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# Risk of Low Birth Weight Among Neonates Born to Mothers With Preeclampsia : A Systematic Review

**Muji Rahayu[1*], Rosmani Sinaga[2], Clinton Antony[3], Enda Angina Br Karo[4], Dui Ronala Sihotang[5]**
[1,2,3,4,5]Sekolah Tinggi Ilmu Kesehatan Mitra Husada Medan
*Email: rahayukubu22@gmail.com[1]

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***ABSTRACT***

***Introduction*** *Preeclampsia is a hypertensive disorder during pregnancy that can be associated with placental dysfunction, fetal growth restriction (FGR), preterm birth, and low birth weight (LBW). This systematic review aims to analyze the latest evidence regarding the risk of LBW in neonates born to mothers with preeclampsia and to identify factors that may influence it.*

***Methods*** *The literature search was conducted based on the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) 2020 through PubMed, Scopus, ScienceDirect, and Web of Science for primary English-language articles published between January 2022 and December 2025. Studies that met the criteria involved mothers with preeclampsia or hypertensive disorders in pregnancy and reported LBW or birth weight. Five primary studies met the criteria and were included in the qualitative synthesis. The synthesis was carried out narratively because there was heterogeneity in study design, population, exposure definitions, and outcomes.*

***Results*** *The results indicate that preeclampsia is associated with an increased risk of low birth weight (LBW), especially in early onset or severe cases, through placental perfusion disturbances, angiogenesis imbalance, fetal growth restriction, and medically indicated preterm delivery. Neonatal risk is also influenced by maternal comorbidities, gestational age at delivery, antenatal monitoring, and timing of delivery.*

***Discussion and Conclusion*** *Early risk detection, fetal growth monitoring, proper maternal management, and coordination of obstetric and neonatal services are necessary to support the prevention of LBW-related morbidity*

***Keywords :*** *preeclampsia, low birth weight, fetal growth restriction, preterm birth, neonatal outcomes*

## INTRODUCTION

Preeclampsia is a multisystem disorder associated with pregnancy, generally diagnosed after 20 weeks of gestation through findings of hypertension accompanied by proteinuria and/or maternal organ dysfunction. Currently, this condition is understood not only as an increase in blood pressure, but as a result of placental and endothelial dysfunction. It is characterized by abnormalities in placental implantation, inadequate uteroplacental perfusion, inflammatory processes, oxidative stress, and an imbalance of angiogenic factors which play a role in the occurrence of fetal growth restriction [1,2,3,4,13]. Globally, preeclampsia affects around 3–8% of women who give birth, while hypertensive disorders in pregnancy contribute to approximately 16% of maternal deaths (nearly 42,000 deaths in 2023) [5,6,17]. The impact is very concerning in low- and middle-income countries, because limitations in antenatal screening, access to diagnosis, referral, and appropriate therapy can increase the risk of poor maternal and perinatal outcomes [1,2,9]. Therefore, early detection and adequate management are necessary to reduce the impact of preeclampsia on fetal and neonatal health.

Low birth weight (LBW) remains an important public health issue. The World Health Organization (WHO) defines LBW as a birth weight < 2,500 grams [10,22]. In 2020, approximately 19.8 million newborns (14.7% of all live births globally) experienced LBW, with the majority of cases occurring in low- and middle-income countries [10]. LBW not only affects the condition of the baby immediately after birth, but is also associated with an increased risk of morbidity and mortality in neonates, slower growth and development, and vulnerability to chronic diseases later in life [9,10,22]. Babies born to mothers with preeclampsia also appear to have a higher risk of experiencing LBW. A study in China reported an LBW prevalence of 6.02% among babies born to mothers with preeclampsia, compared to 2.16% among babies born to mothers with normal blood pressure, with an adjusted OR of 3.01 (95% CI: 2.67–3.40) [7]. In line with this, a 2025 meta-analysis of studies in Indonesia showed a significant association between preeclampsia and LBW, with a pooled OR of 2.16 (95% CI: 1.51–3.08) in cross-sectional studies and 3.15 (95% CI: 1.76–5.64) in case-control studies [8]. The findings suggest that maternal preeclampsia may contribute to an increased risk of low birth weight (LBW). Further assessment of the available evidence is therefore

needed to clarify the extent of this association.

Several mechanisms can explain the occurrence of LBW in neonates from mothers with preeclampsia. First, placental insufficiency can disrupt fetal growth, resulting in low birth weight. Second, LBW can also occur due to decreased gestational age, for example due to medically indicated preterm delivery [7,12,16]. The magnitude of the risk is influenced by the time of onset and degree of preeclampsia, clinical phenotype, and maternal comorbidities. In general, a stronger association with placental dysfunction and fetal growth restriction is found in early-onset preeclampsia, whereas late-onset preeclampsia may involve different pathways on both the maternal and placental sides [18,21]. The risk can also be modified by chronic hypertension, kidney disease, diabetes, obesity, multiple pregnancies, inadequate antenatal care, and delayed referral [2,9,11]. The variability of LBW risk across studies likely reflects differences in population characteristics, diagnostic criteria, timing of onset and severity of the disease, confounder adjustment strategies, as well as study design making it difficult to determine the biological, clinical, and healthcare factors most consistently associated with LBW in neonates exposed to maternal preeclampsia.

Although research on this topic has grown, the evidence on factors associated with low birth weight (LBW) among infants born to mothers with preeclampsia is still not clearly established. Studies have reported associations involving placental function, maternal characteristics, obstetric care, and healthcare system factors, but the findings vary across populations, study designs, and clinical settings. Earlier reviews have mostly focused on broader pregnancy outcomes, including hypertensive disorders, fetal growth restriction, preterm birth, and maternal complications, rather than considering LBW specifically as a neonatal outcome of preeclampsia [15,20]. Differences in study periods, population characteristics, definitions of LBW, and analytical methods also make it difficult to compare findings across studies. An updated systematic review focusing specifically on LBW is thus needed to bring these findings together, assess the quality of the available studies, and provide a clearer picture of the factors associated with LBW among infants born to mothers with preeclampsia.

This systematic review aimed to examine the risk of low birth weight (LBW) among neonates born to mothers with preeclampsia and to identify the biological, clinical,

obstetric, and health system factors that may be associated with this outcome. The review followed the PICO framework. The population (P) included pregnant women and neonates from studies involving preeclampsia. Maternal preeclampsia was considered the exposure (I), while normotensive pregnancies or the lowest-risk reference group were used as comparators (C) when available. The outcome (O) was LBW, defined as a birth weight below 2,500 grams. Based on this framework, the review sought to answer whether maternal preeclampsia is associated with a higher risk of LBW compared with normotensive pregnancies or another appropriate reference group, and which biological, clinical, obstetric, and health system factors are consistently associated with this outcome.

## METHODS

A systematic review was conducted to examine the available evidence on low birth weight (LBW) among neonates born to mothers with preeclampsia and to assess the findings reported in previous studies. The review was conducted and reported in accordance with the 2020 Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) guidelines. The review protocol was not prospectively registered in PROSPERO or any other systematic review registry. The research question and eligibility criteria were developed using the PECO framework. The population (P) included pregnant women and neonates, while the exposure (E) was maternal preeclampsia, including its onset, severity, and clinical phenotype. Normotensive pregnancies or other appropriate reference groups were considered as comparators (C) when available. The primary outcome was LBW, defined as a birth weight of less than 2,500 g. Secondary outcomes included fetal growth restriction (FGR), small for gestational age (SGA), preterm delivery, neonatal intensive care unit (NICU) admission, and neonatal death. The review therefore examined whether maternal preeclampsia was associated with a higher risk of LBW compared with normotensive pregnancies or other appropriate reference groups, as well as which biological, clinical, obstetric, and health system factors were most consistently associated with this outcome.

Relevant primary studies were identified by searching PubMed, Scopus, ScienceDirect, and Web of Science for English-language articles published between January 2022 and December 2025. The final search was performed in December 2025. Search terms were adapted to each database and included both controlled vocabulary and

free-text terms related to preeclampsia, low birth weight (LBW), fetal growth restriction (FGR), small for gestational age (SGA), preterm delivery, and neonatal outcomes. The main search strategy combined terms for the exposure, neonatal outcomes, and study population as follows: ("Preeclampsia" OR "Pre-eclampsia" OR "Pregnancy-Induced Hypertension" OR "Gestational Hypertension") AND ("Low Birth Weight" OR "Birth Weight" OR "Small for Gestational Age" OR "Fetal Growth Restriction") AND ("Neonate" OR "Newborn" OR "Infant" OR "Perinatal Outcomes" OR "Neonatal Outcomes"). Boolean operators, quotation marks, and database-specific field tags were modified as needed to match the search format of each database. The full search strategies, including search terms, field tags, filters, publication dates, and the number of records retrieved, are provided in Supplementary Table S1. Reference lists of the included studies and relevant systematic reviews were also screened manually to identify additional studies that may have been missed during the database searches.

A study is considered eligible if it involves pregnant women and neonates, and evaluates preeclampsia as the main exposure or includes a clearly defined preeclampsia subgroup. A normotensive reference group or other suitable comparison group is considered eligible if available, and LBW/birth weight must be the primary outcome. LBW is defined as a birth weight < 2,500 g, while FGR, SGA, preterm delivery, NICU admission, and neonatal death are included as secondary outcomes. Eligible studies must also provide adequate full information for data extraction and qualitative synthesis, and be published in a peer-reviewed English-language journal during the period January 2022–December 2025. Studies were excluded if: duplicate records were found; the publication was published before 2022; it was not an English-language article; conference abstracts without adequate full-text data; studies on animals/laboratory experiments; studies that assessed other maternal conditions without an identified preeclampsia subgroup; or studies that did not report LBW/birth weight data. Studies that only reported FGR, SGA, preterm delivery, NICU admission, or neonatal death without LBW/birth weight data were also excluded from the main LBW synthesis. Documents such as guidelines, scientific statements, narrative or systematic reviews, meta-analyses, and other secondary publications were not considered primary studies and were only used if relevant as context or background.

The records initially obtained were managed using reference management software. Duplicate citations were then identified, removed, and manually verified. Title and abstract screening was conducted independently by two reviewers based on pre-established eligibility criteria. Records deemed potentially relevant were subsequently evaluated through full-text review by the same two reviewers. The study selection process was recorded using the PRISMA 2020 flow diagram. After screening and eligibility assessment, six primary studies were included in the qualitative synthesis. Guidelines, scientific statements, narrative reviews, systematic reviews, and other publications used only for background or contextual information were excluded from the count of primary studies [16].

Data were extracted using a standardized form developed according to the PECO framework. Two reviewers independently reviewed the extracted information. The data included publication details, study location and design, study period, sample size, participant characteristics, diagnostic criteria for preeclampsia, disease onset and severity, comparison groups, gestational age, the definition of low birth weight (LBW), neonatal outcomes, effect estimates and confidence intervals when reported, potential confounding factors, main findings, and study limitations. After completing the extraction, the two reviewers compared their results and discussed any differences until an agreement was reached. When an agreement could not be reached, a third reviewer was consulted. The final data were organized into structured evidence tables, with particular attention to the reported association between maternal preeclampsia and LBW and to factors that may influence neonatal outcomes.

The methodological quality and risk of bias of the included studies were assessed using the Joanna Briggs Institute (JBI) Critical Appraisal Checklist appropriate to each study design. The assessment considered several key methodological aspects, including participant selection, measurement of exposure and outcomes, management of potential confounding factors, completeness of follow-up where applicable, and the appropriateness of the statistical analysis. Scores for each checklist item were recorded in a quality assessment table and considered when interpreting the consistency and strength of findings across designs and populations. A formal assessment of the certainty of evidence using GRADE was not conducted, so no overall certainty level was assigned. Because

there are significant differences in study design, population, exposure and outcome definitions, as well as reported effect sizes, the synthesis was conducted narratively while considering methodological quality, consistency, directness, precision, and potential sources of bias.

A pooled quantitative analysis was not performed due to substantial methodological, clinical, and outcome heterogeneity among studies. Variations in study design, including cohort, prospective, and cross-sectional studies, contributed to methodological heterogeneity. Clinical heterogeneity was influenced by differences in maternal and neonatal characteristics, healthcare settings, onset and severity of preeclampsia, as well as maternal comorbidities. Differences were also found in the definitions of exposure and comparators, as well as in outcome measurements, particularly in LBW, birth weight, FGR, and SGA. The reported effect measures differed across studies, including adjusted and unadjusted odds ratios, risk estimates, and descriptive data on birth weight. The variables included in the analyses and the level of adjustment for potential confounders also varied between studies. Although some studies reported comparable subgroups, the overall differences in study characteristics and reported outcomes did not allow for a meaningful pooled analysis. The findings were therefore synthesized narratively in accordance with the principles of Synthesis Without Meta-analysis (SWiM). The results were organized into four main domains. The biological domain covered factors such as placental insufficiency, impaired uteroplacental perfusion, and angiogenic imbalance. The clinical domain included early-onset or severe preeclampsia and maternal comorbidities. The obstetric domain included gestational age and medically indicated preterm delivery. The health system domain included antenatal care, referral processes, timing of delivery, and the readiness of neonatal care services.

In each domain, the results were compared based on the direction and magnitude of the association, consistency between studies, characteristics, and methodological quality. Findings from studies with methodological limitations were interpreted more cautiously. Microsoft Excel was used to organize the extracted data, study characteristics, effect estimates, and quality assessment results, without using statistical meta-analysis software.

The potential for selection and reporting bias is attempted to be minimized through

the use of PECO criteria and predetermined eligibility criteria, systematic searches across various databases, removal of duplicates, recording reasons for exclusion, manual checking of reference lists, and assessment of methodological quality. Ethical approval is not required because this review solely uses data from published study publications and does not involve the collection or use of identifiable individual data.

**Table 1. PECO Framework**

| Component | Definition |
|---|---|
| Population (P) | Pregnant women with preeclampsia and their neonates |
| Exposure (E) | Maternal preeclampsia, including onset, severity, and phenotype |
| Comparison (C) | Normotensive pregnancy or an appropriate reference group when available |
| Primary Outcome (O) | Low birth weight (<2,500 g) |
| Secondary Outcomes | FGR, SGA, preterm birth, NICU admission, and neonatal mortality |

**Table 2. Search Strategy and Eligibility Criteria**

| Component | Description |
|---|---|
| Databases | PubMed, Scopus, ScienceDirect, and Web of Science |
| Publication period | January 2022–December 2025 |
| Final search date | December 2025 |
| Language | English |
| Eligible evidence | Empirical primary studies providing relevant primary evidence |
| Primary outcome requirement | Studies were required to report LBW or birth-weight data; LBW was defined as birth weight <2,500 g |
| Secondary outcomes | FGR, SGA, preterm birth, NICU admission, and neonatal mortality |
| Core search concepts | Preeclampsia/hypertensive disorders of pregnancy AND LBW/birth weight/FGR/SGA AND neonatal/perinatal outcomes |
| Search strategy | Controlled vocabulary and free-text terms using Boolean operators (AND/OR), quotation marks, and database-specific field tags |
| Search limits/filters | English-language publications published between January 2022 and December 2025; eligibility determined according to predefined inclusion and exclusion criteria |
| Additional searching | Manual screening of reference lists of eligible primary studies and relevant systematic reviews |
| Duplicate removal | Reference-management software followed by manual verification |
| Study selection | Two-stage screening comprising title/abstract screening followed by full-text assessment according to predefined eligibility criteria |
| Secondary/contextual sources | Guidelines, scientific statements, disease primers, narrative reviews, systematic reviews, meta-analyses, and other secondary sources were used only as background/contextual references and were not counted as included studies |
| Quality assessment | JBI Critical Appraisal Tools appropriate to each study design, with item-level appraisal judgments |
| Evidence synthesis | Structured narrative synthesis following principles of Synthesis Without Meta-analysis (SWiM) |

| Component | Description |
|---|---|
| Meta-analysis | Not performed because of substantial methodological, clinical, exposure/outcome, comparator, and effect-measure heterogeneity; sufficiently homogeneous subsets were considered but no appropriate group was identified for meaningful quantitative pooling |
| Reporting guideline | PRISMA 2020 Statement |

The study selection process is presented in Figure 1. The flow diagram shows the different stages of the selection process, including the number of records identified, screened, and excluded, as well as the six studies included in the final evidence synthesis.

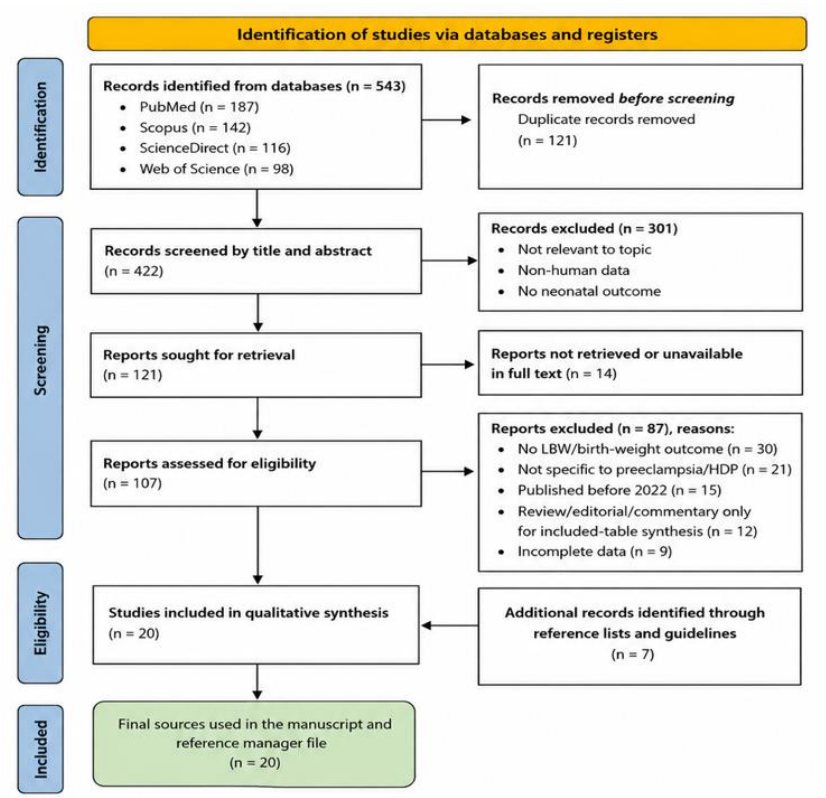



**Table 1. PRISMA 2020 Summary of Study Selection Process**

| PRISMA 2020 Stage | Description | Number of Records |
|---|---|---|
| Identification | Records identified from databases | 543 |
| | Duplicate records removed | 121 |
| Screening | Records screened by title and abstract | 422 |
| | Records excluded | 301 |
| Reports sought | Reports sought for retrieval | 121 |
| | Reports not retrieved or unavailable in full text | 14 |
| Eligibility | Reports assessed for eligibility | 107 |
| | Reports excluded (total) | 87 |
| Included | Studies included in qualitative synthesis | 20 |
| | Additional records identified through reference screening | 7 |
| | **Final sources used in the manuscript and reference manager file** | **20** |

Figure 1. The flow diagram summarizes the study identification, screening, exclusion, and final inclusion process

## RESULT

The study selection process is presented in Figure 1. A total of 543 records were identified from four databases: PubMed (187), Scopus (142), ScienceDirect (116), and Web of Science (98). After removing 121 duplicate records, 422 titles and abstracts were screened. Of these, 301 records were excluded because they did not address the research question, did not examine preeclampsia or hypertensive disorders of pregnancy, or did not report relevant neonatal outcomes. Furthermore, the full texts of 121 articles were retrieved for eligibility assessment. A total of 14 articles could not be obtained in full text, leaving 107 articles for the eligibility assessment stage.

In the next stage, articles were excluded if they did not provide data on low birth weight (LBW) or birth weight, did not have a group that could be clearly identified as patients with preeclampsia or hypertensive disorders in pregnancy, were published before 2022, had inadequate empirical information, or did not meet the established inclusion criteria. Ultimately, a total of six primary empirical studies met all eligibility criteria and were included in the qualitative synthesis.

Six studies included in this review were all conducted in Indonesia using cross-sectional and case-control designs and were published during the period 2022–2025. The studies included Lieskusumastuti et al. (2022), Ferawati et al. (2023), Zuvarcan et al. (2024), Indriany et al. (2024), Nopiarmi et al. (2024), and Dzakiyyah et al. (2025) [23–28]. The sample sizes of each study ranged from 120 to 490 participants, with a total of 1,345 mother and infant observations. Four studies assessed preeclampsia in general [23,25,26,28], while two studies specifically focused on severe preeclampsia [24,27]. All studies used a consistent definition of low birth weight (LBW), namely birth weight less than 2,500 grams. The comparison groups consisted of mothers without preeclampsia or appropriate control/non-exposed groups according to the design of each study [23–28].

Six studies showed a consistent direction of the relationship between maternal preeclampsia, including severe preeclampsia, and the incidence of low birth weight (LBW), although the magnitude of the association varied between studies [23–28]. Lieskusumastuti et al. reported a crude odds ratio (OR) of 6.81 (95% CI: 3.16–14.69), indicating a higher likelihood of LBW in babies born to mothers with preeclampsia compared to mothers without preeclampsia [23]. A stronger association was found in the

study by Ferawati et al. in mothers with severe preeclampsia after adjusting for parity, with an adjusted OR of 29.28 (95% CI: 11.20–76.54) [24]. Another study reported an adjusted OR of 7.75 (95% CI: 2.77–21.71) based on multivariate analysis [25]. Zuvarcan et al. reported a crude OR of 9.49, which was reduced to 5.97 (95% CI: 1.22–29.22) after adjustment for maternal age, parity, and education level [26].

Nopiarmi et al. reported a crude OR of 2.59 among mothers with severe preeclampsia, but no adjusted estimate was provided in the study [27]. Dzakiyyah et al. reported an adjusted OR of 4.61 (95% CI: 1.29–16.55) after accounting for maternal age, parity, anemia, and gestational age at delivery [28]. Overall, all studies indicate that babies born to mothers with preeclampsia or severe preeclampsia have a higher likelihood of LBW [23–28]. The reported effect estimates range from a crude OR of 2.59 in the study by Nopiarmi et al. to an adjusted OR of 29.28 in the study by Ferawati et al. [24,27]. The differences in the magnitude of these estimates should be interpreted cautiously as they may be influenced by variations in study design, sample size, severity of preeclampsia, characteristics of the comparison groups, matching procedures, and confounding factors accounted for in the analysis.

The evidence used to assess the risk of LBW in this review exclusively comes from six primary studies that met the inclusion criteria [23–28]. Findings regarding fetal growth restriction (FGR), small-for-gestational-age (SGA), placental dysfunction, or preterm delivery from other publications were not used as direct evidence of LBW risk if those studies did not explicitly report birth weight or LBW incidence. Other references were only used as contextual and mechanistic evidence to help explain the biological or clinical pathways that may underlie the relationship between preeclampsia and LBW [3,4,13,18,20,21].

The methodological quality and risk of bias in the six studies were assessed using the Joanna Briggs Institute (JBI) Critical Appraisal Tool, adapted to each study design. The assessment covered several key aspects, namely the appropriateness of participant selection, measurement of exposure and outcomes, identification and control of confounding factors, and the suitability of the statistical methods used.

The assessment results for each JBI item for all studies are presented in Table 4. The research characteristics and quantitative findings related to LBW are presented in

Table 3, while Table 4 provides an overview of the methodological quality of each included study. The subsequent research findings are interpreted based on four interrelated domains, namely biological mechanisms, clinical characteristics of preeclampsia, maternal and obstetric factors, and health system and neonatal care factors. These four domains are used to provide context in understanding the relationship between preeclampsia and low birth weight, not to produce additional quantitative estimates.

Placental dysfunction is suspected to be one of the main biological mechanisms linking preeclampsia with reduced birth weight. Abnormal placental implantation, impaired uteroplacental blood flow, endothelial dysfunction, inflammation, and an imbalance of angiogenesis can reduce the supply of oxygen and nutrients to the fetus. These conditions can increase the risk of FGR or SGA births [3,4,13,18,20,21]. These mechanisms provide a biological explanation for the relationship with low birth weight consistently found in all six primary studies [23–28].

Early-onset preeclampsia as well as severe preeclampsia may be associated with an increased risk of adverse fetal outcomes, especially when placental dysfunction and maternal vascular abnormalities are more severe. These conditions may interfere with fetal growth and increase the risk of medically indicated preterm delivery [4,18,21]. This evidence is used to provide biological and clinical context rather than to estimate the risk of LBW quantitatively. The quantitative effect estimates reported in this review are based solely on the six primary studies that met the eligibility criteria [23–28].

The association between preeclampsia and low birth weight may also vary according to maternal and obstetric characteristics. Several of the included studies considered maternal age, parity, anemia, gestational age, and other clinical variables as covariates or potential confounders [23,25,26,28]. Gestational age at delivery is particularly relevant because medically indicated preterm birth shortens the period available for fetal growth and may consequently contribute to a lower birth weight. The link between preeclampsia, preterm birth, and adverse neonatal outcomes is also in line with findings from broader research on hypertensive disorders of pregnancy [16,22].

Health system conditions and the availability of neonatal services may influence the severity of LBW-related outcomes, although the six studies included in this review did not directly establish these factors as determinants of LBW. Adequate antenatal care,

timely referral, appropriate obstetric management, careful delivery planning, and adequate neonatal service capacity may help reduce adverse outcomes, particularly among preterm and LBW infants in resource-limited settings [9,11]. In this review, these factors are therefore considered part of the broader clinical context rather than causal pathways supported by quantitative evidence.

Overall, the association between maternal preeclampsia and low birth weight appears to reflect several interconnected biological and clinical factors. Placental dysfunction and fetal growth restriction may contribute to reduced birth weight, while severe preeclampsia and medically indicated preterm delivery may further increase the risk. Maternal and obstetric characteristics may also affect the magnitude of this association. Although several factors may be involved, the quantitative evidence in this review is based on only six primary studies. Despite differences in study characteristics and analytical approaches, all six studies reported an association in the same direction between maternal preeclampsia and low birth weight [23–28].

A meta-analysis was not performed because the six included studies differed substantially in their study designs, definitions of preeclampsia, comparison groups, sample sizes, adjustment variables, and reported effect measures. The findings were therefore synthesized narratively, with attention to the direction and magnitude of the reported associations and the methodological characteristics of each study [23–28]. The decision not to pool the results was based on these differences in study characteristics and the available data, rather than on an absence of an association between maternal preeclampsia and low birth weight.

Across six studies, maternal preeclampsia was associated with a higher likelihood of LBW, with ORs ranging from 2.59 to 29.28 [23–28]. Variations in effect size may reflect differences in preeclampsia severity, gestational age, maternal characteristics, and study methods.

**Table 3. Summary of Associations Between Maternal Preeclampsia and Low Birth Weight in Included Studies**

| Author (Year) | Study Design | Sample Size (n) | Preeclampsia Exposure | OR (95% CI) | Analysis |
|---|---|---|---|---|---|
| Lieskusumastuti et al. (2022) [23] | Cross-sectional | 490 | Preeclampsia | 6.81 (3.16–14.69) | Crude |
| Ferawati et al. (2023) [24] | Case-control | 148 | Severe preeclampsia | 29.28 (11.20–76.54) | Adjusted |
| Zuvarcan et al. (2024) [25] | Case-control | 120 | Preeclampsia | 7.75 (2.77–21.71) | Adjusted |
| Indriany et al. (2024) [26] | Case-control | 128 | Preeclampsia | 5.97 (1.22–29.22) | Adjusted |
| Nopiarmi et al. (2024) [27] | Case-control | 290 | Severe preeclampsia | 2.59 (NR) | Crude |
| Dzakiyyah et al. (2025) [28] | Perlu verifikasi | Perlu verifikasi | Preeclampsia | 4.61 (1.29–16.55) | Adjusted |

Table 3 summarizes the associations between maternal preeclampsia and low birth weight (LBW) across six included studies. All studies reported positive associations, although the magnitude varied considerably. The reported odds ratios ranged from 2.59 to 29.28, with the highest adjusted estimate observed among mothers with severe preeclampsia in the study by Ferawati et al. (2023). Differences in effect estimates may reflect variations in study design, exposure severity, population characteristics, and adjustment for confounding factors. Because crude and adjusted estimates were reported inconsistently across studies, the findings were synthesized narratively rather than quantitatively pooled.

**Table 4. Thematic Synthesis and Evidence Consistency**

| Theme | Supporting evidence | Consistency | Main finding |
|---|---|---|---|
| Preeclampsia and increased risk of LBW | [23–28] | High | All six primary studies reported a positive association between preeclampsia and LBW. Reported effect estimates indicated substantially higher odds of LBW among neonates born to mothers with preeclampsia, although the magnitude varied across studies. |
| Severe preeclampsia and greater LBW risk | [24,27] | Moderate | Studies specifically evaluating severe preeclampsia reported increased odds of LBW. The magnitude of the association varied across studies, suggesting that the observed relationship may differ according to disease severity and study characteristics. |

| | | | |
|---|---|---|---|
| Maternal and obstetric factors | [23,25,26,28] | Moderate | Maternal age, parity, anemia, gestational age, and other obstetric characteristics were considered potential confounding factors in several studies. Differences in the variables included in the adjustment models may partly explain the variation in effect estimates across studies. |
| Gestational age and fetal growth | [25,26,28] | Moderate | Gestational age may play an important role in the association between preeclampsia and LBW. The higher risk of LBW observed in pregnancies affected by preeclampsia may be related to both restricted fetal growth and earlier delivery. |
| Consistency of the direction of association | [23–28] | High | Although the studies varied in design, population characteristics, definitions of preeclampsia, and statistical adjustments, all six reported a positive association between maternal preeclampsia and LBW. This consistency across studies suggests that preeclampsia is associated with a higher risk of LBW. |

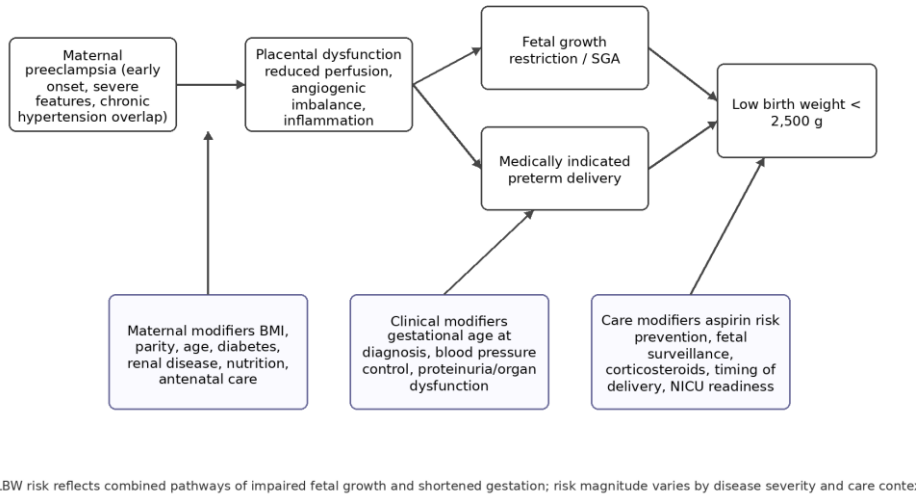



Figure 2. Conceptual framework illustrating pathways linking maternal preeclampsia to low birth weight

## DISCUSSION

The association between preeclampsia and low birth weight (LBW) may involve several related biological and obstetric factors rather than maternal hypertension alone. Placental dysfunction and fetal growth restriction (FGR) may impair fetal growth, while medically indicated preterm delivery can further lower birth weight by reducing the time available for fetal development [3,4,13,20,21]. The strength of this association may also differ according to the onset

and severity of preeclampsia, maternal comorbidities, gestational age at delivery, and access to timely obstetric and neonatal care [16,18]. Taken together, LBW among neonates born to mothers with preeclampsia may reflect the combined effects of impaired fetal growth and a shorter gestational period.

Placental dysfunction is an important biological pathway that may connect preeclampsia with low birth weight (LBW). Impaired remodeling of the spiral arteries can reduce uteroplacental blood flow and limit the delivery of oxygen and nutrients to the fetus [3,4]. Continued placental hypoperfusion may contribute to endothelial dysfunction, inflammation, and an imbalance in angiogenic factors, including alterations in the sFlt-1/PlGF pathway [3,13]. These changes can interfere with normal placental function and fetal growth, increasing the risk of fetal growth restriction (FGR), small-for-gestational-age (SGA), and subsequently LBW [4,13,18,20,21]. Inflammatory responses may further aggravate placental and endothelial dysfunction and interfere with maternal–fetal exchange [3,4,13]. This may partly explain the stronger association between early-onset preeclampsia and FGR reported in previous studies [18,20,21].

Medically indicated preterm delivery is another factor that may contribute to low birth weight (LBW) in pregnancies affected by preeclampsia. In severe preeclampsia, continuing the pregnancy may expose the mother and fetus to serious complications, such as eclampsia, stroke, pulmonary edema, impaired renal function, HELLP syndrome, and placental abruption [1,2,4]. Early delivery may be needed to reduce these risks, although it shortens gestational age and limits the time available for fetal growth and development [1,2,4,9,12]. This may increase the risk of LBW. Thus, LBW in pregnancies complicated by preeclampsia may result from both restricted fetal growth and a shorter gestational period following medically indicated early delivery. The contribution of these factors may differ according to the clinical phenotype and severity of preeclampsia.

Overall, the available evidence suggests an association between early-onset or severe preeclampsia and placental dysfunction, impaired fetal growth, preterm delivery, and lower birth weight. However, the strength of these associations differs across studies and appears to be influenced by the timing of disease onset and its severity. Early-onset preeclampsia is more frequently associated with placental dysfunction and impaired fetal growth than late-onset preeclampsia [4,18,20,21]. These variations may be influenced by differences in diagnostic criteria, timing of onset and disease severity, maternal characteristics, methods of assessing fetal growth, timing of delivery, availability of health care resources, and methods of controlling confounding factors [4,18,20,21]. Interpreting this relationship also needs to consider that birth weight is influenced both by fetal growth and gestational age. Therefore, research that does not

clearly distinguish between FGR and prematurity can produce different estimates of the relationship between preeclampsia and LBW.

The relationship between preeclampsia and low birth weight (LBW) can also vary based on maternal characteristics and clinical conditions. Early-onset preeclampsia and severe preeclampsia are more often accompanied by placental dysfunction, fetal growth restriction (FGR), and medically indicated preterm delivery. In contrast, late-onset preeclampsia more often occurs near term and may have a greater contribution from maternal cardiometabolic factors. Conditions such as chronic hypertension, kidney disease, diabetes, obesity, a history of preeclampsia, and multiple pregnancies can increase the risk of severe preeclampsia or superimposed preeclampsia and contribute to adverse neonatal outcomes [1,2,4,11,21]. Gestational age at delivery is also an important determinant because the shorter the gestation period, the more limited the opportunity for the fetus to gain weight and the higher the risk of complications due to prematurity [12,16]. Therefore, the risk of LBW needs to be understood based on the phenotype and severity of preeclampsia, maternal comorbidities, as well as the timing and clinical indications for delivery, rather than assuming preeclampsia as a uniform exposure condition.

These findings support the need for coordinated obstetric, midwifery, and neonatal care in pregnancies complicated by preeclampsia. Antenatal care should address more than blood pressure control. It should also include early identification of severe preeclampsia, assessment of maternal complications, regular monitoring of fetal growth, evaluation for suspected fetal growth restriction (FGR), and timely referral when further management is required [1,2]. More intensive monitoring and clear referral systems become increasingly important in cases with severe signs, fetal growth disturbances, or worsening maternal or fetal conditions [4]. If preterm delivery or low birth weight is anticipated, coordination among the obstetric team, midwifery staff, and neonatal team is required to support delivery planning and ensure the readiness of neonatal services.

These findings also indicate the need to strengthen the public health system, especially in low- and middle-income countries, because delays in diagnosis, referral, transportation, as well as limited access to specialized obstetric and neonatal services can worsen the consequences of preeclampsia. For preterm and low birth weight infants, essential services include maintaining body temperature, meeting nutritional needs, applying kangaroo mother care when clinically appropriate, preventing infections, and providing follow-up monitoring after discharge [9,10]. Integrating these interventions into the referral system can help ensure that mothers at risk of preterm birth receive services at facilities capable of handling maternal and neonatal conditions adequately. The consistent implementation of recommendations from WHO, ISSHP, and ACOG

can also support the standardization of risk assessment, timely interventions, and continuity of services from the antenatal period through delivery [1,2,9].

This systematic review has several strengths. It focuses specifically on low birth weight (LBW) as a neonatal outcome among mothers with preeclampsia and considers the biological, clinical, obstetric, and health service factors that may be related to this outcome [16,18]. The systematic search conducted in accordance with the PRISMA 2020 framework, together with a formal assessment of methodological quality, adds to the methodological rigor of the review [20]. However, substantial heterogeneity was observed among the included studies in terms of study design, population characteristics, geographical setting, characteristics of preeclampsia, outcome definitions, and approaches to controlling for confounding factors [23–28]. Some studies examined hypertensive disorders of pregnancy more broadly, while others reported birth weight or fetal growth restriction (FGR) as secondary outcomes. Variation in the definitions and assessment methods used for LBW, FGR, small-for-gestational-age (SGA), and preterm birth also limits direct comparison between studies. Given these methodological and clinical differences, pooling the data quantitatively was not considered appropriate, and a reliable overall effect estimate could not be established [23–28].

Future studies should consider well-designed prospective multicenter studies that use standardized definitions for the onset and severity of preeclampsia, fetal growth restriction (FGR), small-for-gestational-age (SGA), preterm birth, and low birth weight (LBW) [16,17]. Distinguishing spontaneous preterm birth from medically indicated preterm delivery would help determine how much LBW is related to restricted fetal growth and how much may be associated with a shorter gestational period. Consistent reporting of adjusted effect estimates, including odds ratios, risk ratios, or hazard ratios with corresponding confidence intervals, would also improve comparisons between studies and make future quantitative synthesis more feasible. A meta-analysis may be appropriate when sufficient evidence with comparable study methods, populations, and outcomes becomes available. More evidence from low- and middle-income countries is also needed to examine whether antenatal monitoring, referral systems, obstetric care capacity, and access to neonatal services are associated with LBW and related neonatal

## CONCLUSIONS

This systematic review found that low birth weight (LBW) among neonates born to mothers with preeclampsia is associated with placental dysfunction, fetal growth restriction (FGR), and medically indicated preterm delivery. The association may be stronger in cases of early-onset or severe preeclampsia and may also be influenced by

maternal comorbidities and gestational age at delivery. These findings support the need for early risk assessment, regular monitoring of fetal growth, timely referral, appropriate delivery planning, and coordinated neonatal care for pregnancies complicated by preeclampsia. Future studies should focus on prospective multicenter research using standardized outcome definitions and consistently reported adjusted effect estimates, particularly in low- and middle-income countries. Meta-analysis may be feasible when sufficient studies with comparable methodological and clinical characteristics become available. However, given the heterogeneity among the included studies and the absence of a formal assessment of the certainty of evidence, these findings should be interpreted as evidence of an association rather than as definitive evidence of a causal relationship.

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## AUTHOR CONTRIBUTIONS

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## REFERENCES

[1] Magee, L. A., Brown, M. A., Hall, D. R., Gupte, S., Hennessy, A., Karumanchi, S. A., Kenny, L. C., McCarthy, F., Myers, J., Poon, L. C., Rana, S., Saito, S., Staff, A. C., Tsigas, E., & von Dadelszen, P. (2022). The 2021 International Society for the Study of Hypertension in Pregnancy classification, diagnosis & management recommendations for international practice. *Pregnancy Hypertension, 27*, 148–169. https://doi.org/10.1016/j.preghy.2021.09.008

[2] Garovic, V. D., Dechend, R., Easterling, T., Karumanchi, S. A., McMurtry Baird, S., Magee, L. A., Rana, S., Vermunt, J. V., & August, P. (2022). Hypertension in pregnancy: Diagnosis, blood pressure goals, and pharmacotherapy: A scientific statement from the American Heart Association. *Hypertension, 79*(2), e21–e41. https://doi.org/10.1161/HYP.0000000000000208

[3] Jung, E., Romero, R., Yeo, L., Gomez-Lopez, N., Chaemsaithong, P., Jaovisidha, A., Gotsch, F., & Erez, O. (2022). The etiology of preeclampsia. *American Journal of Obstetrics and Gynecology, 226*(2 Suppl), S844–S866. https://doi.org/10.1016/j.ajog.2021.11.1356 [4] E. D. et al., "Pre-eclampsia," *Nat. Rev. Dis. Prim.*, vol. 9, no. 1, p. 8, 2023, doi: 10.1038/s41572-023-00417-6.

[4] Dimitriadis, E., Rolnik, D. L., Zhou, W., Estrada-Gutierrez, G., Koga, K., Lim, J. Y., Shirasuna, K., & others. (2023). Pre-eclampsia. *Nature Reviews Disease Primers, 9*, Article 8. https://doi.org/10.1038/s41572-023-00417-6

[5] World Health Organization. (2025, December 10). *Pre-eclampsia*. https://www.who.int/news-room/fact-sheets/detail/pre-eclampsia

[6] World Health Organization, United Nations Children's Fund, United Nations Population Fund, World Bank Group, & United Nations Department of Economic and Social Affairs, Population Division. (2025). *Trends in maternal mortality 2000 to 2023: Estimates by WHO, UNICEF, UNFPA, World Bank Group and UNDESA/Population Division*. World Health Organization. https://www.who.int/publications/i/item/9789240108462

[7] Liu, Y., Li, N., An, H., Li, Z., Zhang, L., Li, H., Zhang, Y., & Ye, R. (2021). Impact of gestational hypertension and preeclampsia on low birthweight and small-for-gestational-age infants in China: A large prospective cohort study. *The Journal of Clinical Hypertension, 23*(4), 835–842. https://doi.org/10.1111/jch.14176

[8] Simbolon, D., Ningsih, L., Andriani, L., & Kamsiah. (2025). Is the incidence of low birth weight in Indonesia due to preeclampsia during pregnancy?: A meta-analysis. *Media Gizi Indonesia, 20*(3), 223–233. https://doi.org/10.20473/mgi.v20i3.223-233 [10] U. and W. H. Organization, "Low birthweight estimates: levels and trends 2000-2020," 2023. [Online]. Available: https://data.unicef.org/resources/low-birthweight-report-2023/

[9] World Health Organization. (2022). *WHO recommendations for care of the preterm or low-birth-weight infant*. World Health Organization. https://www.who.int/publications/i/item/9789240058262

[10] United Nations Children's Fund, & World Health Organization. (2023). *UNICEF/WHO low birthweight estimates: Levels and trends 2000–2020*. World Health Organization. https://data.unicef.org/resources/low-birthweight-report-2023/

[11] American College of Obstetricians and Gynecologists. (2022). Clinical guidance for the integration of the findings of the Chronic Hypertension and Pregnancy (CHAP) study. *Obstetrics & Gynecology, 140*(2), e26–e50. https://www.acog.org/clinical/clinical-guidance/practice-advisory/articles/2022/04/clinical-guidance-for-the-integration-of-the-findings-of-the-chap-study

[12] Ohuma, E. O., Moller, A. B., Bradley, E., Chakwera, S., Hussain-Alkhateeb, L., Lewin, A., Okwaraji, Y. B., Mahanani, W. R., Johansson, E. W., Lavin, T., Fernandez, D. E., Domínguez, G. G., de Costa, A., Cresswell, J. A., Krasevec, J., Lawn, J. E., Blencowe, H., Requejo, J., & Moran, A. C. (2023). National, regional,

and global estimates of preterm birth in 2020, with trends from 2010: A systematic analysis. *The Lancet, 402*(10409), 1261–1271. https://doi.org/10.1016/S0140-6736(23)00878-4

[13] Karumanchi, S. A., & Thadhani, R. (2022). Preeclampsia: A placental angiogenic disorder with maternal and fetal consequences. *Annual Review of Medicine, 73*, 421–436.

[14] Staff, A. C. (2022). Long-term cardiovascular health after preeclampsia: Mechanistic links and clinical opportunities. *Pregnancy Hypertension, 28*, 37–45.

[15] Hutcheon, J. A., & Joseph, K. S. (2022). Epidemiology and clinical classification of hypertensive disorders of pregnancy in contemporary perinatal research. *Best Practice & Research Clinical Obstetrics & Gynaecology, 85*, 3–15.

[16] Ge, J., Gu, X., Jiang, S., Yang, L., Li, X., Jiang, S., Jia, B., Chen, C., Cao, Y., Lee, S. K., Zhao, X., Ji, Y., & Zhou, W. (2023). Impact of hypertensive disorders of pregnancy on neonatal outcomes among infants born at 24+0–31+6 weeks' gestation in China: A multicenter cohort study. *Frontiers in Pediatrics, 11*, Article 1005383. https://doi.org/10.3389/fped.2023.1005383

[17] Li, Y., Chehab, R. F., Wang, E. Z., Susarla, S. M., Voong, C., Chen, H., Cabatu, M. C., Sorsby-Jones, H., & Zhu, Y. (2026). Global prevalence of hypertensive disorders of pregnancy: A scoping review and global perspective by country and region. *Frontiers in Cardiovascular Medicine, 13*, Article 1692590. https://doi.org/10.3389/fcvm.2026.1692590

[18] Hu, W., et al. (2024). Association between early-onset preeclampsia and fetal growth restriction: A population-based cohort study. *Frontiers in Pediatrics, 12*.

[19] Peahl, A. F., & Howell, J. D. (2021). The evolution of prenatal care delivery guidelines in the United States. *American Journal of Obstetrics and Gynecology, 224*(4), 339–347. https://doi.org/10.1016/j.ajog.2020.12.016

[20] Beaulac, A., Cumyn, A., Côté, A.-M., & Caron, N. (2025). Hypertensive disorders of pregnancy: A narrative review. *Canadian Journal of General Internal Medicine, 20*(2), 57–68. https://doi.org/10.3138/cjgim.2024.0032

[21] Masini, G., Foo, L. F., Tay, J., Wilkinson, I. B., Valensise, H., Gyselaers, W., & Lees, C. C. (2022). Preeclampsia has two phenotypes which require different treatment strategies. *American Journal of Obstetrics and Gynecology, 226*(2 Suppl), S1006–S1018. https://doi.org/10.1016/j.ajog.2020.10.052

[22] World Health Organization. (2023). *Low birthweight estimates: Levels and trends 2000–2020*. World Health Organization & United Nations Children's Fund.

[23] Lieskusumastuti, A. D., Setyorini, C., Hanifah, L., & Hapsari, I. A. (2022). Hubungan preeklamsia dengan kejadian berat badan lahir rendah (BBLR) pada ibu bersalin di RS PKU Muhammadiyah Delanggu. *Jurnal Kebidanan Indonesia, 14*(1), 139. https://doi.org/10.36419/jki.v14i1.770

[24] Ferawati, E., Kuswandi, K., & Karmila, N. (2023). Impact of severe preeclampsia on the incidence of low-birth-weight babies. *Majalah Kedokteran Bandung, 55*(4), 227–231. https://doi.org/10.15395/mkb.v55n4.3277

[25] Zuvarcan, D. A., Putra, D. A., & Martuti, S. (2024). Correlation between

preeclampsia and infant low birth weight at Dr. Moewardi Hospital, Surakarta, Central Java, Indonesia. *Journal of Maternal and Child Health, 9*(1), 28–37. https://doi.org/10.26911/thejmch.2024.09.01.03

[26] Indriany, D. S., Yorita, E., Ekanugraheni, D., & Yanniarti, S. (2024). Preeclampsia is a risk factor for low birth weight (LBW) infants. *Jurnal Ners dan Kebidanan Indonesia, 12*(2), 151–167. https://doi.org/10.21927/jnki.2024.12(2).151-167

[27] Nopiarmi, N. W. E., Tedjasulaksana, R., & Dewi, I. G. A. N. (2024). Pengaruh preeklampsia terhadap kejadian berat badan bayi lahir rendah di Rumah Sakit Umum Pusat Prof. Dr. I.G.N.G. Ngoerah Denpasar tahun 2022. *Archive of Community Health, 11*(3), 977–983.

[28] Dzakiyyah, S. A., Rahma, A., Salsabila, A., Agustina, D. S., Qamariah, S., Duarsa, A. M., & Cininta, N. I. (2025). Preeclampsia and preterm birth as predominant factors of low birth weight: Insights from a rural hospital in Indonesia. *Folia Medica Indonesiana, 61*(2), 196–203. https://doi.org/10.65346/2599-056X.2404