Factors related to The incidence of preeclampsia in Sunan Kudus Hospital

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Abstract.

Preeclampsia is one of the main causes of maternal morbidity and mortality in Indonesia which is characterized by increased blood pressure and impaired organ function after 20 weeks of gestation. This study aims to determine the relationship between diabetes mellitus, anemia, and the distance between pregnancies and the incidence of preeclampsia in pregnant women who give birth at Sunan Kudus Hospital in 2024. This study used a quantitative design with a retrospective case-control approach, involving 252 respondents consisting of 63 pregnant women with preeclampsia (cases) and 189 pregnant women without preeclampsia (control). Data were collected secondary through medical records and analyzed using the Chi-Square test with a 95% confidence level and p< significance of 0.05. The results showed that diabetes mellitus was not significantly associated with the incidence of preeclampsia (p = 0.096; OR = 2,737; CI 0.884–8.475), but mothers with DM have a 2.7-fold greater risk of developing preeclampsia. There was a significant association between anemia and the incidence of preeclampsia (p = 0.001; OR = 2,794; CI 1.520–5.136) and between the distance between pregnancy and the incidence of preeclampsia (p = 0.022; OR = 2,053; CI 1,146–3,679). In conclusion, anemia and the distance between pregnancies at risk have a meaningful relationship with the incidence of preeclampsia, whereas diabetes mellitus is not statistically significant but still has the potential to increase risk. Prevention of preeclampsia needs to be focused on monitoring hemoglobin levels, setting ideal pregnancy distances, and managing metabolic diseases during pregnancy through comprehensive antenatal care examinations.

Keywords : *Preeclampsia; morbidity and mortality.*

I. INTRODUCTION

Maternal death is death during pregnancy up to 42 days after childbirth, as a result of complications related to pregnancy or its handling, but not as a result of an accident or injury (WHO, 2021). Most maternal deaths are preventable and treatable, especially in adolescence, during pregnancy, childbirth, and postpartum (UNICEF, 2022). Maternal deaths are generally caused by complications that arise during or after pregnancy and childbirth. Approximately 75% of maternal deaths are caused by several major complications, including heavy bleeding (especially after childbirth), infections (generally postpartum), high blood pressure during pregnancy such as preeclampsia and eclampsia, as well as complications resulting from unsafe childbirth or abortion (WHO, 2021).Preeclampsia is a hypertensive syndrome that occurs during pregnancy, characterized by newly occurring high blood pressure (≥140/90 mmHg), accompanied by proteinuria or dysfunction of the maternal organs, and impaired placental perfusion. This condition usually occurs after 20 weeks of pregnancy and can occur during or after childbirth (Fox et al., 2019). Preeclampsia that is not detected early can lead to various obstetric complications, such as an increased likelihood of cesarean section, bleeding after childbirth, HELLP syndrome (hemolysys, elevated liver enzyme, low platelet count), and congestive heart failure (Mekie et al., 2020). In addition, this condition can also cause fetal growth disorders, lack of amniotic fluid (oligohydramnion), premature birth, low birth weight, and placental solubility, all of which have the potential to cause fetal death (Hutahaean et al., 2024).

In Indonesia in 2023, hypertension complications in pregnancy that cause death reached 412 cases (Ministry of Health, 2023). A similar situation also occurred in Central Java Province with 123 cases of maternal deaths caused by hypertension disorders (Central Java Health Office, 2023). Furthermore, in Kudus City, it was found that as many as 350 pregnant women experienced preeclampsia or eclampsia, a condition that is a severe manifestation of hypertension in pregnancy (Kudus Regency Health Office, 2023). Meanwhile, at Sunan Kudus Hospital in 2022, 122 pregnant women were recorded to experience

preeclampsia. Wilkerson & Ogunbodede (2019) found the risk factors for preeclampsia and grouped the preeclampsia category according to the American College of Obstetricians and Gynecologists (ACOG) into three, namely the first: Low risk is characterized by previous childbirth with a full-term baby. Second: moderate risk factors include nuliparity, high body mass index, family history of preeclampsia, age over 35 years, as well as personal history such as low birth weight and long pregnancy intervals. And third: high risk factors are associated with a previous history of preeclampsia, multiple pregnancies, chronic hypertension, diabetes mellitus, kidney disease, autoimmune disorders, and heart disease.

Meanwhile, the findings of Meazaw et al (2020) suggest that factors such as a history of preeclampsia or eclampsia, high BMI, chronic hypertension, anemia, and lack of regular pregnancy check-ups (antenatal visits) also increase the likelihood of preeclampsia. Diabetes mellitus is one of the risk factors that can cause preeclampsia (Mufdillah et al., 2019). In this condition, the body has difficulty producing or using insulin effectively, resulting in increased blood sugar levels (Denggos, 2023). Problems in blood sugar regulation caused by insulin resistance and disorders in pancreatic beta cells can trigger various disorders in the body that lead to the occurrence of preeclampsia (Tiara et al., 2024). It is a condition that can damage the inner lining of blood vessels (endothelial), cause inflammation throughout the body, and interfere with the function of blood vessels. In addition, high blood sugar levels can also increase the production of inflammatory substances (cytokinins) that worsen blood vessel damage. This combination of blood vessel damage and inflammation leads to high blood pressure and proteinuria that are hallmarks of preeclampsia (Issat et al., 2022). Anemia, which is characterized by decreased hemoglobin levels, can affect maternal and fetal health, as well as contribute to the risk of preeclampsia (Ariandini & Ramadani, 2023). One of the causes is reduced oxygen flow to the placenta (placental ischemia), because blood that lacks hemoglobin is not able to transport oxygen properly. This can lead to a lack of oxygen (hypoxia), which triggers inflammation and damage to the walls of blood vessels (endothelial dysfunction), a hallmark of preeclampsia (Octa Alfiana et al., 2024) The distance between pregnancies is a factor that increases the likelihood of preeclampsia (Sudarman et al., 2021).

A study conducted by İmamoğlu et al (2022) showed that women who get pregnant again in a short period of time are more at risk of developing preeclampsia. This is because the time too close between pregnancies can hinder the recovery process of blood vessels, causing damage to the lining of the vessels (endothelial dysfunction). As a result, there is an increase in resistance in the blood vessels that leads to high blood pressure, one of the main signs of preeclampsia (Nopala & Rachmiyani, 2023). In addition, imperfections in placental development, which often occur in adjacent pregnancies, can cause blood flow to the fetus to be disrupted. This condition triggers oxidative stress and inflammation, which ultimately increases the risk of preeclampsia. (Bisri & Bisri, 2024). The purpose of this study was to determine the relationship between diabetes mellitus, anemia, and the distance between pregnancies and the prevalence of preeclampsia. By identifying these risk factors, it is hoped that more optimal preventive measures, more appropriate screening techniques to detect preeclampsia early, and more effective treatment plans for pregnant women who are at high risk or who have experienced preeclampsia can be carried out. Sunan Kudus Islamic Hospital, which is one of the main referral hospitals in Kudus Regency, has been equipped with adequate facilities to handle pregnancy complications due to preeclampsia. The high interest of people from districts around Kudus, such as Jepara, Demak, and Pati Regencies to conduct health checks at this hospital is the background for a research entitled Factors Related to Preeclampsia at Sunan Kudus Hospital

II. METHODS

This study is a quantitative study with a cross-sectional approach and a retrospective case control design that aims to analyze the relationship between diabetes mellitus, anemia, and the distance between pregnancies and the incidence of preeclampsia. The research was carried out using secondary data from the medical records of maternal mothers in 2024. The study population was 1,816 maternal mothers with 63 cases of preeclampsia. Case samples were taken using the total sampling technique of 63 respondents, while the control sample of 189 respondents was selected through simple random sampling with a case:control ratio of 1:3 to increase the strength of statistical tests. Dependent variables are the incidence of preeclampsia,

while independent variables include diabetes mellitus, anemia, and the distance between pregnancies. Data was collected using a checklist sheet based on medical records that met the inclusion and exclusion criteria. Data analysis was carried out univariously to describe the frequency distribution of each variable, and bivariously using the Chi-Square (χ^2) test to assess the relationship between variables with the calculation of crude odds ratio (COR) and a 95% confidence interval.

III. RESULT AND DISCUSSION

Respondent Characteristics

This characteristic aims to provide an overview of the profile of pregnant women who are respondents in this study. Data is obtained from the patient's medical records and presented in the form of a frequency distribution table to facilitate analysis and interpretation of research results.

Table 1. Characteristics of Respondents by Age

Groups	n	Mean ± elementary school (years)	Median	Minimum (year)	Maximum (year)
Preeclampsia (Case)	63	31.19 ± 5.49	31	23	46
No Preeclampsia (Control)	189	30.26 ± 5.63	30	15	45

The characteristics of the respondents in this study based on age showed that in the case group (preeclampsia) the average age of the respondents was 31.19 years ± 5.49, with the youngest age being 23 years and the oldest age being 46 years. The median age of respondents in the case group was 31 years. Meanwhile, in the control group (not preeclampsia), the average age of respondents was 30.26 years ± 5.63, with the youngest age being 15 years old and the oldest age being 45 years. The median age of respondents in the control group was also 30 years.These results show that in general, the average age of respondents in both groups is in the healthy reproductive age range (20–35 years), which is a period with a relatively low risk of obstetrics according to the Ministry of Health of the Republic of Indonesia (Ministry of Health of the Republic of Indonesia, 2022). However, the age variation in the case group tended to be wider than in the control group, which was indicated by the almost the same standard deviation value but with a wider range of minimum and maximum.

Table 1. Distribution of Respondent Characteristics Based on Jobs

Variable	Preeclampsia (Case)		No Preeclampsia (Control)		Total Population	
	N=63	%	N=189	%	N=252	%
Jobs						
Not working	28	44.4	76	40.2	104	41.3
Private Employees	20	31.7	71	37.6	91	36.1
Civil servant/teacher/lecturer	5	7.9	15	7.9	20	7.9
Labor	7	11.1	9	4.8	16	6.3
Self-employed/trader	2	3.2	18	9.5	20	7.9
Student/Student	1	1.6	0	0	1	0.4
Total	252	100	63	100	189	100

Based on Table 4.2, the majority of respondents are in the category of not working/IRT, which is 104 people (41.3%). The next group is 91 private employees (36.1%), followed by civil servants/teachers/lecturers as many as 21 people (8.3%), workers as many as 16 people (6.3%), self-employed/traders as many as 19 people (7.5%), and students/students as many as 1 person (0.4%). In the preeclampsia group, the largest proportion also came from non-working mothers (44.4%), followed by private employees (31.7%). Meanwhile, in the control group, 76 respondents (40.2%) did not work, and 71 private employees (37.6%).

Univariate Results

This section describes the results of univariate analysis of the main research variables, namely gestational diabetes mellitus, anemia, distance between pregnancies, and the incidence of preeclampsia. This analysis aims to describe the frequency distribution of each variable and provide a preliminary picture of the proportion of events studied.

Table 3. Frequency Distribution of Research Variables

Variable	Preeclampsia (Case)		No Preeclampsia (Control)		Total Population	
	N=63	%	N=189	%	N=252	%
Diabetes mellitus						
Diabetes mellitus	6	9.5	7	3.7	13	5.2
No diabetes mellitus	57	90.5	182	96.3	239	94.8
Anemia						
Anemia	27	42.9	40	21.2	67	26.6
No Anemia	36	57.1	149	78.8	185	73.4
Distance Between Pregnancy						
Risky (< 24 and >60 months)	30	47.6	58	30.7	88	34.9
No Risk (24-60 months)	33	52.4	131	69.3	164	65.1
Total	**252**	**100**	**63**	**100**	**189**	**100**

Table 3 shows that based on the status of diabetes mellitus, out of a total of 252 respondents, there were 13 people (5.2%) who had gestational diabetes mellitus and 239 people (94.8%) who did not have diabetes. In the case group (preeclampsia), there were 6 people (9.5%) with diabetes mellitus, while in the control group only 7 people (3.7%). This shows that the proportion of pregnant women with diabetes mellitus is higher in the preeclampsia group than in the control group.Based on anemia status, there were 67 respondents (26.6%) who had anemia and 185 respondents (73.4%) who did not have anemia. In the preeclampsia group, anemia was experienced by 27 people (42.9%), while in the control group only 40 people (21.2%). These results illustrate that the incidence of anemia is more common in pregnant women with preeclampsia than in mothers who do not experience preeclampsia.Furthermore, based on the distance between pregnancies, as many as 88 respondents (34.9%) had a risk pregnancy distance (less than 24 months or more than 60 months), while 164 respondents (65.1%) had a non-risk pregnancy distance (between 24–60 months). In the preeclampsia group, there were 30 people (47.6%) with a risk pregnancy distance, while in the control group only 58 people (30.7%). These results showed that mothers with a gap between pregnancies were at greater risk of being found in the preeclampsia group than in the non-preeclampsia group.

Bivariate Results

The Relationship of Diabetes Mellitus to the Incidence of Preeclampsia

Table 4. The Relationship between Diabetes Mellitus and the Incidence of Preeclampsia at Sunan Kudus Hospital in 2024

Diabetes Mellitus	Preeclampsia				OR 95% CI	*P value*
	Yes		No			
	f	%	f	%		
Yes	6	9.5	7	3.7	2.737 (0.884-8.475)	0.096
No	57	90.5	182	96.3		
Total	63	100.0	189	100.0		

Table 4.Based on the results of the analysis of this study, it is known that in the case group (pregnant women with preeclampsia) as many as 6 respondents (9.5%) were identified as having diabetes mellitus, while 57 respondents (90.5%) did not experience this condition out of a total of 63 people. Meanwhile, in the control group (pregnant women without preeclampsia) of 189 respondents, there were 7 people (3.7%) with diabetes mellitus and 182 people (96.3%) without diabetes mellitus.The Chi-Square test yielded a p value = 0.096 (p > 0.05) which showed that there was no statistically significant association between diabetes mellitus and the incidence of preeclampsia in pregnant women. Nonetheless, the Odds Ratio (OR) value = 2.737 with a Confidence Interval (CI 95%) = 0.884–8.475 indicates that pregnant women with diabetes mellitus have about 2.7 times higher chance of developing preeclampsia compared to those who do not have diabetes mellitus. However, the relationship is not statistically significant because the CI range still includes the number 1.

The Relationship of Anemia to the Incidence of Preeclampsia

Table 2. The Relationship of Anemia to the Incidence of Preeclampsia at RSI Sunan Kudus in 2024

Anemia	Preeclampsia				OR 95% CI	*P value*
	Yes		No			
	f	%	f	%		
Yes	27	42.9	40	21.2	2.794(1.520-5.136)	0.001
No	36	57.1	149	78.8		
Total	63	100.0	189	100.0		

The table shows that in the case group (preeclampsia), out of 63 respondents, 27 people (42.9%) had anemia, while 36 people (57.1%) did not have anemia. Meanwhile, in the control group (not preeclampsia) of 189 respondents, there were 40 people (21.2%) who had anemia and 149 people (78.8%) who did not have anemia.The results of the Chi-Square test showed a value of p=0.001 (p < 0.05) which means that there is a statistically significant relationship between anemia and the incidence of preeclampsia in pregnant women. Follow-up analysis showed an Odds Ratio (OR) value = 2,794 with a Confidence Interval (CI 95%) = 1,520-5,136, which means that pregnant women who experience anemia have a 2.7 times greater risk of developing preeclampsia compared to pregnant women who do not experience anemia.

The Relationship Between Pregnancy Distance and the Incidence of Preeclampsia

Table 3. The Relationship Between Pregnancy and Preeclampsia Incidence at Sunan Kudus Hospital in 2024

Distance Between Pregnancy	Preeclampsia				OR 95% CI	*P value*
	Yes		No			
	f	%	f	%		
Risky (< 24 and >60 months)	30	47.6	58	30.7	2.053 (1.146-3.679)	0.022
No risk (24-60 months)	33	52.4	131	69.3		
Total	63	100.0	189	100.0		

Based on Table 6. It showed that in the case group (preeclampsia) of 63 respondents, there were 30 people (47.6%) who had a gap between risky pregnancies (less than 24 months or more than 60 months), while 33 people (52.4%) had a gap between pregnancies that were not at risk (24–60 months). In the control group (non-preeclampsia) of 189 respondents, there were 58 people (30.7%) with a distance between pregnancies at risk and 131 people (69.3%) with a distance between pregnancies that were not at risk. The results of the Chi-Square test showed a value of p = 0.022 (p < 0.05), which means that there is a statistically significant relationship between the distance between pregnancy and the incidence of preeclampsia in pregnant women. Follow-up analysis showed an Odds Ratio (OR) value = 2.053 with a Confidence Interval (CI 95%) = 1.146-3.679, which means that pregnant women with a distance between pregnancies are at risk of being 2 times more likely to experience preeclampsia compared to pregnant women who have a gap between pregnancies that are not at risk.

Discussion

Distribution of Diabetes Mellitus

Based on Table 4.2, of all study respondents, only 13 pregnant women (5.2%) had diabetes mellitus. In the preeclampsia group, there were 6 mothers (9.5%) who had diabetes mellitus, while in the group without preeclampsia there were 7 mothers (3.7%). These findings show that most of the respondents do not suffer from diabetes mellitus and indicate that this condition is not the main factor contributing to the incidence of preeclampsia in pregnant women at Sunan Kudus Hospital in 2024. One possible cause of this low proportion is that mothers with diabetes mellitus tend to be more disciplined in maintaining their health, including adopting a healthy diet and monitoring blood glucose regularly, so that the risk of complications can be minimized. In addition, diabetes control is also strongly influenced by behavioral factors such as diet, obesity, and anxiety levels, which have been shown to have a significant relationship with blood glucose levels in patients with diabetes mellitus (Cokropranoto et al., 2025). The results of this study are consistent with the findings of Hidayah et al. (2025) in 136 respondents (46 cases and 92 controls), who reported that only 6 respondents (4.4%) had diabetes mellitus, namely 2 people in the case group and 4 people in the

control group. These findings are also in line with the research of Mohamud & Surury, (2022) stating that among mothers with severe preeclampsia, there are 74 people (49.0%) who have diabetes mellitus, while in mild preeclampsia there are 77 people (51.0%). According to the World Health Organization (WHO), 2024, gestational diabetes mellitus (DMG) is a glucose intolerance that is first detected during pregnancy, generally in the second or third trimester, due to increased insulin resistance triggered by hormonal changes.

Based on the criteria of the American College of Obstetricians and Gynecologists (ACOG, 2021), plasma glucose levels are said to be normal if the fasting value is <92 mg/dL, one hour after TTGO <180 mg/dL, and two hours <153 mg/dL. A value that exceeds one of these limits indicates DMG.Diabetes mellitus is a metabolic disorder characterized by insulin deficiency or ineffectiveness, hyperglycemia, and impaired glycogenesis processes. This condition has long been identified as one of the risk factors for preeclampsia. During pregnancy, the placenta plays an important role in meeting the growth and development needs of the fetus. In mothers with diabetes mellitus, hormonal and metabolic changes can affect placental function. One is the increased production of deoxycorticosteroids (DOC) from progesterone in the third trimester, which contributes to increased blood pressure and triggers the appearance of preeclampsia (Andani et al., 2022). Diabetes that occurs during pregnancy can also cause various complications, both in the mother and the fetus. Pregnant women with diabetes mellitus are at risk of gestational hypertension, preeclampsia, polyhydramnion, and cesarean delivery. In fetuses, emerging risks include macrosomia, neonatal hypoglycemia, as well as airway disorders (Ye et al., 2022). This risk increases as metabolic imbalances are not optimally controlled.In pregnant women with diabetes, the pathophysiology of preeclampsia is generally not

Distribution of Anemia

Anemia in pregnancy is one of the significant health problems because it reduces the blood's capacity to transport oxygen, thereby reducing the perfusion of oxygen to various body tissues, including the placenta. Oxygen deprivation (hypoxia) due to anemia can trigger the production of free radicals and oxidative stress, which further damages the endothelial cells of blood vessels. This endothelial damage is believed to be one of the early mechanisms in the pathogenesis of preeclampsia in which maternal vascular dysfunction leads to vasoconstriction, increased vascular permeability, and impaired blood flow to the placenta (Faidha & Ambarwati, 2024).Placental hypoxia due to anemia can also interfere with the invasion and remodelling of the spiral artery by trophoblast cells. Normally, trophoblast cells invade the uterine wall and overhaul the spiral arteries for optimal placental vascularization. However, in hypoxia conditions, this process fails or is imperfect so that the spiral artery remains narrow and stiff, causing placental perfusion to be inadequate. This condition triggers the release of anti-angiogenic factors and inflammatory mediators into the maternal circulation, exacerbates endothelial dysfunction and increases vascular resistance which can ultimately lead to gestational hypertension and preeclampsia (Octa Alfiana et al., 2024) The study also found that most mothers with anemia were in the control group or mothers with normal pregnancies.

These findings are in line with the physiological theory of pregnancy, which explains that plasma volume begins to increase from the sixth week of pregnancy. The increase in plasma volume is not proportionally followed by an increase in red blood cell mass, resulting in hemodilution which appears to be a decrease in hemoglobin levels without always reflecting the presence of pathological disorders (Ridho et al., 2021). Hayuningtyas & Sasmito, (2025) in their research also emphasized that although some anemic mothers experience preeclampsia, not all anemia conditions are associated with the occurrence of preeclampsia. This means that mothers with mild, moderate, or severe anemia do not always show the incidence of preeclampsia. Thus, the link between anemia and preeclampsia is not universal. Overall, the results of this study confirm that anemia remains an important health problem in pregnant women and has the potential to worsen maternal conditions. Prevention of anemia from the beginning of pregnancy through periodic hemoglobin checks, iron supplementation, nutrition education, and monitoring of compliance with the consumption of blood supplement tablets needs to be carried out continuously. Optimal management of anemia is expected to reduce the risk of preeclampsia and improve the safety of the mother and fetus.

Distribution of Distance Between Pregnancy

Based on the results of the univariate analysis, there were 88 respondents who had a gap between risky pregnancies (<24 months or >60 months), consisting of 30 mothers (47.6%) in the preeclampsia group and 58 mothers (30.7%) in the non-preeclampsia group. The proportion of risk pregnancy intervals in the group of mothers with preeclampsia was higher than in the group without preeclampsia. These findings show that mothers with pregnancy distances that are too close or too far have a greater tendency to experience preeclampsia than mothers with ideal pregnancy distances.In this study, the ideal pregnancy interval was set between 24–60 months from the last birth before the next conception. The pregnancy interval <24 months is categorized as a short interpregnancy interval, while >60 months is categorized as a long interpregnancy interval (UNICEF, 2020). This study also included primigravida mothers who mathematically had a 0-month gestation gap into the risk category according to the hospital's clinical recording system. Biologically, this policy is in line with the obstetric literature which states that the first pregnancy has a higher risk of preeclampsia because maternal immunological adaptation to fetal antigens has not been formed (Rahman et al., 2024; Saito et al., 2023). The results of this study are consistent with the findings of Rahman et al., (2024) at the Sugio Health Center, which involved 63 preeclampsia mothers (cases) and 185 mothers without preeclampsia (control).

There were 37 mothers with risk pregnancy distances in the case group and 86 mothers in the control group. The study showed that the proportion of pregnancy spacing was greater at risk in the preeclampsia group. Similar findings were also reported by Martanti et al., (2021) at Dr. Moewardi Hospital Surakarta, involving 72 pregnant women (36 cases and 36 controls). In the case group, 23 mothers (63.9%) had a risk pregnancy interval (<2 years or >5 years), while in the control group only 12 mothers (33.3%). Overall, 35 mothers (48.6%) had a risk-free pregnancy distance and 37 mothers (51.4%) had a non-risk-free pregnancy distance.The ideal pregnancy interval is in the range of 2–5 years because it is considered the safest for the health of the mother and baby. An interval of more than 2 years provides an opportunity for the mother to recover the condition of the uterus and her overall health, both physically, emotionally, and economically. This optimal recovery plays a role in lowering the risk of various complications in subsequent pregnancies, including the possibility of preeclampsia (Juniarty & Mandasari, 2023).Too long a pregnancy interval (>5 years) can increase the risk of preeclampsia and eclampsia. This condition is related to the increasing age of the mother, which will biologically lead to degenerative processes, such as weakening of the function of the uterine muscles and pelvic floor muscles which play an important role in pregnancy and subsequent delivery. In mothers over 35 years of age, various physiological changes due to aging organs begin to occur, including decreased kidney and liver function, reduced overall physical condition, and an increased tendency to hypertension and diabetes mellitus.

These changes can increase the risk of pregnancy complications, including preeclampsia. Therefore, a pregnancy gap that is too long needs to be watched out for because it can increase the likelihood of health problems during pregnancy (Tapowolo et al., 2018).Physiologically, the too short pregnancy gap does not give the mother's body enough time to recover its reserves of iron, folic acid, and other essential nutrients. This condition increases the risk of anemia, placental hypoxia, and vascular adaptation disorders that can trigger preeclampsia. Conversely, too long a pregnancy gap can lead to a loss of the protective effects of previous pregnancies. The mother's body loses adaptation to the hemodynamic changes of pregnancy so that the cardiovascular system has to readjust, which can lead to endothelial dysfunction and pregnancy hypertension (İmamoğlu et al., 2022). The results showed that pregnancy spacing was more at risk in the group without preeclampsia. This condition illustrates that the distance between pregnancies in the study population is not a dominant factor in triggering preeclampsia. Other stronger risk factors, such as maternal age, history of hypertension, obesity, or metabolic disorders, appear to play more role in the case group so pregnancy distance does not appear as a major determinant. These findings confirm that the relationship between pregnancy distance and preeclampsia is complex and is influenced by a variety of other factors that work simultaneously.

Distribution of Preeclampsia

Based on the results of the univariate analysis, out of a total of 252 respondents, there were 63 mothers (25%) who experienced preeclampsia, while 189 mothers (75%) did not. These figures show that the prevalence of preeclampsia at Sunan Kudus Hospital in 2024 is relatively high, considering that the national figure only ranges from 3% to 10% of all pregnancies (Ministry of Health, 2023). This high prevalence is likely influenced by the characteristics of respondents who are mostly referral patients with a history of obstetric complications and high risk factors during pregnancy.According to the World Health Organization (WHO, 2023), preeclampsia is hypertension that appears after ≥20 weeks of gestation, accompanied by proteinuria ≥300 mg/24 hours or signs of organ dysfunction such as increased liver enzymes, impaired kidney function, and thrombocytopenia. Meanwhile, the American College of Obstetricians and Gynecologists (Hypertension, 2019) defines preeclampsia as systolic blood pressure ≥140 mmHg or diastolic ≥90 mmHg at two examinations with an interval of at least 4 hours, accompanied by proteinuria or clinical signs such as epigastric pain, visual disturbance, and pulmonary edema.Pathophysiologically, preeclampsia is a multisystem disorder that begins with the failure of the spiral artery remodeling in early pregnancy.

As a result, blood flow to the placenta is disrupted and gives rise to hypoxia, which triggers the release of antiangiogenic factors such as soluble fms-like tyrosine kinase-1 (sFlt-1) and endoglin into the mother's circulation. This imbalance of angiogenic factors leads to endothelial dysfunction and vasoconstriction, resulting in increased blood pressure and damage to organs such as the kidneys (proteinuria), liver (increased liver enzymes), and brain (headaches, visual impairments, and eclampsia seizures) (Ives et al., 2020).The results of this study showed that anemia and non-ideal pregnancy spacing were the most associated factors with the incidence of preeclampsia, while diabetes mellitus did not show a significant association. This condition indicates that hypoxia due to anemia and vascular maladaptation due to the distance of pregnancy too close or too far play a major role in the mechanism of preeclampsia. Meanwhile, the low prevalence of diabetes mellitus in respondents may be the cause of the lack of a statistically meaningful association between DM and preeclampsia.Overall, these results confirm the importance of preventing risk factors for preeclampsia through efforts to improve the nutritional status of pregnant women, setting ideal pregnancy distances, and routine screening of blood pressure and hemoglobin levels from early pregnancy.

The Relationship of Diabetes Mellitus to Preeclampsia

Based on the results of the study, the majority of pregnant women in both the case and control groups did not experience diabetes mellitus. Statistical tests showed that there was no significant association between diabetes mellitus and the incidence of preeclampsia in pregnant women in the hospital. Thus, the presence of diabetes mellitus does not increase the risk of preeclampsia compared to pregnant women who do not have the condition. Because pregnant women with diabetes mellitus generally do better health management, including blood sugar control and a healthy lifestyle, so that it can reduce the risk of complications.These findings are in line with the results of a study (Khariza et al., 2024) at Siti Fatimah Makassar Mother and Child Hospital which also found no significant association between diabetes mellitus and preeclampsia (p = 1,000; OR = 1,000; CI 95%: 0.378–2.647). The study confirms that diabetes mellitus is not the only determining factor for the occurrence of preeclampsia because this condition is also influenced by other factors such as nutritional status, history of chronic hypertension, and genetic predisposition.The findings of this study are in line with the results of a study conducted by Mohamud & Surury, (2022) at PKU Muhammadiyah Hospital Bantul, which reported that there was no significant relationship between diabetes mellitus and the incidence of preeclampsia (p-value = 0.430; OR = 0.7). These results suggest that in the study population, diabetes mellitus was not a factor that significantly increased the risk of preeclampsia.

However, the results of this study are different from the findings (Rezeki et al., 2022) which reported a significant relationship between diabetes mellitus and preeclampsia (p-value = 0.000; OR = 4.6). These results showed that pregnant women with diabetes were 4.6 times more likely to experience preeclampsia than pregnant women who did not have diabetes. These differences in results are likely due to variations in the study design, respondent characteristics, and the number of samples used. Physiologically, the link

between diabetes mellitus and preeclampsia can be explained through the mechanism of insulin resistance that causes endothelial dysfunction, increased oxidative stress, and systemic inflammation that leads to hypertension in pregnancy (Murtiningsih et al., 2021). Therefore, although diabetes mellitus is theoretically one of the risk factors for preeclampsia, the results of a study at RSI Sunan Kudus in 2024 show that these factors do not have a significant relationship, possibly due to optimal control of blood sugar levels as well as good antenatal supervision.

IV. CONCLUSION

Based on the results of statistical analysis, it can be concluded:

1. General Conclusion

This study shows that there is a meaningful relationship between anemia and the distance between pregnancy and the incidence of preeclampsia in pregnant women. Meanwhile, the association between diabetes mellitus and the incidence of preeclampsia was not statistically significant, although mothers with diabetes mellitus tended to have a greater chance of developing preeclampsia than mothers who did not have diabetes. Overall, the results of this study show that maternal health conditions during pregnancy and reproductive factors such as distance between pregnancies play an important role in the risk of preeclampsia.

2. Special Conclusion

a. Of the total 252 respondents, there were 6 mothers (9.5%) who had diabetes mellitus in the preeclampsia group and 7 mothers (3.7%) in the group without preeclampsia. The results of the statistical test showed a value of p = 0.096 with OR = 2.737 (95% CI: 0.884–8.475). This suggests that there is no significant association between diabetes mellitus and the incidence of preeclampsia. However, clinically, mothers with diabetes mellitus have a tendency to have a risk of about 2.7 times greater risk of developing preeclampsia than mothers who do not have diabetes mellitus. These results suggest that diabetes mellitus may be one of the potential risk factors for preeclampsia, but it is not statistically robust enough in this study, so it needs to be further studied with measurements of blood sugar levels and other more specific clinical variables.

b. Of the total 252 respondents, there were 27 mothers (42.9%) who experienced anemia in the preeclampsia group, while in the group without preeclampsia there were 40 mothers (21.2%). The results of the statistical test obtained a value of p = 0.001 with OR = 2.794 (95% CI: 1.520–5.136). These findings suggest that there is a significant association between anemia and the incidence of preeclampsia. Mothers with anemia have a risk of developing preeclampsia about 2.8 times greater than mothers who are not anemic. These findings reinforce the evidence that anemia plays an important role as a risk factor for preeclampsia, as decreased hemoglobin levels can lead to placental hypoxia and endothelial dysfunction that triggers increased blood pressure during pregnancy. Prevention and early detection of anemia is an important step in reducing the risk of preeclampsia complications.

c. Of the total 252 respondents, there were 30 mothers (47.6%) with a distance between pregnancies at risk in the preeclampsia group and 58 mothers (30.7%) in the non-preeclampsia group. The results of the statistical test showed a value of p = 0.022 with OR = 2.053 (95% CI: 1.146–3.679). These results indicate that there is a significant relationship between the distance between pregnancy and the incidence of preeclampsia. Mothers with a risk pregnancy distance have about 2 times greater chance of developing preeclampsia than mothers with a non-risk pregnancy distance. Mothers with a pregnancy gap are at risk of having about twice the chance of developing preeclampsia compared to mothers with an ideal gestational distance (24–60 months). These results suggest that pregnancy intervals that are too short or too long can increase the risk of preeclampsia because they affect the mother's physiological recovery, nutritional balance, and cardiovascular system function. Therefore, setting the ideal pregnancy distance is an important part of preventing preeclampsia.

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