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Potential Maternal Risk Factors for Low Birth Weight in Indonesia: A Systematic Review

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ABSTRACT

This review was conducted with the aim of summarizing the articles on the potential maternal risk factors for Low Birth Weight (LBW) in Indonesia. All observational studies conducted in Indonesia between 2010 and 2022 were thoroughly reviewed in this study. The articles were retrieved from "PubMed", "ScienceDirect", "Web of Science", and "Garuda". The retrieval was supplemented by snowball sampling technique. This review was constructed according to the PRISMA guidelines and the quality of the articles was assessed according to the STROBE guidelines. Of the 129 articles, only 12 articles met the inclusion criteria. Maternal variables such as education (50%), household wealth (33.3%), nutritional status (33.3%), age (25%), pregnancy complications (25%), marital age (16.7%), gestational weight gain (16.7%), ANC visit (16.7%), weight at third trimester (16.7%), twin birth (16.7%), birth interval (16.7%), iron supplementation (8.3%), parity (8.3%), and anemia status (8.3%) were found to be the risk factors for LBW incidence. This review found that almost all potential maternal risk factors contributing to LBW are preventable. It may help policy makers to design a more effective LBW prevention intervention and early risk identification for pregnant women. Appropriate follow-up by health workers for clinical intervention will also help to improve their pregnancy outcomes.

Keywords: Indonesia, low birth weight, maternal, pregnancy, risk factors

INTRODUCTION

Data from the Indonesian Demographic and Health Survey (IDHS) 2017 showed that the trend of Infant Mortality Rate (IMR) decreased by 25% from 32 per 1,000 live births to 24 per 1,000 live births (IDHS 2017). The target of the National Long and Medium Term Development Plan (RPJMN) is to achieve an IMR of 16 per 1,000 live births by 2024. In order to achieve this, it is important to address one of the major contributing factors to IMR, which is Low Birth Weight (LBW).

According to the 2018 Basic Health Survey (Riskesdas) report, the prevalence of LBW in Indonesia was 6.2% (Ministry of Health Republic of Indonesia (MoH RI) 2018). However, there are some provinces in Indonesia where the prevalence is still higher thatn the national prevalence, such as Central Sulawesi (8.9%) and North Maluku (8.7%) (Badan Penelitian dan Pengembangan Kesehatan (Balitbangkes) 2019). Compared to newborns with normal birth weight, newborns with LBW are 3.38 times more likely to experience stunting during childhood (Fakhrina *et al.* 2020). Several strategies and programs have been implemented to overcome low birth weight, such as health education, supervision and monitoring, measurement of maternal nutritional status, and antenatal care program (Pristya *et al.* 2020), but nowadays LBW is still widely recognized as a serious public health problem, particularly in developing countries such as Indonesia.

It is well established that maternal characteristics, namely maternal nutritional

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status, marital age, and Antenatal Care (ANC) visits, influence the pregnancy outcomes. Neonatal nutritional status is influenced by maternal nutritional status as measured by Body Mass Index (BMI) and Mid Upper Arm Circumference (MUAC). Early marriage among women, resulting in early pregnancy, also affects the birth weight. Early maternal age at the time of conception increases the risk of LBW because the mother is not mature enough and also shows inefficiency in the placental transfer mechanism as compared to a young adult. In addition, the reproductive organs of women under the age of 20 are also not in optimal condition to carry a baby (Kamini & Avvaru 2014). All these factors can have a lasting impact on the health and physical status of the growing baby.

Fortunately, several predictors of LBW are preventable (Lutfitasari & Mulyanti 2023), and this review will focus only on the preventable maternal risk factors for LBW incidence. This systematic review aimed to provide a summary of the maternal risk factors influencing LBW and hopefully the results will facilitate the health authority in planning appropriate intervention program to minimize the LBW incidence, such as promoting maternal health services by developing screening tools to predict LBW risk since early pregnancy. The results of this review may also be useful for other developing countries with LBW problem.

METHODS

Design, location, and time

The study design was a systematic review. Studies that were published in the last ten years (2012–2022) were retrieved from four scientific literature databases: PubMed, ScienceDirect, Web of Science, and Garuda. In addition, the snowball technique was also used to search for other articles from references listed in related studies. This study follows the PRISMA guideline (Moher *et al.* 2009).

Study selection (Screening)

All screening processes were based on the following inclusion and exclusion criteria. The inclusion criteria were: 1) peer-reviewed observational studies written in Indonesian or English; 2) studies conducted in Indonesia; 3) full text and open access published between 2012–2022 (last ten years). The search terms used were: "factors", "Indonesia", "low birth weight", "pregnancy". Non-original research studies, reviews, and short communication articles were excluded.

Data collection

Data collection was based on the procedure recommended by Rethlefsen *et al.* (2021), which included the following four steps: 1) data were collected by using a search engine with specific keywords and Boolean operators in English such as (potential risk factors or maternal risk factor) and (low birth weight or LBW infant) and (Indonesia); 2) the title, abstract, and keywords of the selected articles were analyzed according to the eligibility criteria; 3) these articles were partially or fully read to determine whether they met the inclusion criteria or not; 4) the reference of the selected articles were scanned to identify relevant studies.

Through a cycle of recurring author assessments, the five authors collaborated on the data collection. All records were screened by titles and abstracts obtained from the search engine. Studies that met the inclusion criteria were selected. At least two of the five authors in the article screening process agreed on the selection of the manuscript. Any disagreements among the authors were discussed until agreement was reached.

Zotero Standalone software was used to manage the references. The following steps were performed on the selected articles: excluding duplicate articles, checking the title and abstract of the article to ensure that it met the inclusion criteria, reading the entire article and implementing the exclusion criteria, and manually searching the references of the selected articles. These steps were performed by two reviewers. Each selected article was then manually extracted into a table as shown in Table 1. A total of 129 articles were obtained, but only 12 articles met the inclusion criteria (Figure 1).

Data analysis

Five criteria, based on the STROBE recommendations for cross-sectional studies (Malta *et al.* 2010) and the Newcastle-Ottawa Scale for cohort and case-control studies (Wells *et al.* 2017), were used to assess the quality of the selected articles (Table 2). One point was

assigned for each criterion met. The final score could range from zero to five (Barreto *et al.* 2019). The summary table for this review was created manually from each selected study by extracting from that included information about the journal author (year), location, population, type of study, statistical method, results, and quality assessment (Table 1).

RESULTS AND DISCUSSION

Twelve articles were selected for review after meeting the inclusion criteria for this study. Table 1 shows these twelve selected articles. The STROBE checklist was used to examine the consistency of reporting of all studies and outcomes from zero to five, as shown in Table 2 (Barreto *et al.* 2019).

The results revealed that all articles for the review were from studies conducted in western, central, and eastern parts of Indonesia (Table 1). The maternal variables consist of education, household wealth, nutritional status, marital age, maternal age, Gestational Weight Gain (GWG), ANC visits, pregnancy complications, iron supplementation, parity, anemia status, third trimester weight, family income, twin birth , and birth interval.

As shown in Table 2, only two studies met all established quality criteria, whereas ten

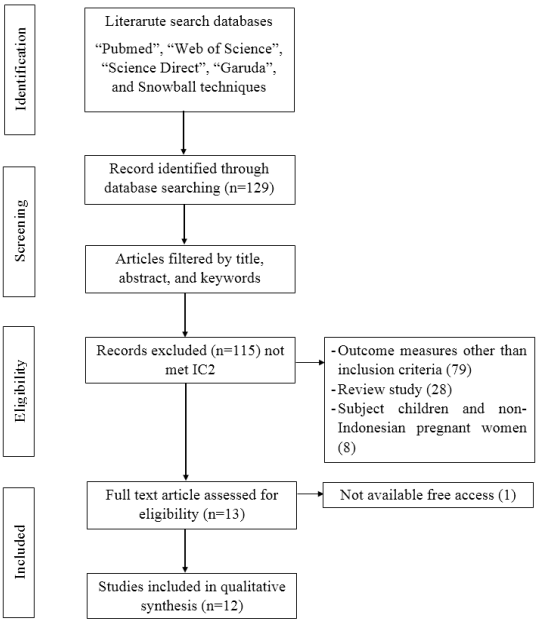

Figure 1. Flowchart for selection of articles

studies did not. Ten articles studied birth weight without adjusting LBW for Gestational Age (GA) or independently studied preterm birth and Intrauterine Growth Restriction (IUGR). Among the five points for analyzing the quality of articles, the lowest score was did not adjust LBW for GA or independently analyzed IUGR and prematurity.

The studies investigated risk factors associated with LBW in Indonesia, and the most common maternal risk factors identified included education (six articles, 50%), household wealth (four articles, 33.3%), nutritional status (four articles, 33.3%), age (four articles, 25%), and pregnancy complications (four articles, 25%). Other risk factors identified to be associated with LBW were marital age (two articles, 16.7%), GWG (two articles, 16.7%), ANC visits (two articles, 16.7%), third trimester weight (two articles, 16.7%), twin birth (two articles, 16.7%), and birth interval (two articles, 16.7%). An association was also found between iron supplementation (one article, 8.3%), parity (one article, 8.3%), and anemia status (one article, 8.3%) and LBW incidence in Indonesia (Table 1).

Malnutrition during pregnancy affects the development and the growth of the fetus. According to the fetal origin disease hypothesis, fetal adaptation to the malnourished environment or placental insufficiency causes hypertension, insulin resistance, dyslipidemia, heart disease, and non-insulin-dependent diabetes in adolescents (Hocher 2014). Fetal programming can influence future disease because the body's memory of malnutrition during a critical period is manifested in the pathology that causes future disease (Barker 1995).

Furthermore, among the modifiable determinants of LBW, maternal education is one of them. The incidence of LBW is associated with the level of maternal education (Sebayang *et al.* 2012; Paramitasari *et al.* 2018; Supadmi *et al.* 2020; Azinar *et al.* 2022; Okriyanto *et al.* 2022; Wulandari *et al.* 2022). A study by Nuryani & Rahmawati (2017) also showed that LBW was associated with maternal education. High level of education would allow mothers to get necessary information about prenatal care, infant care, and also nutritional fulfillment (Bhaskar 2015).

Household wealth is also associated with the incidence of LBW. Among women with older Age at First Marriage (AFM) (>35 years old)

Table 1. The general characteristics of the twelve selected studies

Author (year)	Location	Population	Type of study	Statistical method	Result	Quality assessment
Sebayang *et al.* (2012)	Lombok	Data from The SUMMIT; the total respondents were 14.040 for LBW analysis with 13.498 data for preterm births and 13.461 data for SGA births.	A double-blind cluster-randomized controlled trial.	Software: SAS PROC GENMOD Hierarchical logistic regression partial PAR.	Determinant of maternal factors of LBW were education, height, residence, MUAC, season at birth, household wealth, and pregnancy interval.	4
Anggondowati *et al.* (2017)	East Java	650 data of women and their baby.	Observational prospective cohort study.	Software: SPSS 17.0 Multivariate analysis.	The risk of LBW, VLBW, stillbirth and neonatal death was reduced by referral from a care facility.	5
Soltani *et al.* (2017)	Western Sumatra	607 pregnant women, recruited in 2010.	Observational cohort study.	Software: SPSS 24.0 Logistic regression, multivariate logistic and linear regression Level of significance: $p<0.05$.	Obese women were more likely to deliver macrosomia infant compared to those with a normal BMI. Meanwhile, for women with inadequate GWG, they were having greater probability to deliver LBW and premature infants.	5
Paramitasari *et al.* (2018)	Madiun General Hospital, East Java	200 newborn babies consist of 50 LBW infants and 150 infants with normal weight.	Analytical observational study with a case-control design.	Software: STATA 13 Path analysis.	The incidence of LBW were significantly increased with anemia, multiparity, and maternal age <20 or >35 years. In the other hand, the incidence of LBW was significantly decreased with good maternal nutritional status, maternal education ≥high school, and wide birth space.	3
Supadmi *et al.* (2020)	34 provinces in Indonesia	Data from 2017 IDHS. By using sample stratification and multistage random sampling, there were 1,741 women aged 15–49 who gave birth in 5 years prior to the survey as respondents.	Cross-sectional study design.	Software: SPSS 22.0 Chi-Square, Binary logistic regression.	The significant predictors of LBW infants in Indonesia were ANC visits, maternal educational level, age group, and maternal wealth status.	3
Adawiyah *et al*. (2021)	Kanjilho Health Center, South Sulawesi	150 pregnant mothers visited in 2019.	Cross-sectional with secondary data.	Univariate, bivariate, multivariate as well as ROC curve.	The weight 60.5 kg at third trimester can predict LBW.	3

Continue from Table 1

Author (year)	Location	Population	Type of study	Statistical method	Result	Quality assessment
Djokosujono *et al.* (2021)	Anny Rahardjo Maternity Clinic's registry, Jakarta, Indonesia	278 pregnant mothers who visited clinic in 2017–2018.	Cross-sectional study.	Correlation, Logistic regression analysis Level of significance: p<0.05 ROC.	Weight at early third trimester is s ignificantly associated with LBW. The minimum weight is 59.8 kg AUC=0.68, Se 67%, Sp 63%).	3
Maulinda *et al.* (2021)	34 provinces in Indonesia	4,561 women aged 15–49 years from 2017 IDHS who where married and delivered a baby within the 5 years preceding the survey.	Cross-sectional study design.	Binary logistic regression binomial probit regression.	AFM affected the likelihood of childbirth complications and LBW babies Low or high AFM increased the risk of having LBW newborn.	4
Aji *et al.* (2022)	West Sumatra	195 pregnant women.	Observational cohort study analysis.	Software: SPSS 23.0 Chi-Square test, One-way ANOVA, Logistic regression, Level of significance: p<0.05.	Mother with pre-pregnancy BMI in overweight/obese category were more likely to have an excessive GWG than those whose weight was normal, and more likely to have macrosomia newborn. For the mother with inadequate GWG were more likely to have LBW infant.	5
Azinar *et al.* (2022)	Grobogan District, Central Java	First child born to a woman aged less than 30 years from January 2020 to July 2021 (n=3,400).	Observational cohort retrospective study.	Chi-Square test.	The maternal risk factors associated with LBW were maternal educational level, place of residence, employment status, and age at the first marriage.	3
Oktriyanto *et al.* (2022)	Madiun General Hospital, East Java	200 newborn babies consist of 50 LBW infants and 150 infants with normal weight.	Analytical observational study with a case-control design.	Software: STATA 13 Path analysis.	The incidence of LBW were significantly increased with anemia, multiparity, and maternal age <20 or >35 years. In the other hand, the incidence of LBW was significantly decreased with good maternal nutritional status, maternal education ≥high school, and wide birth space.	3

Continue from Table 1

Author (year)	Location	Population	Type of study	Statistical method	Result	Quality assessment
Wulandari *et al.* (2022)	34 provinces in Indonesia	Data from 2017 IDHS. By using sample stratification and multistage random sampling, there were 1,741 women aged 15–49 who gave birth in 5 years prior to the survey as respondents.	Cross-sectional study design.	Software: SPSS 22.0 Chi-Square, Binary logistic regression.	The significant predictors of LBW infants in Indonesia were ANC visits, maternal educational level, age group, and maternal wealth status.	3

AFM: Age at First Marriage ; ANC:Antenatal Care; AUC:Area Under the Curve; BMI: Body Mass Index; GWG: Gestational Weight Gain; IDHS: Indonesian Demographic and Health Survey; LBW: Low Birth Weight; MUAC: Mid Upper Arm Circumference; PAR: Population Attributable Risks; ROC: Receiving Operating Characteristics; SGA: Small for Gestational Age; SUMMIT: Supplementation with Multiple Micronutrient Intervention Trial; VLBW: Very Low Birth Weight

or younger AFM (<19 years old), those from low-income households appeared to be more likely to experience malnutrition than those from higher-income households (Sebayang *et al.* 2012; Supadmi *et al.* 2020; Okriyanto *et al.* 2022; Wulandari *et al.* 2022).

The present study also revealed that Very Low Birth Weight (VLBW) and neonatal death were strongly influenced by young maternal age (Maulinda *et al.* 2021; Azinar *et al.* 2022). These findings emphasize the importance of supporting family planning services for young people who aspire to be parents. The median AFM is increasing, according to IDHS data from 1991 to 2017. In Indonesia, the median AFM is 21.8 years, implying that about a half of Indonesian women are married before the age of 21 (BKKBN/BPS/Kemenkes/ICF 2018). In some

Table 2. Quality assessment of the articles

References	Quality sssessment[1]					Total
	A Use census or representative probabilistic sample of the target population	P Under than 20% loses	I Adjusted LBW by gestational age or independently examined the IUGR and premature birth	E Having a description of the criteria used to classify the populations	C Having the estimates of the adjusted effect controlling confounded factors	
Sebayang *et al.* (2012)	1	1	1	1	1	4
Anggondowati *et al.* (2017)	1	1	1	1	1	5
Soltani *et al.* (2017)	1	1	1	1	1	5
Paramitasari *et al.* (2018)	1	1	0	1	0	3
Supadmi *et al.* (2020)	1	1	0	1	0	3
Adawiyah *et al.* (2021)	1	1	0	1	0	3
Djokosujono *et al.* (2021)	1	1	0	1	1	4
Maulinda *et al.* (2021)	1	1	0	1	1	4
Aji *et al.* (2022)	1	1	1	1	1	5
Azinar *et al.* (2022)	1	1	0	1	0	3
Okriyanto *et al.* (2022)	1	1	0	1	1	4
Wulandari *et al.* (2022)	1	1	0	1	0	3
Total articles per item	12	12	4	12	6	

[1]A: Use census or representative probabilistic sample of the target population; P: Have under than 20% of participant loses; I: Have an adjusted LBW by gestational age or independently examined the IUGR and prematurity; E have a description of the criteria used to classify the populations; C: Have the estimates of the adjusted effect and controlling confounded factors

regions of Indonesia where the child marriage is the norm, unmarried women as young as 17 are occasionally referred to as "old virgins". This societal perception puts pressure on girls to marry at a young age. To change this perception, it is crucial to develop specialized programs that increase knowledge about prenatal care, delivery strategies, safe pregnancy, early warning signs of pregnancy risks, emergency preparedness, and the significance of secondary and tertiary levels of care to ensure optimal outcomes when complications occurs such as excessive bleeding, high blood temperature, gestational diabetes, etc (Maulinda *et al.* 2021; Okriyanto *et al.* 2022; Wulandari *et al.* 2022).

The present review also highlights another risk factor for LBW, which is nutritional status. Many people believe that pregnant women should eat twice as much as they did before they became pregnant because they have to meet the nutritional requirements of two individuals (mother and fetus) during pregnancy. This assumption is incorrect. According to the Indonesian Dietary Recommendation, pregnant women need more calories up to 180 kcal in the first trimester and 300 kcal in the second to third trimester (Peraturan Menteri Kesehatan Republik Indonesia (PMK RI) 2019).

Measurement of MUAC has been used to predict whether pregnant women are at risk of delivering LBW newborns. If the MUAC is less than 23.5 cm, then the pregnant women are in Chronic Energy Deficiency (CED) and are at risk of delivering LBW infants (Schetter & Tanner 2012). Pre-pregnancy BMI is also critical for monitoring GWG. The Institute of Medicine (IOM) recommends that GWG be based on pre-pregnancy BMI because of the numerous negative consequences of both inadequate and excessive weight gain. Women should strive to gain weight within the recommended guidelines, as this is crucial for fetal growth. Tsai *et al.* (2015) revealed that underweight women should adhere to the upper range of the IOM recommendations to prevent LBW newborns.

Antenatal Care, also known as ANC, is a term for the prenatal health services that mothers receive during their pregnancy and are provided by health professionals such as physicians, midwives, and nurses.

Antenatal records during ANC visits are challenging based on the previous research (Anggraini *et al.* 2018; Anggraini *et al.* 2019), and so is ANC coverage in some parts of Indonesia. According to the previous research, the lowest distribution of four ANC visits as a minimum standard was in the eastern region of Indonesia. The percentage was concentrated in the Java-Bali region, followed by the western region. A study conducted in East Nusa Tenggara, Indonesia, showed that pregnant women chose not to receive standard ANC, continued to work at home, and followed several food restrictions due to the cultural practices or "traditional pregnancy care" in order to ensure a smooth delivery (Anggrahini *et al.* 2020).

Third trimester weight also affects the incidence of LBW. Pregnant women in rural areas usually attend ANC at the third trimester (Adawiyah *et al.* 2021; Djokosujono *et al.* 2021). Therefore, early weight at the third trimester is another risk factor for LBW in Indonesia, as rapid gestational weight gain still occurs during this period, so nutrition programs canstill be implemented to address LBW. The cut-off point for weight in the third trimester is between 59.8 kg and 60.5 kg (Adawiyah *et al.* 2021; Djokosujono *et al.* 2021).

In addition, LBW was highly correlated with birth interval (Sebayang *et al.* 2012; Wulandari *et al.* 2022). Mothers who gave birth within 24 months or less were more likely to deliver LBW infants. Nutritional deprivation after the second or third child may increase the likelihood of LBW and SGA (Sebayang *et al.* 2012).

Other factors associated with LBW were twin birth, parity, and pregnancy complications. Twin pregnancy is the most risky variable for LBW and poses a higher chance for infants to develop LBW compared to singleton pregnancies (Okriyanto *et al.* 2022; Wulandari *et al.* 2022). This review recommends that pregnant women with a family history of twin births should monitor their health during pregnancy by attending regular ANC apppointments.

Parity is also associated with the incidence of LBW. Parity has been described as the number of live births. Compared to parity 1 or >3, parity 2 or 3 decreased the probability of LBW incidence (Paramitasari *et al.* 2018). In line with the study by Putri *et al.* (2017), pregnant women with parity >2 had a 12.3 times higher probability of delivering LBW infants. Parity

was discovered to be a high risk factor for LBW, IUGR, prematurity, and neonatal mortality. High parity in the mother can cause a deterioration of the elasticity of the tissues that have been repeatedly stretched by pregnancy, so that it will cause the abnormal growth of the placenta and also the fetus, ultimately causing the incidence of LBW (Putri *et al.* 2017).

Furthermore, another factor influencing the incidence of LBW newborns is iron supplementation. Iron supplementation during pregnancy is associated with an increase in infant birth weight, and significantly affects the incidence of LBW (Shi *et al.* 2021; Okriyanto *et al.* 2022). Iron is needed to prevent hemorrhage during childbirth and also to prevent complications during pregnancy. In addition, it is also needed for the production of Hemoglobin. During childbirth, the uterine contractions are stronger or more intense to deliver a baby. Hemoglobin, which transports oxygen and other nutrients, decreases in anemic pregnant women. Meanwhile, blood-supplied oxygen and energy are needed to make the uterine contractions. As the supply of these needs is getting smaller, the capacity to perform contraction is decreasing, causing hemorrhage (Watkins & Stem 2020).

The strengths of this review are that we used a comprehensive search strategy to maximize the identification of all relevant literature. This review also strengthens other studies on the predictors of LBW in Indonesia. Several articles reviewed in this study used the same data with different inclusion criteria, but resulted in the similar risk factors of LBW. The limitation of this review is the limited number of case-control and cohort studies among the reviewed articles.

CONCLUSION

This study discovered that the incidence of LBW newborns was significantly correlated with several maternal risk factors, such as maternal education, household wealth, nutritional status, age, pregnancy complications, marital age, ANC visits, third trimester weight, twin birth, birth interval, parity, iron supplementation, and anemia status. Most of these risk factors are preventable. Thus, the incidence of LBW can be reduced through interventions that target these risk factors.

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DECLARATION OF INTERESTS

The authors declare that they have no conflicts of interest.

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