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Anemia in Pregnant Women and Incidence of Preeclampsia

THE RELATIONSHIP BETWEEN ANEMIA IN PREGNANT WOMEN AND THE INCIDENCE OF PREECLAMPSIA IN INDONESIA: A SYSTEMATIC REVIEW

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ABSTRACT

Preeclampsia is the biggest cause of morbidity and mortality worldwide and the second most common cause of maternal death in Indonesia. One of the highest risk factors for preeclampsia is anemia, so this study aimed to conduct a systematic review of the relationship between anemia in pregnant women and the incidence of preeclampsia. This research was an analytic type with a systematic review method from previous research with an observational case-control approach design with secondary data sources. The data were obtained from the results of previous research with a literature time limit of the last 5 years (2018–2022). This study used databases from Google Scholar, Pubmed, ScienceDirect, Garuda, and Summon Universitas Airlangga. The search yielded 2161 studies; after eliminating 439 duplicates, 1732 remained. After exclusion based on titles and abstracts, 36 studies remained, which were screened in full text. Finally, 8 studies were eligible and included in the review. Four studies showed a relationship between anemia in pregnant women and the incidence of preeclampsia, while four other studies showed no relationship. The prevalence of anemia in pregnant women in Indonesia ranges from 13.27% to 80.8%, with an average of 44.1%. Ages at risk for preeclampsia in Indonesia are pregnant women aged <20 years and >35 years. There is a relationship between anemia in pregnant women and the incidence of preeclampsia in Indonesia. Therefore, anemia can be a risk factor for preeclampsia.

INTRODUCTION

Preeclampsia is a major cause of maternal and perinatal morbidity and mortality in the world[1]. Ten to 15% of maternal deaths are related to preeclampsia and eclampsia[2]. Based on data from the WHO, the incidence of preeclampsia ranged from 0.51% - 38.4% in 2017[3]. The incidence of preeclampsia in Indonesia reaches 3–10% of all pregnancies[4]. The

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etiology of preeclampsia is not well known yet, but several risk factors can predispose to preeclampsia, including genetic factors and medical conditions in pregnant women such as diabetes, kidney disease, obesity, and anemia. Other risk factors are age >30 years, previous history of preeclampsia, s pregnancies[5].

Twenty-six percent of pregnant women with preeclampsia are known to have anemia as a risk factor[6]. One of the risk factors for preeclampsia is anemia, a condition that is quite common in pregnant women. The prevalence of anemia in pregnant women globally is 36.5%[7], while the prevalence of anemia in Indonesia itself is still high at 48.9% in 2018, where there is 11.8% increase in prevalence from 37.1% in 2013[8].

In one study in Indonesia, it was stated that there was a relationship between anemia in pregnancy and the incidence of preeclampsia. The possibility of preeclampsia was 2.7 times higher in pregnant women with anemia than in those who were not anemic[9], while contradictory results were found in another study that stated that anemia and the incidence of preeclampsia were not related[10].

Based on the illustration above, the prevalence of preeclampsia and anemia in Indonesia is still high and concerning. As there were differences in results between previous studies, the study aimed to review systematically the relationship between anemia in pregnant women and the incidence of preeclampsia in Indonesia.

MATERIALS AND METHODS

This systematic review was conducted following the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) guidelines.

We systematically searched the Google Scholar, PubMed, ScienceDirect, Garuda, and Summon UNAIR databases. The key terms searched were "preeclampsia", "anemia", "pregnant women", and "Indonesia".

We retrieved all the literature from 2017 until 2022. The included literature were those with research subjects of pregnant women tested for anemia during their pregnancy, the literature were written in English and Indonesian with qualitative methods of research located in Indonesia. We excluded literature that used qualitative methods and could not be retrieved with full access. The extracted data from all the retrieved literature was collected and tabulated using Rayyan and Microsoft Excel to be further analyzed.

RESULTS

Guidelines for searching data in this study were based on the PRISMA flowchart (Figure 1). This guide was divided into three phases, starting with identification, screening, and included studies. Identification of study searches was based on keywords: anemia, pregnant women, preeclampsia, and Indonesia into databases. The literature search used 5 databases with a total of 2,161 literature collected. Before the screening, 429 pieces of literature were collected and erased due to duplication. The initial stage of screening was to construct a study with an appropriate title and abstract. After screening the titles and the abstracts, 1,696 pieces of literature were excluded. Literature that passed the screening—as many as 36 pieces—were accessed in full text to assess the feasibility of literature based on inclusion and exclusion criteria. Two pieces of literature were found using a cross-sectional study design, one literature

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had an inappropriate sample, and 25 pieces of literature that did not meet the inclusion criteria were excluded. In this literature research, eight literature were finally selected. The assessment of the quality of

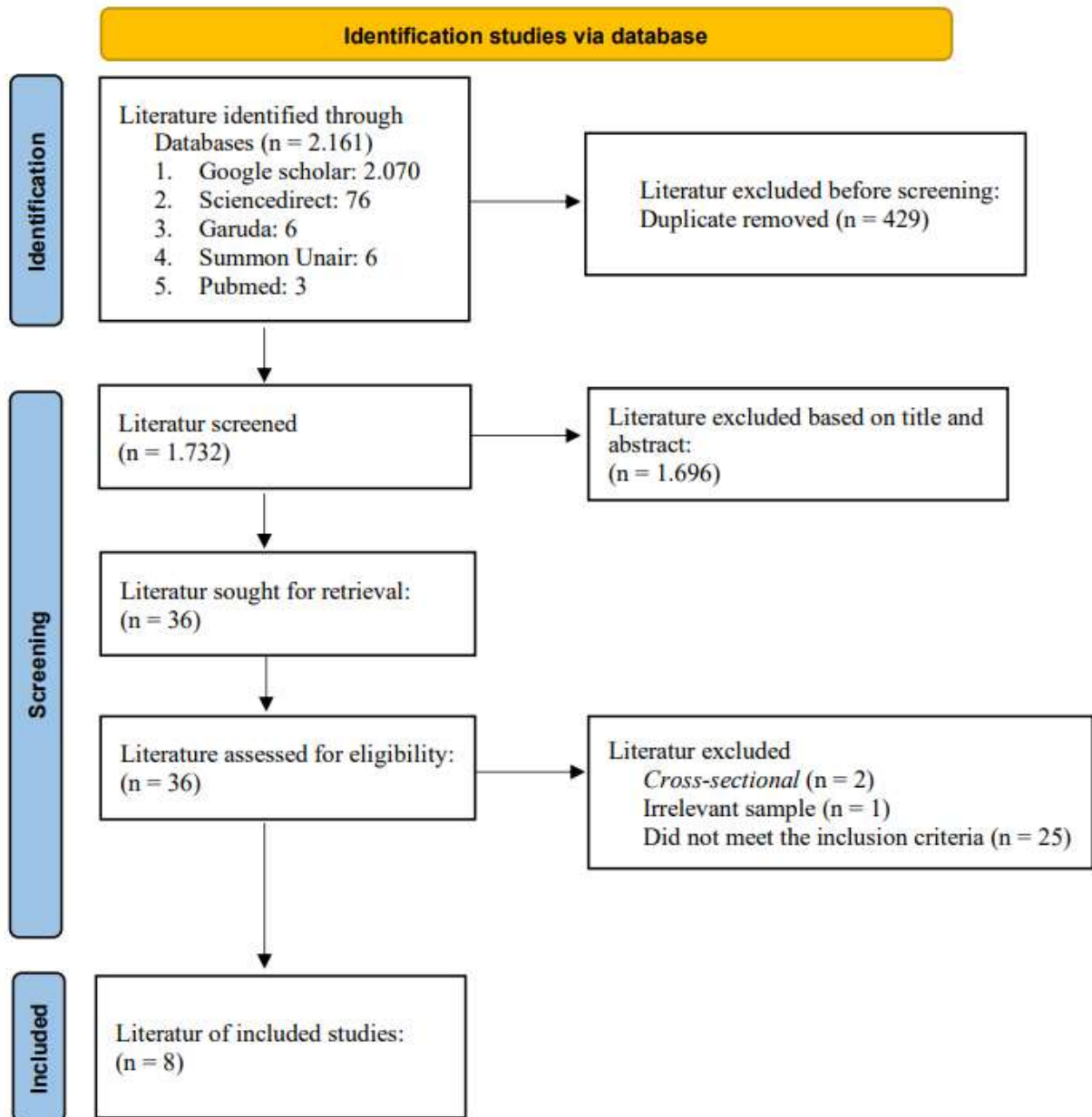the literature in this study used JBI Critical Appraisal Tools.

Figure 1. Literatures Search Result with PRISMA chart (2020)

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Table 1 contains the general characteristics of the literature that used in this systematic review, including the name of the author, the title of the study, the location of the study, the year of the study, and the study design. Table 2 contains the characteristics of the study subjects (maternal age, gestational age, number of gravidas) and the number of subjects with anemia and preeclampsia. The literature were obtained from 2018 – 2022. The research locations were spread across several regions of Indonesia. All literature used a case-control research design.

Table 3 contains four literature published from 2018 to 2022 that showed a relationship between anemia in pregnancy and the incidence of preeclampsia with a p-value less than 0.05[9,11,12,16]. On the contrary, there were four literature that showed an insignificant relationship between anemia in pregnancy and the incidence of preeclampsia with a p-value greater than 0.05[13-15,17].

Table 4 shows the data on pregnant women with anemia with the incidence of preeclampsia and non-preeclampsia. The classification of anemia in this study was based on the level of hemoglobin (Hb) below 11g/dL. Table 4 shows that four literature reveal that women with anemia in pregnancy are experiencing preeclampsia.

Table 1. The General Characteristics of Literature

Author	Title	Location	Year
Ameliai, E. & Sutarno, M.	The influence of anemia in the event of preeclampsia in maternal	Banten Regional Police Bhayangkara Hospital	2021
Hamzah, S., et al.	Antenatal care parameters that are the risk factors in the event of preeclampsia in primigravida	HM. Djafar Harun dan Benyamin Guluh Regional Public Hospital, Southeast Sulawesi	2021
Nanda, A. & Semarawisma, A.	The association between anemia and preeclampsia: a case control study in Gorontalo region, Indonesia	Dr. M.Dunda Regional Public Hospital, Gorontalo	2022
Pradipta F., et al.	The relationship between anemia in pregnancy and the incidence of preeclampsia for mothers in birth at yogyakarta city hospital years Old 2017 – 2018	Yogyakarta City Regional Public Hospital	2019
Prasetya, P.	The relationship between first trimester anemia and preeclampsia in pregnant women at the sidotopo wetan health center in Surabaya	Sidotopo Wetan Surabaya Health Center	2018
Pujiyani, H.	Risk factors for preeclampsia	Soeselo Slawi Regional Public Hospital, Tegal	2018
Ridho, H., et al.	The correlation between anemia and preeclampsia in Universitas Airlangga Hospital in 2017	Universitas Airlangga Hospital, Surabaya	2021
Tarisma, A., et al.	The relationship between anemia of third trimester pregnant women and the incidence of preeclampsia for mothers in birth at Muntilan Hospital, Magelang Regency 2018	Muntilan Regional Public Hospital, Magelang	2018

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Table 2. The Characteristics of Literature Subjects

Author, year	Characteristics			Anemia		Preeclampsia	
	Mother's Age	Gestational Age	Gravida	Yes (n)	No (n)	Yes (n)	No (n)
Ameliai, E. & Sutarno, M., 2021	-	-	-	119	227	173	173
Hamzah, S., et al., 2021	14-28 years (537) 29-49 years (291)	-	Primigravida (828)	669	159	414	414
Nanda, A. & Semarawisma, A., 2022	18-34 years (52) <18 and >34 years (212)	<33 weeks (188) ; 33-42 weeks (76)	Primigravida (111) Multigravida (153)	132	132	132	132
Pradipta F., et al., 2019	<20 and >35 years (37) 20-35 years (85)	-	Primigravida (52) Multigravida (70)	34	88	61	61
Prasetya, P., 2018	<20 and >35 years (20) 20-35 years (78)	1 - 13 weeks (98)	Primigravida (33) Multigravida (65)	13	85	49	49
Pujiyani, H., 2018	<20 and >35 years (89) 20-35 years (133)	-	Primigravida (209) Multigravida (72)	151	71	111	111
Ridho, H., et al., 2021	< 20 years (1) 20-35 years (166); >35 years (37)	-	Primigravida (70) Multigravida (134)	87	117	68	136
Tarisma, A., et al., 2018	<20 and >35 years (46) 20-35 years (88)	29-41 weeks (134)	Primigravida and Grande Multigravida (63) Multigravida (71)	48	86	67	67

Table 3. The Outcome of Literature that Show a Relationship between Anemia in Pregnancy and Preeclampsia

Author, Year	Number of Samples (n)		Outcome
	Case	Control	
Ameliai, E. & Sutarno, M., 2021	173	173	There is a significant relationship between anemia and the incidence of preeclampsia, with a p-value of 0.00 (p<0.05) and an OR of 2.794 (95% CI = 1.75–4.44). It shows that pregnant women with anemia have a risk of experiencing preeclampsia that is 2.794 times greater than pregnant women without anemia.
Tarisma, A., et al., 2018	67	67	There is a significant relationship between anemia in the third trimester of pregnancy and the incidence of preeclampsia, with a p-value of 0.047 (p<0.005) and a risk of experiencing preeclampsia 2.207 times greater than that of third trimester pregnant women without anemia, with an OR of 2.207 (95% CI = 1.07–4.551).
Pradipta, et al., 2019	61	61	There is a significant relationship between anemia in pregnancy and the incidence of preeclampsia, with a value of p = 0.015 (p<0.05). Pregnant women with anemia have a 2.751 times greater risk of experiencing preeclampsia than pregnant women without anemia (OR = 2.751; 95% CI = 1.196–6.239).
Prasetya, A., 2018	49	49	There is a relationship between first-trimester anemia and preeclampsia in pregnant women with a value of p = 0.037 (p<0.05) and first-trimester pregnant women with anemia have a risk of experiencing preeclampsia 3.932 times greater than first-trimester pregnant women without anemia (OR = 3.932; 95% CI = 1.10–15.303).
Hamzah, S., et al., 2021	427	427	There is no relationship between anemia in pregnant women and preeclampsia, with a value of p = 0.537 (p > 0.005). Based on this study, low hemoglobin levels (Hb<11 g/dL) are not a risk factor for preeclampsia (OR = 0.897; 95% CI = 0.634–1.268).
Nanda, A. & Semawawisma, A., 2022	132	132	There was no significant relationship between the incidence of anemia in pregnancy and the incidence of preeclampsia, with a p-value of 0.712 (p > 0.05).
Pujiyani, H., 2018	111	111	There was no significant relationship between anemia in pregnancy and the incidence of preeclampsia (p = 0.150; p > 0.05). Based on this study, anemia is not a risk factor for preeclampsia (OR = 0.632; 95% CI = 0.358–1.1117).
Ridho, H. et al., 2021	68	136	There was no significant relationship between the incidence of anemia in pregnancy and the incidence of preeclampsia, with a p-value of 0.133 (p>0.05)

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Table 4. The Relationship between Anemia in Pregnancy and Incidence of Preeclampsia

Author	Title	Independent Variable (Anemia)	n	Dependent Variable (Preeclampsia)	
				Yes	No
Ameliai, E. & Sutarno, M., 2021	Influence of Anemia of the event preeclampsia in maternal	Hb<11 g/dL	346	79	40
		Hb>11 g/dL		94	133
Pradipta F., et al., 2019	Relationship of Anemia in Pregnancy with the Incidence of Preeclampsia for Mothers in Birth at Yogyakarta City Hospital Years Old 2017 – 2018	Hb<11 g/dL	122	23	11
		Hb>11 g/dL		38	50
Prasetya, P. , 2018	Relationship between First Trimester Anemia and Preeclampsia in Pregnant Women at the Sidotopo Wetan Health Center in Surabaya	Hb<11 g/dL	98	10	3
		Hb>11 g/dL		39	46
Tarisma, A., et al., 2018	Relationship between Anemia of Third Trimester Pregnant Women and the Incidence of Preeclampsia for Mothers in Birth at Muntilan Hospital, Magelang Regency 2018	Hb<11 g/dL	134	30	18
		Hb>11 g/dL		37	49
Hamzah, S., et al., 2021	Antenatal care parameters that are the risk factors in the event of preeclampsia in primigravida	Hb<11 g/dL	828	331	338
		Hb>11 g/dL		83	76
Nanda, A. & Semarawisma, A., 2022	Association between anemia and preeclampsia: a case control study in Gorontalo region, Indonesia	Hb<11 g/dL	254	58	64
		Hb>11 g/dL		64	68
Pujiyani, H., 2018	Risk Factors for Preeclampsia	Hb<11 g/dL	222	70	81
		Hb>11 g/dL		41	30
Ridho, H., et al., 2021	Correlation between Anemia and Preeclampsia in Universitas Airlangga Hospital in 2017	Hb<11 g/dL	204	34	53
		Hb>11 g/dL		34	83

DISCUSSION

Anemia is marked by a low red blood cell count and/or a low hemoglobin (Hb) concentration. Diagnosis thresholds are <13g/dL for adult males, <12g/dL for adult females, and <11g/dL for pregnant women[18]. WHO defines pregnant women as those aged 15 to 49[7]. During pregnancy, anemia is often caused by increased requirements for iron and folic acid. Anemia in pregnancy can also arise due to expanded plasma volume, influenced by progesterone and estrogen hormones promoting uterine growth. This effect persists until peaking around weeks 32–34 or early third trimester[19]. Anemia can trigger hypoxia in the systemic vascular system. Persistent hypoxia narrows blood vessels, decreasing placental perfusion, which may lead to ischemia and contribute to preeclampsia[20].

In the studies from eight literature, the prevalence of anemia in pregnant women was investigated. Among the control group, 23.1% of pregnant women were identified with anemia, while in the case group, this

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figure was higher at 45.7%. This results in an overall population of pregnant women with anemia of 34.4%. Another study by Prasetya, involving 98 participants, revealed that 20.4% of pregnant women in the case group and 6.1% in the control group had anemia during the first trimester, resulting in a population of pregnant women with anemia of 13.27%[11].

In Pradipta et al.'s study out of 122 participants, 37.7% of pregnant mothers exhibited anemia in the case group, compared to 18% in the control group, resulting in a 27.9% overall prevalence[9]. In Ridho et al.'s study involving 204 participants, anemia prevalence was 50% in the case group and 39% in the control group, yielding a 42.6% prevalence among pregnant women[15]. Additionally, Hamzah, S., et al.'s study with 828 participants found anemia rates of 80% and 81.6% in the case and control groups, respectively, contributing to an overall prevalence of 80.8% among pregnant mothers[14].

In the study by Nanda & Semarawisma, involving 264 participants, the prevalence of anemia among pregnant women was 50%, with 25.7% in the case group and 24.2% in the control group[13]. The study also categorized anemia severity based on Hb levels into severe (5.3%), moderate (19.7%), and mild (25%) classifications. In Pujiyani's study with 222 participants, the overall prevalence of anemia among pregnant women was 68%, with 63.1% in the case group and 73% in the control group[17].

The analysis of eight literature sources revealed a wide range of anemia prevalence among pregnant women, with the highest rate at 80.8%[14] and the lowest at 13.27%[11]. The average prevalence across these studies was 44.1%. While specific maternal age and anemia status were not consistently provided in these sources, Sari et al.'s study demonstrated a strong correlation between age and anemia incidence during pregnancy[21]. High-risk ages (<20 or >35 years) were associated with a significantly higher likelihood of anemia (p = 0.001; OR = 3.921, 95% CI = 1.731-2.878). This relationship was confirmed by Wijayanti & Qonitun's study, which indicated that pregnancy between ages 20 and 35 was associated with fewer complications and better physiological and psychological conditions[22]. Conversely, ages <20 and >35 carried higher risks of anemia due to suboptimal reproductive development in early-age women and aging factors in later-age women.

Globally, the highest prevalence of anemia in women and children during 2019 was found in Southeast Asia, according to WHO data[7]. In Indonesia, according to Riskesdas, a significant increase in anemia among pregnant women occurred from 2013 to 2018, rising from 37.1% to 48.9%[8]. However, WHO data for 2021 indicates a decrease in anemia prevalence among women of reproductive age to 38% and among pregnant women aged 15–49 to 44.2%[7]. Despite the decline since 2018, these rates still fall short of the 28% anemia prevalence target for pregnant women set by the 2015–2019 National Medium-Term Development Plan (RPJMN).

The data highlights the necessity for enhanced interventions among pregnant women. These interventions involve health education to foster health promotion through primary healthcare centers, community involvement, and family support. Additionally, the implementation of integrated antenatal care, coupled with the essential 10T activities, is crucial for the early identification of pregnancy-related risks and childbirth. These strategies

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aligned with recommendations from both Triharini et al. and the Ministry of Health, Republic of Indonesia, emphasizing the importance of a comprehensive approach to improving maternal well-being[8, 23].

Anemia during pregnancy has detrimental effects on maternal and fetal health, contributing to increased morbidity and fetal mortality rates[24]. Pregnant women with anemia face heightened risks of perinatal infections, preeclampsia, and hemorrhage. The relationship between anemia and preeclampsia is linked to vascular dysfunction, resulting in elevated blood pressure due to decreased nitric oxide and increased endothelin levels. This condition also leads to proteinuria[25]. Severe anemia poses a significant risk of hemorrhage, potentially leading to maternal and neonatal mortality. Anemia's impact on placental function affects fetal well-being through reduced oxygen and nutrient supply. Additionally, anemia increases the likelihood of delivering low-birth-weight infants due to compromised placental function involving hypertrophy, calcification, and infarction[26].

Preeclampsia is characterized by hypertension and proteinuria occurring after the 20th week of pregnancy in previously normotensive individuals[27]. Its prevalence varies globally, with developed countries experiencing rates of 1.3%–6% and developing countries ranging from 1.8%–18%. In Indonesia, the prevalence was reported as 9.4% in 2020, while East Java Province witnessed an incidence of 27.27% in 2019 and 30.88% in 2020[28].

The systematic review consists of a case-control research design to explore preeclampsia as the dependent variable. In seven out of eight selected studies, an equal distribution of case and control samples yields a 50% prevalence of preeclampsia among pregnant women. Notably, the study by Ridho et al. deviates, with 33.33% of the total sample representing preeclampsia cases[15]. The sample sizes vary across studies, ranging from 49 in Prasetya[11] to 414 in Nanda & Semarawisma[13].

Preeclampsia is a complex condition influenced by multiple factors, including genetics, maternal/ environmental elements, and immunology. In the reviewed literatures, maternal age emerges as a noteworthy factor affecting preeclampsia risk. Out of 8 studies, 7 mention maternal age, with 3 studies revealing a significant association between ages <20 and >35 years and preeclampsia ($p<0.05$). Out of seven reviewed literature sources, five studies had research subjects with a greater number of pregnant women who were not at risk compared to those at risk. The study by Hamzah categorized pregnant women into age groups of 14–28 years and 29–49 years, with a larger number of subjects falling in the 14–28 age group[14]. Similarly, the study by Nanda & Semarawisma categorized age as 18–34 years and <18 and >34 years, with a higher subject count in the <18 and >34 years age groups[13]. Additionally, the study by Tarisma et al. stated that pregnant women aged <20 years and >35 years had a greater risk for preeclampsia, with an odds ratio of 4.03 (CI 1.863–8.725)[12]. These age groups pose higher risks, as supported by a study by Marniati et al. indicating that <20 and >35-year-old pregnant women face a 9.444 times greater likelihood of preeclampsia[29]. However, a majority of studies in this systematic review show that non-risky pregnant women outnumber risky age groups, suggesting other contributing factors. Notably, studies emphasize the role of various factors, such as nulliparity, obesity, multiple pregnancies, genetics, and

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prior preeclampsia history, which collectively impact preeclampsia occurrence beyond maternal age. It is clear that while maternal age plays a role, a comprehensive understanding of preeclampsia's complexity is crucial for effective prevention and management strategies.

Preeclampsia, a pregnancy-related condition, is commonly associated with its occurrence in the third trimester. However, there are cases that manifest earlier due to pre-existing conditions and fetal-placental complications[30]. This suggests a need for vigilant monitoring throughout pregnancy. Among the reviewed studies, a subset considers maternal gestational age. Some studies focus on the third trimester, while others examine the first trimester.

Preeclampsia risk factors include maternal age and the number of pregnancies. Nulliparous (first-time mothers) and grand multigravida (multiple pregnancies) women are found to have a higher risk of preeclampsia in several studies. Among the reviewed literature, seven out of eight sources mention the number of pregnancies in their samples. Only the study by Pujiyani established a significant association between the risk of pregnancies and preeclampsia occurrence[17]. This finding aligned with a theory proposed by Palupi et al., suggesting that first-time mothers might experience a higher risk due to an incomplete immune response or histo-placental incompatibility[31]. Further research is needed to better understand these associations and mechanisms.

Preeclampsia carries severe complications, including eclampsia, HELLP syndrome, pulmonary edema, and more. Fetal complications like IUGR and placental abruption also arise[32].

Governments and healthcare providers must emphasize prevention due to the discussed risk factors and complications. Prevention involves three stages: the first, primary prevention, entails avoiding disease occurrence. Quality antenatal care detects early unwanted events (risk factors) in pregnancy, preventing maternal deaths. Increased visits expedite intervention for pregnancy complications[33].

NICE guidelines discussed by Fox et al., categorize women into high and moderate risk groups for preeclampsia based on various factors[34,35]. High-risk factors include a history of hypertension during previous pregnancies, maternal diseases like chronic kidney disease, autoimmune disorders, diabetes, or chronic hypertension. Moderate-risk factors include nulliparity, age ≥ 40, BMI $\geq 35 kg/m^2$, family history of preeclampsia, multifetal pregnancies, or an interpregnancy interval >10 years. Aspirin prophylaxis is recommended if one high-risk factor or two or more moderate-risk factors are present, and if administered before 16 weeks of gestation, it effectively reduces preeclampsia risk.

Secondary prevention in preeclampsia aims to halt the disease's progression before symptoms or clinical emergencies occur. Management strategies prioritize maintaining proper blood pressure control through pharmacological interventions like beta blockers, vasodilators, and calcium channel blockers. To prevent seizures in pregnant women, intravenous prophylactic magnesium sulfate is administered, and fetal morbidity is managed by considering pregnancy termination[36]. Tertiary prevention focuses on preventing complications arising from the disease process.

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Correlation of Anemia in Pregnancy and Preeclampsia. The prevalence of pregnant women with anemia and the incidence of preeclampsia in eight literature ranged from 39.08% to 76.92%, with an average of 56.99%. In four studies, the average prevalence of anemia in pregnant women who had preeclampsia had a p<0.05 of 68.36%. These results are higher compared to a study conducted by Ramakrishnan and Poorana in Chennai, India, where the prevalence of anemic pregnant women and preeclampsia was 18.5%[37]. Haile et al. found the prevalence of anemic pregnant women in hospitals in Ethiopia was 11.6%[38]. The literature study here did not discuss the dominant age in anemia in pregnancy with preeclampsia, but a study by Burwick et al. stated that pregnant women with anemia who suffer from preeclampsia tend to be younger, with an average age of 28.6 years[39]. Anemia is also commonly found in pregnant women under the age of 20. At a young age, under 20 years, the body needs a lot of nutrients to meet growth. The condition of pregnancy makes the body need more nutrients for the growth of the mother and fetus, so it is very susceptible to anemia, which puts the mother at risk of preeclampsia[40].

In the two literature reviews in this study, those by Pujiyani, H., and Hamzah, S., et al., it is stated that anemia is not a risk factor for preeclampsia[14,17]. Meanwhile, four studies stated that anemia is a risk factor for preeclampsia. Research results by Ameliai & Sutarno, Pradipta et al., and Tarisma et al. showed that pregnant women with anemia have about two times the risk of experiencing preeclampsia than pregnant women who are not anemic[9,12,16]. Research conducted by Prasetya, P. at a health center in Surabaya stated that pregnant women in the first trimester with anemia had a 3,932

times greater risk of experiencing preeclampsia compared to first-trimester pregnant women who were not anemic[11].

This is in line with research using case-control studies conducted by Endeshaw et al. in Ethiopia, which stated that pregnant women who experience anemia during the first trimester are 2.47 times more at risk of experiencing preeclampsia compared to pregnant women without anemia[41]. Research in low- to middle-income countries also has consistent results that say mothers with severe anemia are three times more at risk of experiencing preeclampsia than those who do not have anemia[42]. Research conducted by Ramakrishnan and Poorana in Chennai, India, states that the incidence of preeclampsia increases with the severity of anemia[37].

During pregnancy, there will be an increase in plasma volume, red blood cell volume, and hemoglobin. Anemia caused by micronutrient deficiencies causes an increase in serum norepinephrine concentrations, thus inducing the synthesis of corticotropin-releasing hormone (CRH) produced by the placenta. This condition increases CRH stimulation, resulting in increased inflammatory cytokines, glucocorticoids, and oxidative stress, which then induces inflammatory cytokines that bind growth factors. vascular endothelium (VEGF) and placental growth factor (PlGF). This condition causes systemic vascular dysfunction, which will lead to an increase in blood pressure characterized by decreased nitric oxide (NO) and increased endothelin[25].

CONCLUSION

The prevalence of anemia in pregnant women in Indonesia ranges from

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13.27% to 80.8%, with an average of 44.1%. Ages at risk for preeclampsia among pregnant women in Indonesia are <20 years and >35 years. There is a relationship between anemia in pregnant women and the incidence of preeclampsia in Indonesia. Therefore, anemia can be a risk factor for preeclampsia. However, this study cannot state how strong the relationship between anemia and the mother is. It is hoped that future researchers can continue their research using meta-analysis of the results of a systematic review of this study so that statistical analysis can be carried out regarding the strength of the relationship between anemia in pregnant women and the incidence of preeclampsia.

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CONFLICT OF INTEREST

All Authors have no conflict of interest

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All authors have contributed to all process in this research, including preparation, data gathering and analysis, drafting and approval for publication of this manuscript.

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