaller than 30 cm. This smaller body size is closely related to growth limitations during pregnancy (Matsas et al., 2023). Furthermore, LBW babies tend to be less active because their muscles are still hypotonic or weak, so their motor reflexes are not as strong as those of babies with a normal birth weight. Gestational age is also generally less than 37 weeks, so most LBW babies are born prematurely. The baby's body proportions are also different, with a head that appears larger in comparison to the body, thin and fine hair growth, and a soft skull with relatively large fontanelles and sutures (Fournier-Goodnight & Holm, 2024).

Other common characteristics include ears with thin cartilage and a simple shape, as well as the absence of breast tissue and small nipples. The respiratory system of LBW babies is also not fully mature, characterized by an irregular breathing pattern and frequent apnea attacks. Skin-wise, babies have thin, translucent skin with abundant lanugo, or fine hair, especially on the forehead, temples, and arms (Ding et al., 2024). This condition is exacerbated by a lack of subcutaneous fat, making the baby appear thin and vulnerable to heat loss. Genital characteristics also show imperfections; for example, in baby girls, the labia minora are not fully covered by the labia majora. Important reflexes such as sucking, swallowing, and coughing are still weak, so LBW babies often have difficulty meeting their nutritional needs (Verduci et al., 2021).

From an immune perspective, LBW babies are at high risk of infection because their immune systems are not fully developed. Leukocytes are still low in their ability to fight disease, while antibody production is also inadequate, severely limiting their

immune system. This condition requires intensive care from birth. Therefore, preventive measures should be implemented during the antenatal period to minimize the risk of preterm labor and prevent the birth of low birth weight babies. This prevention includes optimal pregnancy care, monitoring maternal nutrition, early detection of complications, and comprehensive medical supervision so that fetal growth can proceed normally until the pregnancy reaches full term (Hunter et al., 2023).

METHODS

The study is a systematic review design and utilizes secondary data from existing and published survey studies. Reputable databases such as PubMed, Cochrane Library, Science Direct, and DOAJ were used to search for articles. Searches were conducted using keywords such as "LBW OR low birthweight" AND "risk factors OR associated factors" AND "LBW in developing countries OR low birth weight in developing countries". The final search was completed in November 2020. Inclusion criteria for this study were case-control studies published between 2015 and 2022 with available secondary data, including adjusted odds ratio (aOR) value. In addition, papers had to be available for full-text access. Articles were excluded if they did not focus on developing countries as defined by GDP per capita, Human Development Index (HDI), or World Bank classification, or if they were not written in English.

The paper selection process was based on the PRISMA flow diagram (UNC, 2020) and encompassed the identification, screening, and inclusion (eligibility) stages. In the identification phase, duplicate papers were removed. In the screening phase, papers that did not meet the criteria were excluded, including papers published outside the 2015-2022 time period, non-English language papers, non-full-text papers, paid papers, and papers lacking adjusted odds ratio values (aOR). During the inclusion phase, selected articles underwent critical appraisal to assess their validity and relevance. The researchers used Mendeley software to eliminate duplicate articles, screened using Microsoft Excel, and independently managed the entire process for two weeks.

The selection of data collection in this study utilized a 3-step PRISMA flowchart (UNC, 2020). Initially, the identification stage included the formulation of specific and accurate research questions. Related literature was searched using appropriate databases such as PubMed, Science Direct, Cochrane Library, and DOAJ. At the included stage, the screened articles underwent a quality assessment using the Center for Evidence-Based Medicine (CEBM) standards for Case-Control Studies. In this study, only articles that showed a significant rating of 50% or higher were used. In the selection phase, articles were selected by evaluating the title, abstract, and full text based on the prescribed inclusion and exclusion criteria. Articles that met the criteria were retained for further evaluation.

RESULT AND DISCUSSION

Results of the paper search were obtained by searching papers through databases, including journals. Details of the search are shown in Figure 1.

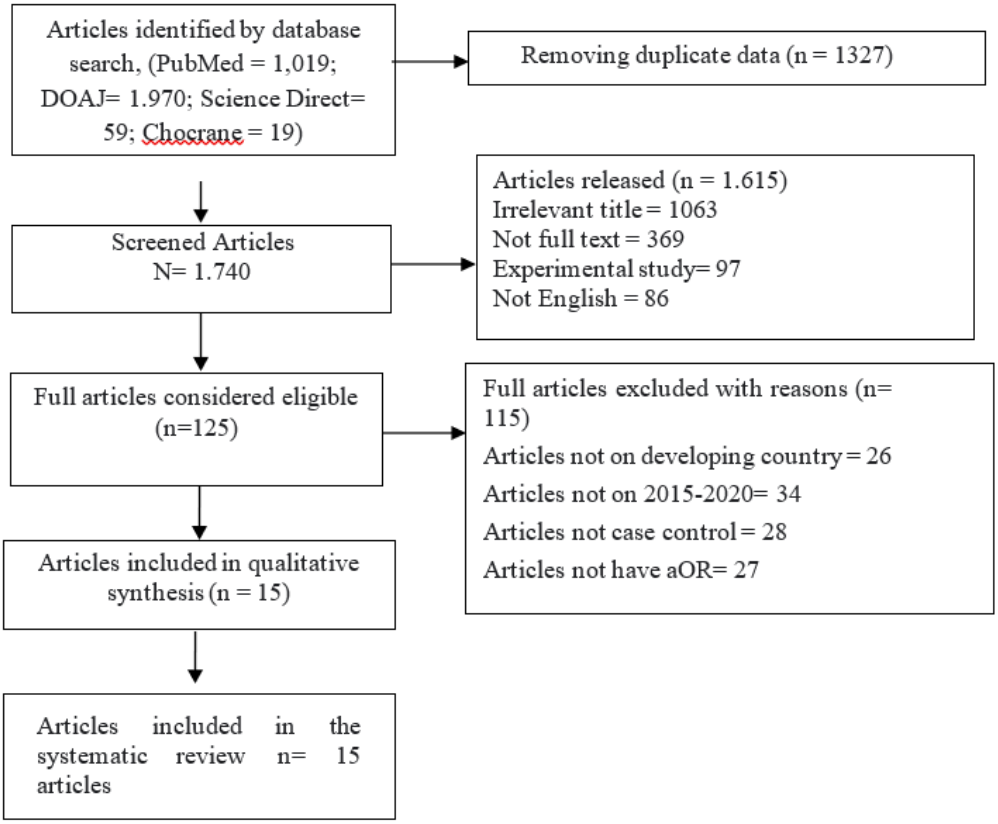

Figure 1. Prisma Flow Diagram

After the paper was searched, the quality evaluation was carried out using CEBMA's (Center for Evidence-Based Medicine). The assessment of the quality of the case-control study consists of 12 questions, but (1) Does the study address a clearly focused question /problem? (2) Is the research methodology (research design) appropriate to answer the research questions? (3) Were a sufficient number of subjects (employees, teams, departments, organizations) involved in the study to establish that the research results did not occur by chance? (4) Is the selection of cases and controls based on external, objective, and validated criteria? (5) Were the two groups comparable at the beginning of the study? (6) Are objective and unbiased outcome criteria being used? (7) Is data dredging being performed? (8) Are objective and validated measures of outcome being used to measure the results? (9) Are the effect sizes substantially related? (10) How accurate are the effect estimates? (11) Are there possible unexplained confounding factors? and (12) Are the results applicable to your organization?

A score of 2 was given to those who answered "available", a score of 1 was given to those who answered "available but cannot be explained", and a score of 0 was given to those who answered "not available".

Table 1. Critical Appraisal Assessment

Author (Year)	Checklist Question												Total
	1	2	3	4	5	6	7	8	9	10	11	12	
Deriba and Jemal (2021)	2	2	2	2	0	2	1	2	2	2	0	2	19
Demelash et al (2015)	2	2	2	2	0	2	2	2	2	2	1	2	21
Adam et al (2019)	2	2	2	2	0	2	2	0	2	2	1	2	19
Girma et al (2019)	2	2	2	2	0	2	2	2	1	2	2	2	21
Ahmed (2018)	2	2	2	2	1	2	2	2	2	2	2	2	23
Tadese et al (2021)	2	2	2	2	0	2	2	0	2	2	2	2	20
Asmare et al (2018)	2	2	2	2	2	2	0	2	2	2	2	2	22
Desta et al (2020)	2	2	2	2	2	2	0	0	2	2	2	2	20
Kargbo et al (2021)	2	2	2	2	2	2	2	2	2	2	0	2	22
Gizaw and Gebremedhin (2018)	2	2	2	2	0	2	2	2	2	2	0	2	20
Hailu and Kebede (2018)	2	2	0	2	0	2	2	0	2	2	2	2	18
Bhaskar et al (2015)	2	2	1	2	2	2	2	0	2	2	0	2	19
Wachamo et al (2019)	2	2	2	2	2	2	0	2	2	2	0	2	20
Sharma et al (2015)	2	2	2	2	2	2	2	2	2	2	0	2	22
KC et al (2020)	2	2	2	2	2	2	0	2	2	2	2	2	22

Based on the table above, the article is subject to systematic review, since the critical rating score is 50% or more. Important assessments are used to evaluate the research subject to study. If the study score exceeds 50% (score >12) and meets the inclusion criteria, it can be used in this study.

Important Evaluation: if the evaluation has been completed, the selected article will be listed in the table. This table consists of the author, country, study design, sample, and PICO analysis. P (Population) is the mother who gives birth to a baby, I (Intervention) do a questionnaire or interview administration questionnaire, C (Comparison) compares with the mother who gives birth to a baby with normal birth weight, and O (Outcome) is the factor that causes the baby to be born with LBW. After PICO analysis, the article will be identified based on the study result, i.e, the intensity associated with LBW with the risk factors in the adjusted Odds Ratio (aOR). Description of the primary study in Appendix 1 and the adjusted Odds Ratio (aOR)of LBW Risk Factors in Developing Countries in Appendix 2.

The main risk factors for LBW can be categorized into maternal factors and socio-demographic factors. Maternal factors include ANC visits, nutritional counseling, iron and folic acid consumption, anemia, MUAC, maternal height, parity, complications during pregnancy, gestational weeks at birth, and maternal age at pregnancy.

Regular ANC visits are important to monitor pregnancy and prevent complications, significantly reducing the incidence of LBW. Studies have shown that mothers who do not attend ANC checkups are 172.79 times more likely to have LBW babies than those who regularly attend (Anil et al., 2020; Asmare et al., 2018; Bhaskar et al., 2015; Deriba & Jemal, 2021; Desta et al., 2020; Gizaw & Gebremedhin, 2018; Kargbo et al., 2021; Tadese et al., 2021). ANC visits also provide important nutritional counseling, and mothers who do not receive nutritional counseling are 4.05 times more likely to have LBW babies (Ahmed et al., 2018; Girma et al., 2019). In addition, iron and folic acid intake during pregnancy significantly increases the likelihood of normal birth weight by 5.02 times (Desta et al., 2020; Deriba & Jemal, 2021; Adam et al., 2019; Girma et al., 2019; Ahmed et al., 2018; Tafere et al., 2018; Asmare et al., 2018; Hailu & Kebede, 2018).

Anemia during pregnancy is another important factor, which increases the likelihood of LBW by a factor of 1 to 3.54 (Adam et

al., 2019; Ahmed et al., 2018; Bhaskar et al., 2015; Deriba & Jemal, 2021; Girma et al., 2019; Gizaw & Gebremedhin, 2018; Sharma et al., 2015; Tadese et al., 2021). Low hemoglobin levels lead to insufficient oxygen supply to the fetus and impaired growth (Ahmed et al., 2018; Kargbo et al., 2021). MUAC (Mid-Upper Arm Circumference) is an important indicator of maternal nutrition, and mothers with MUAC less than 23 cm are 5.62 times more likely to have LBW babies (Ahmed et al., 2018; Asmare et al., 2018; Deriba & Jemal, 2021; Girma et al., 2019). Similarly, a mother's height of less than 155 cm increases the LBW risk by a factor of 20.3 (Bhaskar et al., 2015; Desta et al., 2020).

Nutritional problems are a major factor contributing to premature birth (before 37 weeks), which is one of the main causes of LBW due to incomplete development of fetal organs and body weight (Asmare et al., 2018; Hailu and Kebede et al., 2018). (Sema et al., 2019) noted that each unit increase in preterm birth score increases the probability of LBW by 18.48 times (AOR = 18.48, 95% CI: 6.51, 52.42). Gestational age of less than 37 weeks affects the incidence of LBW 14.28 times compared to gestational age more than 37 weeks (Desta et al., 2020). Childbirth at a gestational age of less than 32 weeks can cause a 58.5-fold increase in the likelihood of LBW compared to gestational ages above 37 weeks (Demelash et al., 2015).

Complications during pregnancy also significantly affect the incidence of LBW. (Wachamo et al., 2019) found that mothers with pregnancy complications are 5.70 times more likely to have LBW babies than uncomplicated mothers. Complications such as pregnancy-induced hypertension can cause pre-eclampsia, reduce fetal perfusion and nutritional supply, and trigger intrauterine growth restriction (IUGR) and intrauterine fetal death (IUFD) (Xi et al., 2020). For immature reproductive development, especially younger maternal age under the age of 20, is another cause of LBW (Adam et al., 2019). Although some studies have not found that maternal age is a significant predictor of LBW(Elaabsi et al., 2022), others report that pregnant women under the age of 20 are 20 times more likely to have LBW babies compared to pregnant women over the age of 2 (Sharma et al., 2015). Similar results have been found in studies conducted by (Asmare et al., 2018; Deriba & Jemal, 2021; Hailu & Kebede, 2018; and Kargbo et al., 2021), which show that mothers under the age of 20 and over the age of 35 are risk factors for pregnancy. Pregnant women under the age of 20 affect the incidence of LBW by 6.42 times compared to mothers aged 21-35 years (Desta et al., 2020). The condition of nulliparity or primigravida also increases the risk of LBW. Primiparous mothers are 1.8 times more likely to have LBW babies (Anil et al., 2020). On the other hand, the risk of a prolific mother is 2.28 times, and the risk of a large mother is 2.20 times (Tadese et al., 2021). This increased risk in primigravida mothers is due to the short length of the endometrial cavity, which can lead to premature birth. Premature birth is the most important risk factor for LBW(Ediriweera et al., 2017).

Social demographic factors such as maternal education, occupation, residence, and smoking status also indirectly cause LBW. Based on the research by (Adam et al., 2019), found that mothers with only primary education are 1.15 times more likely to have LBW babies. Mothers with secondary education are 4.19 times more likely (Adam et al., 2019; Asmare et al., 2018; Demelash et al., 2015; Tadese et al., 2021). Maternal education is one of the risks of LBW. Education can affect a person's perception and disposition of many things, including health. In higher education, a person can determine what is good for their pregnancy. Both nutrition, activity, and health services are good for her and the fetus contained in her (Demelash et al., 2015). Formal education taken by mothers can increase their capacity so that they can earn better. Education can force a person to make independent decisions (Gizaw & Gebremedhin, 2018). Therefore, mothers who do not work and do not have skills, even if they come from a low middle class, can cause their babies to be born in LBW. Unemployment and poverty contribute to the nutritional intake of mothers during pregnancy (Kargbo et al., 2021)

Therefore, with insufficient education and a lack of work, the likelihood of a pregnant woman living in unsafe housing affects pregnancy. Mothers living in rural areas were found to be at higher risk for LBW because of a lack of medical care in rural areas; while mothers living in urban areas were more likely to have LBW children due to lack of rest and ongoing work during pregnancy (Demelash et al., 2015). Maternal residence in rural areas may have a 3.12-fold effect on the incidence of LBW compared to living in urban areas (Tadese et al., 2021). Similar things have been found in other studies (Asmare et al., 2018; Demelash et al., 2015). However, a study conducted by (Gizaw & Gebremedhin, 2018) reported that mothers living in urban areas may have a 0.66-fold effect on the incidence of LBW babies compared to rural mothers.

Smoking is one of the influencing factors affecting LBW babies. Some studies have revealed that families with lower middle-class incomes are more likely to use cigarettes (Mallol et al., 2021). As a result, pregnant women in this situation can be exposed to tobacco smoke. Pregnant women who are exposed to tobacco smoke during their pregnancy may have children with low birth weight. This is due to a decrease in fetal supply caused by carbon monoxide and nicotine-related vasoconstriction that inhibits fetal growth (Kargbo et al., 2021; Xi et al., 2020). Another socio-demographic factor is secondhand smoke, which may increase the incidence of LBW (Anil et al., 2020).

CONCLUSIONS

The results of this systematic review highlight that the most influential factors associated with the incidence of low birthweight in developing countries are gestational age, maternal height, and antenatal care (ANC) visits. These findings underscore that LBW is not only a medical issue but also a reflection of broader maternal health and sociodemographic conditions. The interrelation between nutritional status, maternal characteristics, and access to health services indicates that interventions targeting a single factor may not be sufficient to reduce the prevalence of LBW. Instead, comprehensive strategies are required that simultaneously address maternal nutrition, quality of antenatal care, early detection of pregnancy complications, and broader determinants such as education and living conditions. Therefore, tackling LBW should be approached through multi-sectoral and multi-component efforts involving the health sector, community programs, and policy-level interventions. Strengthening maternal health services, expanding access to nutrition counseling, and ensuring adequate supplementation during pregnancy are critical

steps. At the same time, improving education, reducing socioeconomic disparities, and addressing lifestyle-related risks can enhance maternal well-being and ultimately lower LBW incidence. A collaborative approach between healthcare providers, policymakers, and community stakeholders is essential to create sustainable improvements and break the cycle of risk factors contributing to low birthweight in developing countries.

REFERENCES

1. Adam, Z., Ameme, D. K., Nortey, P., Afari, E. A., & Kenu, E. (2019). Determinants of low birth weight in neonates born in three hospitals in Brong Ahafo region, Ghana, 2016- an unmatched case-control study. BMC Pregnancy and Childbirth, 19(1), 1–9. https://doi.org/10.1186/s12884-019-2315-6
2. Ahmed, S., Hassen, K., & Wakayo, T. (2018). A health facility based case-control study on determinants of low birth weight in Dassie town, Northeast Ethiopia: The role of nutritional factors. Nutrition Journal, 17(1), 1–10. https://doi.org/10.1186/s12937-018-0409-z
3. Alabbad, D. A., Ajibi, S. Y., Alotaibi, R. B., Alsqer, N. K., Alqahtani, R. A., Felemban, N. M., ... & Youldash, M. M. (2024). Birthweight range prediction and classification: A machine learning-based sustainable approach. Machine Learning and Knowledge Extraction, 6(2), 770-788.
4. AlQurashi, M. A. (2021). Survival rate of very low birth weight infants over a quarter century (1994–2019): A single-institution experience. Journal of Neonatal-Perinatal Medicine, 14(2), 253-260.
5. Anil, K. C., Basel, P. L., & Singh, S. (2020). Low birth weight and its associated risk factors: Health facility-based case-control study. PLoS ONE, 15(6 June), 1–10. https://doi.org/10.1371/journal.pone.0234907
6. Asmare, G., Berhan, N., Berhanu, M., & Alebel, A. (2018). Determinants of low birth weight among neonates born in Amhara Regional State Referral Hospitals of Ethiopia: Unmatched case control study. BMC Research Notes, 11(1), 1–7. https://doi.org/10.1186/s13104-018-3568-2
7. Bhaskar, R. K., Deo, K. K., Neupane, U., Chaudhary Bhaskar, S., Yadav, B. K., Pokharel, H. P., & Pokharel, P. K. (2015). A Case Control Study on Risk Factors Associated with Low Birth Weight Babies in Eastern Nepal. International Journal of Pediatrics, 2015, 1–7. https://doi.org/10.1155/2015/807373
8. Damhuis, S. E., Ganzevoort, W., & Gordijn, S. J. (2021). Abnormal fetal growth: small for gestational age, fetal growth restriction, large for gestational age: definitions and epidemiology. Obstetrics and gynecology clinics of North America, 48(2), 267-279.
9. Demelash, H., Motbainor, A., Nigatu, D., Gashaw, K., & Melese, A. (2015). Risk factors for low birth weight in Bale zone hospitals, South-East Ethiopia : A case-control study. BMC Pregnancy and Childbirth, 15(1), 1–10. https://doi.org/10.1186/s12884-015-0677-y
10. Deriba, B. S., & Jemal, K. (2021). Determinants of Low Birth Weight Among Women Who Gave Birth at Public Health Facilities in North Shewa Zone: Unmatched Case-Control Study. Inquiry (United States), 58, 1–11. https://doi.org/10.1177/00469580211047199
11. Desta, S. A., Damte, A., & Hailu, T. (2020). Maternal factors associated with low birth weight in public hospitals of Mekelle city, Ethiopia: A case-control study. Italian Journal of Pediatrics, 46(1), 1–9. https://doi.org/10.1186/s13052-020-00890-9
12. Devaguru, A., Gada, S., Potpalle, D., Dinesh Eshwar, M., & Purwar, D. (2023). The Prevalence of Low Birth Weight Among Newborn Babies and Its Associated Maternal Risk Factors: A Hospital-Based Cross-Sectional Study. Cureus, 15(5). https://doi.org/10.7759/cureus.38587
13. Diabelková, J., Rimárová, K., Urdzík, P., Dorko, E., Houžvičková, A., Andraščíková, Š., Drabiščák, E., & Škrečková, G. (2022). Risk Factors Associated With Low Birth Weight. Central European Journal of Public Health, 30(June), S43–S49. https://doi.org/10.21101/cejph.a6883
14. Ding, J., Wei, C., Xu, Y., Dai, W., & Chen, R. (2024). 3D printing of Ceffe-infused scaffolds for tailored nipple-like cartilage development. BMC biotechnology, 24(1), 25.
15. Ediriweera, D. S., Dilina, N., Perera, U., Flores, F., & Samita, S. (2017). Risk of low birth weight on adulthood hypertension - Evidence from a tertiary care hospital in a South Asian country, Sri Lanka: A retrospective cohort study. BMC Public Health, 17(1), 15–20. https://doi.org/10.1186/s12889-017-4268-x
16. Elaabsi, M., Loukid, M., & Lamtali, S. (2022). Socio-economic and cultural determinants of mothers and fathers for low birth weight newborns in the region of Marrakech (Morocco): A case-control study. PLoS ONE, 17(6 June), 1–10. https://doi.org/10.1371/journal.pone.0269832
17. Fournier-Goodnight, A., & Holm, H. B. (2024). Early neurobehavioral outcomes in infants with suspected abusive head trauma: performance across and relationship between measures. Applied Neuropsychology: Child, 13(4), 385-393.
18. Girma, S., Fikadu, T., Agdew, E., Haftu, D., Gedamu, G., Dewana, Z., & Getachew, B. (2019). Factors associated with low birthweight among newborns delivered at public health facilities of Nekemte town, West Ethiopia: A case control study. BMC Pregnancy and Childbirth, 19(1), 1–6. https://doi.org/10.1186/s12884-019-2372-x
19. Gizaw, B., & Gebremedhin, S. (2018). Factors associated with low birthweight in North Shewa zone, Central Ethiopia: Case-control study. Italian Journal of Pediatrics, 44(1), 1–9. https://doi.org/10.1186/s13052-018-0516-7
20. Gladstone, M. E., Salim, N., Ogillo, K., Shamba, D., Gore-Langton, G. R., Day, L. T., ... & Lawn, J. E. (2021). Birthweight measurement processes and perceived value: qualitative research in one EN-BIRTH study hospital in Tanzania. BMC pregnancy and childbirth, 21(Suppl 1), 232.
21. Hailu, L. D., & Kebede, D. L. (2018). Determinants of low birth weight among deliveries at a Referral Hospital in Northern Ethiopia. BioMed Research International, 2018. https://doi.org/10.1155/2018/8169615
22. Hunter, P. J., Awoyemi, T., Ayede, A. I., Chico, R. M., David, A. L., Dewey, K. G., ... & Askari, S. (2023). Biological and pathological mechanisms leading to the birth of a small vulnerable newborn. The Lancet, 401(10389), 1720-1732.

23. Kargbo, D. K., Nyarko, K., Sackey, S., Addo-Lartey, A., Kenu, E., & Anto, F. (2021). Determinants of low birth weight deliveries at five referral hospitals in Western Area Urban district, Sierra Leone. Italian Journal of Pediatrics, 47(1), 1–11. https://doi.org/10.1186/s13052-021-01160-y
24. Khazaei, Z., Mehdi, M., Bagheri, Goodarzi, E., Moayed, L., Ebrahim, N., Abadi, Maryam, S., Bechashk, Shokrollah, Mohseni, Mansoureh, Safizadeh, Maryam, Behseresht, Ahmad, Naghibzadeh, & -Tahami. (2017). Risk Factors Associated with Low Birth Weight Among Infants: A Nested Case-Control Study in Southeastern Iran. International Journal of Preventive Medicine, 8, 1–6. https://doi.org/10.4103/ijpvm.IJPVM
25. Krasevec, J., Blencowe, H., Coffey, C., Okwaraji, Y. B., Estevez, D., Stevens, G. A., ... & Hayashi, C. (2022). Study protocol for UNICEF and WHO estimates of global, regional, and national low birthweight prevalence for 2000 to 2020. Gates open research, 6, 80.
26. Kuo, C. H., Wu, Y. L., Chen, C. N., Lo, Y. R., Yen, I. W., Fan, K. C., ... & Li, H. Y. (2025). Re-evaluating large for gestational age: differential effects on perinatal outcomes in term and premature births. Frontiers in Medicine, 11, 1498712.
27. Mahumud, R. A., Sultana, M., & Sarker, A. R. (2017). Distribution and determinants of low birth weight in developing countries. Journal of Preventive Medicine and Public Health, 50(1), 18–28. https://doi.org/10.3961/jpmph.16.087
28. Mallol, J., Urrutia-Pereira, M., Mallol-Simmonds, M. J., Calderón-Rodríguez, L., Osses-Vergara, F., & Matamala-Bezmalinovic, A. (2021). Prevalence and Determinants of Tobacco Smoking among Low-Income Urban Adolescents. Pediatric, Allergy, Immunology, and Pulmonology, 34(2), 60–67. https://doi.org/10.1089/ped.2021.0018
29. Matsas, A., Panopoulou, P., Antoniou, N., Bargiota, A., Gryparis, A., Vrachnis, N., ... & Valsamakis, G. (2023). Chronic stress in pregnancy is associated with low birth weight: a meta-analysis. Journal of Clinical Medicine, 12(24), 7686.
30. Roggero, P., Ryumina, I., Gunier, R. B., Winsey, A., Rauch, S. A., Zarco, I. A. C., ... & Villar, J. (2024). Postnatal growth of etiologically characterized preterm newborns according to gestational age at birth. Pediatric Research, 1-9.
31. Sema, A., Tesfaye, F., Belay, Y., Amsalu, B., Bekele, D., & Desalew, A. (2019). Associated Factors with Low Birth Weight in Dire Dawa City, Eastern Ethiopia: A Cross-Sectional Study. BioMed Research International, 2019. https://doi.org/10.1155/2019/2965094
32. Sharma, S. R., Giri, S., Timalsina, U., Bhandari, S. S., Basyal, B., Wagle, K., & Shrestha, L. (2015). Low birth weight at term and its determinants in a tertiary hospital of nepal:A case-control study. PLoS ONE, 10(4), 1–10. https://doi.org/10.1371/journal.pone.0123962
33. Tadese, M., Minhaji, A. S., Mengist, C. T., Kasahun, F., & Mulu, G. B. (2021). Determinants of low birth weight among newborns delivered at Tirunesh Beijing General Hospital, Addis Ababa, Ethiopia: a case-control study. BMC Pregnancy and Childbirth, 21(1), 1–9. https://doi.org/10.1186/s12884-021-04275-6
34. Tafere, T. E., Afework, M. F., & Yalew, A. W. (2018). Providers adherence to essential contents of antenatal care services increases birth weight in Bahir Dar City Administration, north West Ethiopia: A prospective follow up study. Reproductive Health, 15(1), 1–8. https://doi.org/10.1186/s12978-018-0610-8
35. UNC. (2020). Creating a PRISMA flow diagram: PRISMA 2020.
36. UNICEF & WHO. (2023). Low Birthweight.
37. Verduci, E., Calcaterra, V., Di Profio, E., Fiore, G., Rey, F., Magenes, V. C., ... & Zuccotti, G. V. (2021). Brown adipose tissue: new challenges for prevention of childhood obesity. a narrative review. Nutrients, 13(5), 1450.
38. Wachamo, T. M., Yimer, N. B., & Bizuneh, A. D. (2019). Risk factors for low birth weight in hospitals of North Wello zone, Ethiopia: A case-control study. PLoS ONE, 14(3), 1–15. https://doi.org/10.1371/journal.pone.0213054
39. WHO. (2014). Low birth weight. Jama, 287(2), 270. https://doi.org/10.1001/jama.287.2.270
40. Xi, C., Luo, M., Wang, T., Wang, Y., Wang, S., Guo, L., & Lu, C. (2020). Association between maternal lifestyle factors and low birth weight in preterm and term births: A case-control study. Reproductive Health, 17(1), 1–9. https://doi.org/10.1186/s12978-020-00932-9

Appendix 1. Description of Primary Studies

Author (Year)	Country	Study Design	Sample	P	I	C	O
Deriba and Jemal (2021)	North Shewa	Case-Control	Cases Grup: 190 Control Grup: 380	Newly delivered mothers	Data was collected using interviewer-administered questionnaire. A questionnaire has been prepared in regional languages and English	Mothers who give birth to babies weighing more than 2500 gr	Education, Nutrition Counseling, Iron and Folic Acid Consumption, Menu Choices, Restrictions in Food, MUAC of the Mother, Mother's Height, ANC, Anemia, Medical Diseases During Pregnancy, Complications During Pregnancy, Alcohol Consumption, Atern Pregnancy
Demelash et al (2015)	Ethiopia	Case-Control	Cases Grup: 136 Control Grup: 272	Newly delivered mothers	The intervention in this study was an interview using structured and pre-tested questionnaire	Mothers who give birth to babies over 2500gr	Mother's Age, Residence, Education, Mother's Job, Husband's Job, Monthly Income, Decision on resource utilization, ANC, Mother's Height, Maternal BMI, Pregnancy-Related Health Issues, Pregnancy Distance, Ever Khat chewing, Hand Washing, Daily Drinking Water Consumption, Separate Kitchen Space, Sources of energy for cooking
Adam et al (2019)	Ghana	Case-Control	Cases Grup: 360 Control Grup:	Newly delivered mothers	Data is collected using questionnaires. Questionnaires obtained both primary data and secondary data	Mothers who give birth to babies	Gestation at birth, Education, Iron Consumption, Who

			828			over 2500gr and below 3400gr	Accompanies During Pregnancy, First Trimester Hemoglobin, Pregnancy Hospitalizations,
Girma et al (2019)	Ethiopia	Case-Control	Cases Grup: 93 Control Grup: 186	Newly delivered mothers	Semi-structured interviewer-administered questionnaires	Mothers who give birth to babies weighing more than 2500 gr	Iron and folic acid consumption Nutritional Advice, Snack Food Consumption During Pregnancy, Pregnant Women's MUAC, Anemia Women's minimum food diversity score
Ahmed et al (2018)	Ethiopia	Case-Control	Cases Grup: 95 Control Grup: 191	Newly delivered mothers	Data collected with face-to-face interviews and structure and pretested questionnaire	Mothers who give birth to babies over 2500gr	Iron and Folic Acid Consumption, Nutrition Consultation, Supplementary Foods, Nutritional Status, Anemia, MDD-W
Tadese et al (2021)	Ethiopia	Case-Control	Cases Grup: 151 Control Grup: 302	Newly delivered mothers	A standardized and pre-tested checklist. .	Mothers who give birth to babies over 2500gr	Mother's Age, Residence, Education, Occupation, Parity, ANC Visit, Iron Consumption, Hemoglobin, Chronic Hypertension, Hypertension Due to Pregnancy, Danger Signs During Pregnancy, History of LBW, Weight Loss During Pregnancy, Birth Defects
Asmare et al (2018)	Ethiopia	Case-Control	Cases Grup: 151 Control Grup: 302	Newly delivered mothers	Data collected using a structured interviewer administered questionnaire	Mothers who give birth to babies over 2500gr	Gender, Residence, Education, MUAC, Abortus History, ANC Visit, Complications during

							pregnancy, Iron Consumption, Parity, Gestational Age, LBW History
Desta et al (2020)	Ethiopia	Case-Control	Cases Grup: 127 Control Grup: 254	Newly delivered mothers	Data collected using a structured interviewer administered questionnaire.	Mothers who give birth to babies weigh 2500gr – 4000gr	ANC, Hx of Chronic Medical Illness, How Much Medication, Maternal Height, Weight gain During Pregnancy, Ummur Pregnancy, Age
Kargbo et al (2021)	Sierra Leone	Case-Control	Cases Grup: 146 Control Grup: 292	Newly delivered mothers	Data were collected using a questionnaire developed specifically for the study	Mothers who give birth to babies over 2500gr	Maternal Age, Occupation, Marital Status, Maternal Height, Gravidity, ANC Visits, Gestational Age, Anemia, Birth Distance, Hypertension, HIV, Syphilis, Malaria, Iron and Folic Acid Consumption, Smokers, Smoking Spouses, Herbal Medicine Consumption
Gizaw and Gebremedhin (2018)	Ethiopia	Case-Control	Cases Grup: 94 Control Grup: 376	Newly delivered mothers	Data was collected by interviewing mothers, reviewing medical records, and measuring maternal and newborn anthropometry	Mothers who give birth to babies weigh 2500gr – 4000gr	Age, Residence, Education, Marital Status, Religion, Ethnicity, Gestational Age, ANC during Pregnancy, Avoidance of food due to food taboos, Dietary counseling during pregnancy, Iron Consumption, Food security status
Hailu and Kebede (2018)	Ethiopia	Case-Control	Cases Grup: 147 Control Grup: 294	Mother's birth record	Data is collected with a history of birth records and an ANC file of the mother.	Mothers who give birth to babies over 2500gr	Birth Sex, Mother's Age, Abortus History, Gestational Age, Mode of Delivery, ANC Visits, Hemoglobin, Iron

							Consumption, Chronic Hypertension, PIH, History of Anemia, Chronic DM, Trauma during Pregnancy, Pregnancy Complications
Bhaskar et al (2015)	Nepal	Case-Control	Cases Grup:159 Control Grup: 159	Newly delivered mothers	Data collected using interview techniques	Mothers who give birth to babies over 2500gr	Maternal Weight, Maternal Height, ANC Visits, Iron Consumption, Calcium Consumption, Blood Type, Education, Diseases During Pregnancy, Hypertension, Anemia, Maternal Age, BMI, Income, House Type
Wachamo et al (2019)	Ethiopia	Case-Control	Cases Grup: 125 Control Grup: 250	Newly delivered mothers	Data was collected with inverview using structured questionnaire	Mothers who give birth to babies weigh 2500gr – 4000gr	Husband Education, ANC Visit, Information on pregnancy danger signs, Complications during last birth, Maternal Weight, Maternal Height, Maternal Age, Gravidity, Gestational age at the first ANC visit, Khat Chewing, Drinking water source, Drinking water storage area, Water treatment, Hand washing, Presence of windows, Separate kitchen room, Family water consumption
Sharma et al (2015)	Nepal	Case-Control	Cases Grup: 155 Control Grup: 310	Newly delivered mothers	Data were collected using interview	Mothers who give birth to babies over 2500gr	History of preterm labor, Heavy physical labor, Mother's age, Hemoglobin, Consumption of

								healthy foods
KC et al (2020)	Nepal	Case-Control	Cases Grup: 123 Control Grup: 246	Newly delivered mothers	Data was collected with inverview using structured questionnaire	Mothers who give birth to babies over 2500gr		Mother's Age, Husband support in daily activities, Cooking materials, Kitchen room location, Family members smoking, Smoking habits, Food frequency per day, Type of food, ANC visits, Iron consumption, Weight gain, Number of children, Medical history, Premature birth

Appendix 2. Risk Factors' Adjusted OR Values for the Incidence of LBW Infants in Developing Countries

Category	Author (aOR)													
Mother's Education														
Primary		1.6	1.15			0.59	0.93							
Secondary		0.7	4.19			0.68	0.92							
Tertiary														
Nutrition Counseling														
Yes														
No	2.14			4.05	4.05									
Consumption of Iron and Folic Acid														
Yes														
No	3.78		3.19	2.84	2.84	1.13	2.82	5.02			0.607			
MUAC														
<23 cm	2.85			5.62	5.62		1.66							
≥23 cm														
Mother's Height														
≤ 155 cm	3,58							9.27	1.52			20.38	0.46	
> 155 cm														
ANC														
Yes														
No	1.03					0.41	2.31	3.22	1.07	0.864		172.79		1.7
Anemia														
< 11 g/dl	2.34		3.14	3.54	3.54	1.11				0.955		1.27	0.51	
≥ 11 g/dl														
Complications during pregnancy														
Yes	3.39						2.79				2.708	4.24	5.70	
No														
Gestational Age														
>37 weeks														
32-36 weeks (Preterm)	0.91		13.7				3.33	14.28	4.07		5.321			
Severe preterm			58,											

Category	Author (aOR)									
(<32 weeks)		5								
Mother's Age										
≤ 20 Age	3.1		0.41		6.42	1.75	0.54	1.454	1.46	1.98	0.8
21-35 Age										
> 35 Age	0,9		2.45		0.867			0.961		0.84	1.5
Residence										
Rural	0.9		3.12	1.0							
City							0.66				
Mother's Work											
Employee											
Housewives	0,5		1.13			2.52					
Parity											
Primipara				1.45		1.77					1.8
Multipara			2.28						0.36		0.4
Grand multipara			2.20						0.44		0.6
Smoke											
Passive											1.4