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REVIEWS

Compliance iron supplement intake on maternal anemia and low birth weight in indonesia: meta-analysis

Cumplimiento de la ingesta de suplementos de hierro en la anemia materna y el bajo peso al nacer en indonesia: metanálisis

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ABSTRACT:

Background: According to the Indonesia Ministry of Health in 2023, only 20% of pregnant women adhared to iron supplement intake. Poor adherence to iron supplementation also leads to increased prevalence of maternal anaemia and low birth weight.
Objective. This review to analyze the adherence or compliance to iron supplement intake among pregnant women.
Methods. The study employed a systematic review and meta-analysis based on the PRISMA 2020 guidelines. During the article selection, the study applied inclusion criteria, such as original research articles conducted in Indonesia, using Indonesian or English language, and published between 2019 and 2024. Additionally, the articles must discuss the effect of adherence to iron supplement intake on the incidence of maternal anemia and low birth weight. They were systematically searched in the following databases: PubMed, Science Direct, Springer, Google Scholar, and Proquest. To facilitate the systematic review analysis, the Odds ratio (OR) was analyzed using Review Manager 5.4.
Results. A total of 16 studies (10 articles on maternal anemia and 6 articles on low birth weight) were included in this meta-analysis. The results revealed that maternal anemia had a significant relationship with adherence to iron supplement intake (OR: 0.10, 95%CI 0.06 - 0.14; p-value <0.001) and also low birth weight (OR: 0.42, 95%CI 0.21 - 0.86; p-value: 0.02).
Conclusion. Based on this finding, poor adherence to iron supplement intake significantly increase risk of maternal anemia and low birth weight.

Keywords: Anemia, Iron Supplements, Low Birth Weight, Pregnant Women

RESUMEN:

Antecedentes: Según el Ministerio de Salud de Indonesia, solo el 20% de las embarazadas se adhirieron a la suplementación con hierro en 2023. La mala adherencia a la suplementación con hierro conlleva un aumento de la prevalencia de anemia materna y bajo peso al nacer.
Objetivo: Esta revisión busca examinar la adherencia a la suplementación con hierro en embarazadas.
Métodos: Este estudio utilizó la observación sistemática y un metanálisis basado en las directrices PRISMA de 2020. Los criterios de inclusión para la selección de artículos fueron artículos de investigación realizados en Indonesia, escritos en indonesio o inglés, y publicados entre 2019 y 2024. Además, los artículos debían abordar la relación entre la adherencia a la suplementación con hierro y la incidencia de anemia materna y bajo peso al nacer. Se realizó una búsqueda sistemática en las siguientes bases de datos: PubMed, Science Direct, Springer, Google Scholar y Proquest. En un análisis descriptivo sistemático, se analizaron las razones de probabilidades (OR) con Review Manager 5.4.
Resultados: Se incluyeron en el metanálisis un total de 16 estudios (10 artículos sobre anemia materna y 6 artículos sobre bajo peso al nacer). Los resultados mostraron que la anemia materna se asoció significativamente con la suplementación con hierro (OR: 0,10; IC95%: 0,06-0,14; valor p <0,001) y el bajo peso al nacer (OR: 0,42; IC95%: 0,21-0,86; valor p: 0,02).
Conclusión: Según estos hallazgos, la suplementación deficiente con hierro aumenta significativamente el riesgo de anemia materna y bajo peso al nacer.

Palabras clave: Anemia, Suplemento de hierro, Bajo peso al nacer, Mujeres embarazadas.

INTRODUCTION

Iron deficiency anemia, the most common hematologic disorder in pregnant women[1], contributes significantly to maternal anemia, a global public health problem. Maternal anemia often results from poor nutrition and is widely used as an indicator of poor maternal health[2,3]. Pregnant women are often unaware of the increased nutritional requirements, especially for iron and folic acid which are essential for maintaining healthy hemoglobin levels during pregnancy. As a result, pregnant women are prone to suffer inadequate iron-folic acid supplement intake, which is recognized as a significant risk factor for maternal anemia[4].

According to the World Health Organization (WHO), maternal anemia occurs when hemoglobin (Hb) levels fall below 110g/dL in the first and third trimesters and below 105g/dL in the second[5]. Pregnant women with anemia are 3.6 times more likely to die than women without anemia[6]. In addition to increasing health risks for the mother, maternal anemia is also detrimental to fetal growth and pregnancy outcomes[7,8]. Low birth weight, for example, has been consistently linked to maternal anemia[9]. WHO defined low birth weight as a neonatal weight of less than 2500 g (up to and including 2499g)[10]. Iron-folic acid is an essential micronutrient for fetal growth, development, and overall physiological function. Pregnant women with maternal anemia face a higher risk of giving birth to babies with low birth weight compared to those with adequate iron levels[9]. To support healthy fetal growth, pregnant women must increase iron-folic acid intake during pregnancy because the nutrients are essential for nourishment and oxygen transport through the placenta[11].

In 2019, the World Health Organization (WHO) stated that the global anemia prevalence among reproductive women was 29.9%, equivalent to more than half a billion women aged 15-49 years. The prevalence was even higher among pregnant women, reaching 36.5%[12] Southeast Asia had the highest prevalence of anemia at 42%[13]. In Indonesia, data from the Indonesian Basic Health Survey (RISKESDAS) showed that the

prevalence of maternal anemia increased from 37.1% in 2013 to 48.9% in 2018[14,15]. It is still a major contributor to maternal mortality in Indonesia, with a prevalence of 50-70%[16]. The increasing prevalence of maternal anemia has also contributed to an increase in low birth weight (LBW) cases. According to the Indonesian Basic Health Research, the prevalence of LBW rose from 5.7% in 2013 to 8.9% in 2018[14,15]. Hence, maternal anemia and LBW continue to be serious maternal and child health issues in Indonesia that can increase the risk of maternal and infant mortality. Addressing maternal anemia is crucial, as it is primarily caused by nutritional deficiencies (iron, folic acid, vitamin B12, and protein), gestational diabetes, multiple pregnancies, teenage pregnancies, and infections during pregnancy[17].

Given the persistent challenge of maternal anemia, iron supplementation is one of the most widely implemented strategies for its prevention, alongside iron fortification of foods and nutrition education through communication, information, and education strategies[18]. Folic acid and iron supplementation are very important for pregnant women because their nutritional needs increase significantly during pregnancy. These nutrients are crucial to support fetal development, maintain maternal health, and prevent complications caused by nutrient deficiencies[19]. Iron is needed to support increased hemoglobin production and fetal development[20], while folic acid is essential for the early development of the fetal nervous system and DNA formation[21].

WHO recommends that pregnant women take daily oral iron-folic acid supplements containing 30-60 mg of iron and 0.4 mg of folic acid to prevent maternal anemia, puerperal sepsis, low birth weight, and preterm birth[1]. The Indonesian Ministry of Health advises pregnant women to consume at least 90 iron tablets during pregnancy. However, only 61.9% of pregnant women adhere to this recommendation[22]. More recent data from 2023 indicate a decrease as only 28.6% of pregnant women received iron tablets as recommended, and just 20% consistently took all 90 tablets during pregnancy[23]. As a result, maternal anemia is difficult to solve as the adherence to iron-folic acid among pregnant women is poor.

OBJECTIVE

The main objective of this review to analyze the adherence or compliance to iron supplement intake among pregnant women. This study also explores its implications for maternal anemia and low birth weight in Indonesia.

MATERIALS AND METHODS

Study Design

The study employed a systematic review and meta-analysis design. Meta-analysis is a statistical technique aimed at combining the results of two or more original studies. It can be viewed as part of a systematic review that uses formal statistical analysis to synthesize findings. In this study, the meta-analysis was conducted based on the PRISMA (Preferred Reporting Items for Systematic Review and Meta-Analysis) 2020 guidelines. The review protocol was registered with the International Prospective Register of Systematic Reviews (PROSPERO) database (registration number: CRD42024607710) and the protocol has been published [https://www.crd.york.ac.uk/PROSPERO/view/CRD42024607710].

Search Strategy

The electronic databases used to search for articles included PubMed, Science Direct, Springer, Google Scholar, and Proquest. The search terms were iron supplementation, anemia, and low birth weight. Additionally, the databases were searched using the following keywords: (('iron supplementation')) AND (('anemia')) AND (('low birth weight')). The study's search strategy is detailed in Table 1.

Table 1. Databases and search strategies

Databases	Search strategy
PubMed, Science Direct, Springer, Google Scholar, and Proquest	1. (('iron supplement')) AND (('low birth weight')) 2. (('anemia')) AND (('low birth weight')) 3. (('iron supplement')) AND (('anemia')) AND (('low birth weight'))

Inclusion and Exclusion Criteria

To ensure the relevance and quality of the studies included in this review, specific inclusion and exclusion criteria were applied. The inclusion criteria were as follows: (1) studies published in Indonesian or English language, (2) articles from the years 2019 to 2024, (3) original research articles, and (4) studies conducted in Indonesia. Meanwhile, the exclusion criteria were: (1) editorial notes or review articles (e.g., systematic review, literature review, or Meta-Analysis), (2) articles with only titles and abstracts available, (3) articles that did not cover topics on adherence to iron supplement intake among pregnant women and its implications for maternal anemia and low birth weight.

Quality Assessment and Risk of Bias (RoB)

The methodological quality of the included study was assessed using the National Institutes of Health (NIH) Quality Assessment Tool for Observational Cohort and Cross-sectional. The NIH tools consist of 14 questions with three possible responses: 1=yes, 0=no, and others (N/A=not applicable, N/R=not reported). The quality of the studies was classified as "good", "fair", or "poor".

The risk of bias in the selected studies was considered to be inversely related to the quality of the research. Specifically, good-quality research is deemed to have a low risk of bias (ROB), while a fair-quality study has a moderate ROB. Additionally, a poor-quality study is often associated with a high ROB (1). Table 2 shows the quality of the studies using the NIH Quality Assessment Tool and the risk of bias (ROB) for each study. This study involved 16 articles (10 related to anemia and 6 related to low birth weight). Of these, 10 articles were classified as a good quality, so the risk of bias was low. Then, 3 articles were of poor quality, indicating a high risk of bias, and the remaining 3 were of fair quality with a moderate risk of bias.

Data Extraction

This study applied a structured data extraction process to systematically collect and analyse relevant data, a structured data extraction process was employed. Six researchers were involved in the extraction stage to ensure the accuracy and consistency of the results. The research process began with a manual search of various

electronic databases, such as PubMed, ScienceDirect, Springer, Google Scholar, and Proquest. The articles were then filtered to select those that met the eligibility criteria. Once the eligible articles were identified, the researcher determined the specific data to be extracted. Data extraction focused on iron supplements, anemia, and low birth weight. The extracted data were recorded in a formatted table for analysis. Finally, the data were analyzed, and a systematic review was conducted.

Data Analysis

The authors reviewed the results of each study individually, extracting data with predetermined topics. These data were categorized into seven categories: author/year, type of research, tool, quality scoring, quality rating, risk of bias, and results, as provided in Table 2. The initial search strategy yielded 3,889 studies, with 600 articles remaining after initial screening. After a detailed review, 16 articles were included in the final sample of the systematic review and meta-analysis. The process of the article selection is illustrated in Figure 1.

Statistical Analysis

Data analysis was conducted using Review Manager 5.4 software. Dichotomous data (risk ratio and odds ratio) were analyzed using the Mantel-Haenszel statistical method to evaluate iron supplement intake among pregnant women and its implications for maternal anemia and low birth weight. Furthermore, heterogeneity was analyzed using the DerSimonian and Laird random effects model. Sensitivity analysis was also performed using a left-one-out approach to detect study outliers and changes in heterogeneity (I^2), with I^2 values of 0-50% representing low heterogeneity, 50-75% representing moderate heterogeneity, and 76-100% representing substantial heterogeneity. Depending on the heterogeneity observed in the data, data analysis involved the application of fixed or random effects models. All statistical analyses with a p-value <0.05 were considered statistically significant.

Figure 1. Preferred Reporting Items for Systematic Review and Meta-Analyses (PRISMA) flow diagram of study selection.

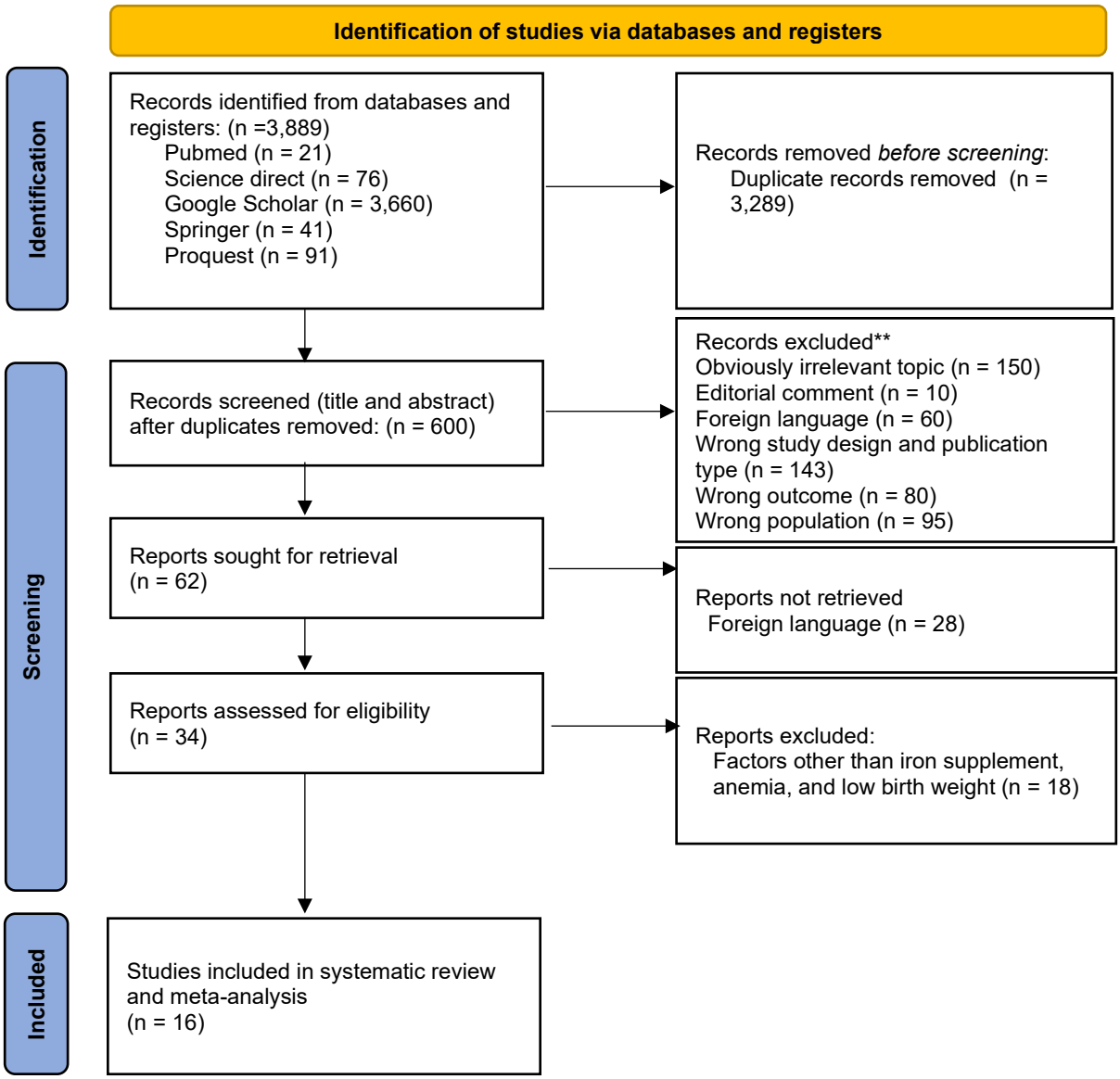


Table 2. Characteristics of articles included in the study

Author/ Year	Type of Research	Tool	Quality scoring	Quality rating	Risk of bias (RoB)	Results
Anemia						
Berthelin et al. (2022)[24]	Cross-sectional	Questionnaire instrument	10	Good	Low	The study revealed that compliance with taking Fe tablets and nutritional status has a significant relationship with the incidence of anemia in pregnant women.
Dolang (2020)[25]	Cross-sectional	Questionnaire instrument	10	Good	Low	The study found a relationship between participation in

Author/ Year	Type of Research	Tool	Quality scoring	Quality rating	Risk of bias (RoB)	Results
						consuming Fe tablets and the regularity of ANC (Antenatal Care) visits with the incidence of anemia in pregnant women at the Passo Health Center in Ambon City.
Nur Fitriyah et al. (2022)[26]	Cross-sectional	Observation sheet and hemometer	8	Poor	High	There was a relationship between the compliance of pregnant women in consuming iron tablets and the occurrence of anemia.
Agnes Kusumasatiri et al. (2021)[27]	Retrospective approach	Questionnaire instrument	8	Poor	High	A relationship was found between compliance in consuming Fe tablets and the risk of anemia in pregnant women at the Sleman Health Center.
Millah (2019)[28]	Cross-sectional	Questionnaire instrument	10	Good	Low	The study demonstrated a relationship between the consumption of Fe tablets and the incidence of anemia in pregnant women.
Omasti et al. (2022)[29]	Cross-sectional	Questionnaire instrument	10	Good	Low	There was a relationship between compliance with iron tablet consumption and the incidence of anemia in pregnant women.
Putri & Sari (2023)[30]	Cross-sectional	Questionnaire instrument	8	Poor	High	This study showed that the consumption of Fe tablets was related to the incidence of anemia in pregnant mothers.
Ramadhini & Dewi (2021)[31]	Cross-sectional	Questionnaire instrument	10	Good	Low	Age, parity, and compliance with iron supplement tablet consumption were related to the incidence of anemia in pregnant women.

Author/ Year	Type of Research	Tool	Quality scoring	Quality rating	Risk of bias (RoB)	Results
Sari & Djannah (2020)[32]	Cross-sectional	Questionnaire instrument	10	Good	Low	There was a significant relationship between compliance in consuming Fe tablets and the incidence of anemia in pregnant women at the Kotagede II Health Center, Yogyakarta.
Wirke et al. (2022)[33]	Cross-sectional	Questionnaire instrument	10	Good	Low	A significant relationship was found between ANC visits, compliance with Fe tablet consumption and nutritional status with the incidence of anemia in pregnant women in the third trimester at the Kutaraya Health Center, Kayuagung City District, Ogan Komering Ilir (OKI) Regency in 2021.
Low Birth Weight						
Afrina et al. (2023)[34]	Cross-sectional	Secondary and primary data	10	Good	Low	There was no significant relationship between the variable of iron (Fe) tablet intake and the incidence of LBW.
Aprisia & Simbolon (2022)[35]	Cross-sectional	Questionnaire instrument	10	Good	Low	This study confirmed the association of the iron supplementation of pregnant women with the baby's birth weight.
Natalia et al. (2024)[36]	Retrospective cohort	Secondary data	10	Good	Low	A significant relationship was observed between adherence to the consumption of Blood Added Tablets in pregnant women and low birth weight (BBLR) in the Working Area of the Kampung Dalam Health Center in East Pontianak 2022.
Rahim et al. (2022)[37]	Cross-sectional	Questionnaire instrument	9	Fair	Moderate	They discovered no significant relationship between adherence to

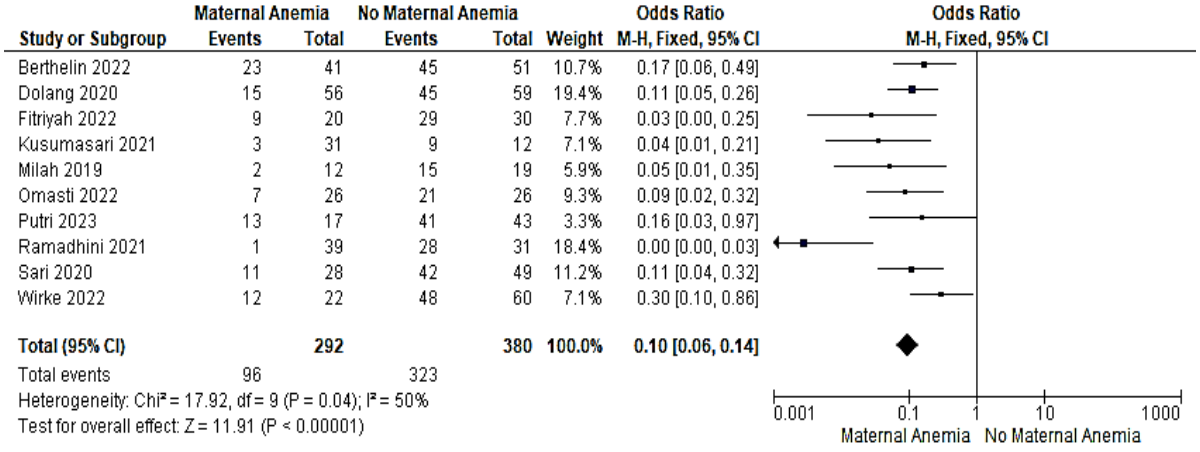
Author/ Year	Type of Research	Tool	Quality scoring	Quality rating	Risk of bias (RoB)	Results
						blood-added tablet consumption and the incidence of low birth weight.
Said & Marwati (2019)[38]	Cross-sectional	Questionnaire instrument	9	Fair	Moderate	Also, there was no relationship between the consumption of Fe tablets and the incidence of LBW.
Tiyasasih et al. (2022)[39]	Cross-sectional	Secondary data (KIA Book)	9	Fair	Moderate	There was a relationship between iron supplementation during pregnancy and the incidence of LBW in the Tamanan Bondowoso Community Health Center Work Area.

RESULTS

This section presents the systematic review and meta-analysis findings, summarizing the included studies and their key outcomes. A total of 16 studies conducted across various regions in Indonesia were analyzed, including Java[27, 35, 24, 28, 32, 39], East Nusa Tenggara[26], Bali[29], Bengkulu[30], North Sumatra[31], West Sumatra[33], Aceh[34], Kalimantan[36], Gorontalo[37], Maluku[25, 38]. These studies, published in international or national journals from 2019-2024, were all cross-sectional in design. The findings showed an association between adherence to iron supplementation and maternal anemia, as well as low birth weight (p-value <0.05), aligning with the meta-analysis in this study. The complete results of the meta-analysis are presented in Figure 2.

Adherence to Iron Supplement Intake and Its Implications for Maternal Anemia

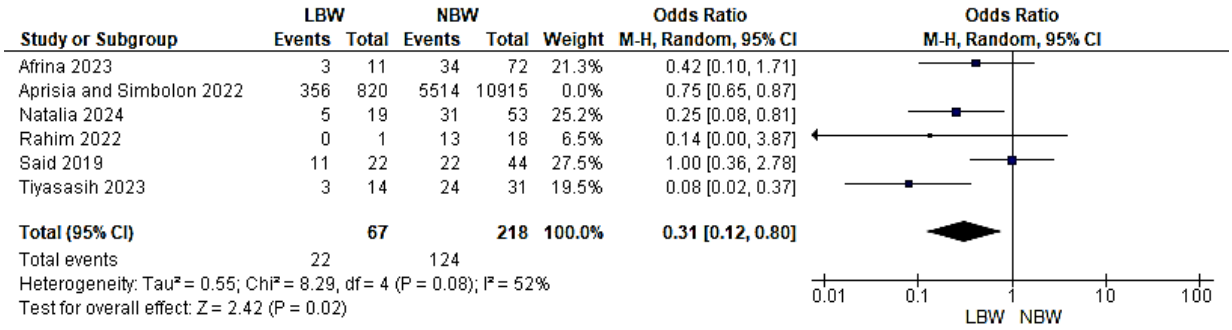
Figure 2. Meta-Analysis of iron supplement intake and maternal anemia



Iron supplementation plays a crucial role in preventing anemia during pregnancy. This section examines the relationship between adherence to iron supplement intake and the incidence of maternal anemia. As shown in Figure 2, a total of 10 articles were included in the meta-analysis. The results indicated a significant relationship between the two variables (OR: 0.10, 95%CI 0.06 - 0.14; p-value <0.001). The finding suggests pregnant women who consume iron supplements have a 0.10 times lower risk of having anemia than those in the control group.

Adherence to Iron Supplement Intake and Its Implications for Low Birth Weight

Figure 3. Meta-Analysis of iron supplement intake and low birth weight



Ensuring adequate iron intake during pregnancy is essential not only for maternal health but also for fetal development. This section evaluates the relationship between iron supplement intake and the incidence of low birth weight. A total of 6 articles were included in the meta-analysis. As shown in Figure 3, the analysis demonstrated a significant relationship between iron supplement intake and the incidence of low birth weight (OR: 0.42, 95%CI 0.21 - 0.86; p-value: 0.02). Thus, it suggests that pregnant women who adhered to iron supplementation have a 0.42 times lower risk of giving a low birth weight than the control group.

DISCUSSION

This study aimed to analyze adherence to iron supplement intake among pregnant women and its implications for maternal anemia and low birth weight in Indonesia. The result of this meta-analysis indicated a significant relationship between adherence to iron supplement intake and the two variables. Additionally, a significant relationship was found between adherence to iron supplement intake and maternal anemia (OR: 0.10, 95%CI 0.06 - 0.14; p-value <0.001). These findings are consistent with previous studies, for example, by Zhao et al. (2015)[40] in China, that showed iron supplementation can improve maternal hemoglobin and iron status, as well as reduce anemia (RR: 0.53; 95% CI: 0.43, 0.66). Similarly, a systematic review and meta-analysis by Haider et al. (2013) revealed that iron supplementation increased maternal hemoglobin at or near term by 4.59 g/L[41].

The significant relationship between iron supplementation and maternal anemia, as shown in this meta-analysis, indicates a critical need for adequate iron intake during pregnancy. During this period, iron requirements increase significantly due to physiological and hormonal changes driven by fetal growth and development[42]. The

increase occurs very rapidly because iron is needed to support fetoplacental development, maternal red blood cells, and fetal circulation[43]. Since pregnant women cannot produce sufficient iron for themselves and their fetuses, iron supplementation is very important to reduce the incidence of maternal anemia and other related risks such as low birth weight, bleeding, preterm birth, and maternal mortality[40]. In this study, of 10 studies that linked iron supplementation with maternal anemia, 8 demonstrated that pregnant women who adhered to iron supplementation did not have maternal anemia[24, 25, 26, 28, 29, 30, 32, 33]. The other two studies showed that pregnant women who did not adhere to iron supplementation had maternal anemia[27,31].

Adherence to iron supplement intake is defined as pregnant women consuming one iron supplement tablet regularly for at least 90 days during pregnancy[44]. Studies indicate that adherence to this regulation is effective in covering the iron requirement and reducing the prevalence of maternal anemia by 20-25%[45]. Pregnant women who consume iron supplements during the first trimester or around 12 weeks can increase their hemoglobin level from 8.45 gr/dl to 11.45 gr/dl[30].

In this study, an analysis of 16 studies showed that 12 studies reported that pregnant women adhered to taking 90 iron supplements during pregnancy[24, 27, 26, 34, 28, 36, 29, 30, 37, 32, 39, 33], while 4 studies[25, 31, 35, 38] showed non-compliance with iron supplement intake. This study also found a significant relationship between adherence to iron supplement intake and the incidence of low birth weight (OR: 0.42, 95%CI 0.21 - 0.86; p-value: 0.02). Pregnant women who adhered to iron supplementation had a lower risk of delivering low-birth-weight infants than those who did not. Similarly, a meta-analysis by Bekele et al.[46] showed that iron and folic acid (IFA) and iron-only supplementation reduced the odds of low birth weight by 63% (OR 0.37; 95% CI: 0.29, 0.48) and 68% (OR 0.32; 95% CI: 0.21 to 0.50), respectively. Furthermore, Shi et al.[47] reported their multiple linear regression analysis, showing that the iron supplementation during pregnancy had a positive effect on the birth weight (BW), with an average increase of 43.07 g ($\beta = 43.07$, $t = 3.55$, and $p < 0.001$).

Pregnant women who consume iron supplements as recommended by health care providers will be able to fulfill their iron requirements during pregnancy. This adherence can increase their hemoglobin levels and prevent maternal anemia. A study by Omasti et al.[29] in Bali, Indonesia, found the largest odds ratio (OR=11.4) among other studies, which was 11.4. This finding means that pregnant women who comply with iron supplements have an 11.4 times greater chance of not experiencing maternal anemia than those who do not adhere. Meanwhile, in this study, the OR value was 0.10, which means that pregnant women who are not adherent to consuming iron supplements have a 0.10 times higher chance of experiencing maternal anemia than those who adhere. In other words, adherence to iron supplementation is associated with a 90% reduction in the likelihood of developing anemia (1 - 0.10 = 0.90 or 90%).

The 95% confidence interval (CI) in this study was very narrow, indicating a precise estimate of the odds ratio. A narrow CI also suggests little variability or uncertainty about the effect of iron supplementation on anemia prevention. It increases confidence that the observed OR closely reflects the true effect of iron supplementation on anemia prevention. In addition, this result indicates a strong and reliable association between iron supplementation and a reduced anemia risk.

This meta-analysis also observed a relationship between adherence to iron supplementation and the incidence of low birth weight (p-value = 0.002). Based on the six studies analyzed, three studies reported a relationship between adherence to iron supplementation and low birth weight [35, 36, 39]. In contrast, the other three reported no relationship between the two variables [34,37,38]. Adherence to iron supplementation can increase iron availability in the blood, which is important in forming red blood cells and absorbing nutrients from the fetus [36]. This ensures that the fetus is healthy and has no problems with its growth and development. According to Stangret et al.[48], a decrease in hemoglobin levels disrupts placental angiogenesis, limiting oxygen availability to the fetus and increasing the potential for intrauterine growth restriction. Pregnant women who did not adhere to iron supplements had a 0.42 times greater risk of giving birth to low birth weight babies than those who regularly adhered to iron supplements. However, there are three studies whose results do not align with this study, suggesting that other factors are more influential on the incidence of low birth weight. Said & Marwati [38], for example, stated that age and antenatal care visits are more influential on LBW, while Afrina et al. [34] argued that age and education have more influence.

Overall, these results show an association between adherence to iron supplementation and anemia and LBW in pregnancy, providing a strong basis for strengthening clinical practices and public health policies in Indonesia. At the clinical level, healthcare providers can improve surveillance, education, and early intervention for anemia and LBW. At the policy level, the government should expand access to iron supplements for pregnant women, increase public awareness through health education, and ensure adequate availability throughout the region, especially in areas with the highest need.

This study has several limitations that should be considered when interpreting the findings. Methodological variations across studies, including differences in the definitions of iron supplement adherence as well as in the measurement of anemia and low birth weight, introduced heterogeneity that may affect the strength of data synthesis. Moreover, most of the included studies employed a cross-sectional design, which limits the ability to establish causal relationships. Another limitation is the potential for publication bias, as only studies published in Indonesian and English were included, and studies with negative or non-significant results may not have been available. Lastly, the geographic concentration of most studies in specific regions of Indonesia may limit the generalizability of the findings, as they may not fully reflect the diverse socio-cultural contexts across the country.

CONCLUSIONS

This research reviewed studies that involving participants across the Indonesian archipelago from Sabang to Merauke and identified a relationship between adherence to iron supplement intake among pregnant women, maternal anemia, and low birth weight. These findings imply that, to prevent and control maternal anemia and reduce adverse pregnancy outcomes such as low birth weight, pregnant women should regularly consume iron supplementation, while public health practices should prioritize improving access to supplements, strengthening education, monitoring adherence, and integrating iron supplementation into broader maternal nutrition programs. Furthermore, future research is recommended to examine the long-term effectiveness of iron supplementation, identify factors influencing adherence, and assess the impact of different supplementation strategies, as effective implementation of these efforts may

substantially contribute to reducing anemia in pregnancy and low birth weight rates in Indonesia.

ETHICAL ASPECTS AND CONFLICT OF INTEREST

In this research, ethical aspects do not apply.

All the authors declare that there are no conflicts of interest.

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