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Maternal risk factors for hypertension in pregnancy: A quantitative study on the role of demographics, obesity, and healthcare compliance

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Abstract

Hypertension in pregnancy is a major contributor to maternal and perinatal morbidity and mortality. This study examined the associations between maternal risk factors and hypertension in pregnancy. A prospective observational cohort study was conducted at Wonoayu Health Center, Sidoarjo, Indonesia, from November 2024 to January 2025. Fifty-seven pregnant women with a gestational age of at least 28 weeks and a positive mean arterial pressure screening result were recruited through consecutive sampling. Data were collected from medical records, interviews, adherence cards, physical examinations, blood pressure measurements, and proteinuria tests and analyzed using chi-square tests and multivariable logistic regression. Maternal age ($p = 0.022$; adjusted OR = 11.848; 95% CI: 1.422–98.739) and adherence to calcium lactate supplementation ($p = 0.021$; adjusted OR = 0.371; 95% CI: 0.160–0.858) were significantly associated with hypertension in pregnancy. Maternal age and adherence to calcium lactate supplementation may be important factors associated with hypertension in pregnancy. (*Afr J Reprod Health* 2026; 30 [19]:71-80).

Keywords: Maternal mortality, pregnancy, hypertension, antenatal care

Résumé

L'hypertension artérielle au cours de la grossesse constitue un facteur majeur de morbidité et de mortalité maternelles et périnatales. Cette étude visait à examiner les associations entre les facteurs de risque maternels et l'hypertension artérielle au cours de la grossesse. Une étude de cohorte observationnelle prospective a été menée au centre de santé de Wonoayu, à Sidoarjo, en Indonésie, de novembre 2024 à janvier 2025. Cinquante-sept femmes enceintes ayant un âge gestationnel d'au moins 28 semaines et présentant un résultat positif au dépistage de la pression artérielle moyenne ont été recrutées par échantillonnage consécutif. Les données ont été recueillies à partir des dossiers médicaux, d'entretiens, de carnets d'observance, d'examen physiques, de mesures de la pression artérielle et de tests de protéinurie, puis analysées à l'aide du test du chi carré et d'une régression logistique multivariée. L'âge maternel ($p = 0,022$; OR ajusté = 11,848 ; IC à 95 % : 1,422–98,739) et l'observance de la supplémentation en lactate de calcium ($p = 0,021$; OR ajusté = 0,371 ; IC à 95 % : 0,160–0,858) étaient significativement associés à l'hypertension artérielle au cours de la grossesse. L'âge maternel et l'observance de la supplémentation en lactate de calcium pourraient constituer des facteurs importants associés à l'hypertension artérielle au cours de la grossesse. (*Afr J Reprod Health* 2026; 30 [19]: 71-80).

Mots-clés : Mortalité maternelle, grossesse, hypertension artérielle, soins prénatals

Introduction

Hypertension in pregnancy is a serious pregnancy complication with a pathophysiology that is not yet fully understood. It is characterized by elevated blood pressure (systolic >140 mmHg and diastolic >90 mmHg) accompanied by one or more of the

following: proteinuria, maternal organ dysfunction (including liver, kidney, and neurological involvement), or hematological and/or uterine involvement.¹ Hypertension in pregnancy is a major contributor to maternal mortality and morbidity, alongside infection and hemorrhage.² Globally, hypertensive disorders of pregnancy affect

approximately 5–10% of pregnancies and remain a major cause of maternal and perinatal morbidity and mortality worldwide.³ The burden is particularly high in low- and middle-income countries, where limited access to quality antenatal care contributes to delayed diagnosis and management. In Africa, hypertensive disorders of pregnancy are among the leading causes of maternal death and adverse neonatal outcomes, highlighting the continuing global challenge posed by this condition.²

In Indonesia, based on Maternal Perinatal Death Notification (MPDN) data, maternal deaths reached 4,005 in 2022 and increased to 4,129 in 2023, with hypertension in pregnancy as one of the leading causes. In East Java, the Maternal Mortality Rate (MMR) was 98.40 per 100,000 live births in 2020, rising sharply to 234.7 per 100,000 live births in 2021, then declining to 93.00 in 2022 and slightly increasing to 93.73 in 2023. The leading cause, based on ICD-10 MM codes, was hypertension in pregnancy, childbirth, and the puerperium.⁴ In Sidoarjo Regency, the 2023 MMR was 48.38 per 100,000 live births, with hypertension in pregnancy accounting for 29.4% of maternal deaths.⁵ At the Wonoayu Health Center, hypertension in pregnancy cases increased from 19 in 2022 to 25 in 2023, and to 38 cases between January and September 2024 (KIA Wonoayu Health Center, 2024), indicating a rising trend in prevalence.

Hypertension in pregnancy has significant adverse effects on both the mother and fetus. In the fetus, it can cause low birth weight (LBW) due to reduced placental blood flow resulting from spasm of the spiral arterioles, leading to placental dysfunction. This condition may result in fetal hypoxia, intrauterine growth restriction (IUGR), and intrauterine fetal death. In mothers, complications include placental abruption, hypofibrinogenemia, hemolysis, cerebral hemorrhage, pulmonary edema, liver necrosis, and cardiac damage. If untreated, hypertension in pregnancy can progress to eclampsia, which may result in maternal death.⁶

Various risk factors, including advanced maternal age, a history of hypertension, diabetes, obesity, and primigravidity, contribute to the development of hypertension in pregnancy. In addition, nutritional factors, particularly mineral intake, play an important role in the pathogenesis of hypertension in pregnancy.⁶ Calcium is a key

mineral that helps reduce hypertensive disorders in pregnancy by decreasing parathyroid hormone release and intracellular calcium levels, thereby reducing smooth muscle contraction and promoting vasodilation.⁷ Previous studies have shown that adequate calcium intake during pregnancy can lower the risk of hypertension, a major cause of maternal mortality and preterm birth.^{8–10}

Hypertension in pregnancy can be prevented through early detection and appropriate management of high-risk pregnancies. One method for early detection is the measurement of Mean Arterial Pressure (MAP), which represents the average arterial pressure during one cardiac cycle. In addition, the World Health Organization (WHO) recommends calcium supplementation of 1,500–2,000 mg/day in populations with low dietary calcium intake as part of antenatal care (ANC). In Indonesia, similar recommendations are outlined in the Pocket Book for Maternal Health Services at Primary and Referral Health Facilities, although they have not yet been fully implemented as a mandatory national program. Consequently, the implementation of calcium supplementation varies across health centers in terms of timing and dosage.¹¹

Evidence supports the effectiveness of calcium supplementation in reducing blood pressure among pregnant women. A study by Pitilin et al. (2024) involving 30 pregnant women with a history of hypertension in pregnancy showed significant reductions in blood pressure after 8 weeks of calcium supplementation (3×500 mg/day).¹² However, adherence to calcium intake remains a challenge. Many pregnant women do not meet the recommended daily calcium intake, often due to limited knowledge, inadequate access to calcium-rich foods, and negative attitudes toward supplementation.¹³

Based on a preliminary survey conducted in Cluster 2 of the Wonoayu Health Center in October 2024, 66 pregnant women underwent MAP screening, with several showing positive results. Among 10 interviewed participants, 3 (30%) were non-adherent to daily calcium lactate consumption recommendations. This finding highlights a gap in compliance that may contribute to the risk of hypertension in pregnancy. Therefore, this study aims to analyze maternal risk factors for hypertension in pregnancy through a quantitative

study on the role of demographics, obesity, and healthcare compliance. The findings are expected to provide evidence for strengthening early detection strategies, improving maternal health education, and supporting targeted interventions to reduce the incidence and complications of hypertension in pregnancy at the primary healthcare level.

Methods

Research design

This study employed a quantitative analytic approach using a prospective observational cohort design. This design allowed the researchers to examine the relationship between adherence to calcium lactate supplementation and the occurrence of hypertension in pregnancy without introducing any intervention or manipulating the study variables. Adherence to calcium lactate supplementation was monitored using a daily adherence card over a 60-day period. Participants were instructed to take 500 mg of calcium lactate three times daily, corresponding to a total of 180 tablets during the observation period. The adherence rate was calculated by dividing the number of tablets consumed by the total number prescribed and multiplying the result by 100. Participants were categorized as adherent if they consumed at least 90% of the prescribed tablets, equivalent to 162–180 tablets; partially adherent if they consumed 75% to less than 90%, equivalent to 135–161 tablets; and non-adherent if they consumed less than 75%, equivalent to fewer than 135 tablets. Participants were recruited using consecutive sampling because the study targeted pregnant women with specific eligibility criteria. Accordingly, all pregnant women who met the inclusion criteria, did not meet any exclusion criteria, and agreed to participate were recruited consecutively during the data collection period until the required sample size was reached.

Population and sample

The population of this study consisted of all pregnant women who underwent pregnancy check-ups at Cluster 2 of Wonoayu Health Center in November 2024. The inclusion criteria included pregnant women with a gestational age of ≥ 28 weeks and a

positive MAP screening result. The exclusion criteria included pregnant women who refused to participate in the study, as well as those with medical conditions contraindicated for calcium lactate consumption, such as kidney disorders or allergies to calcium. The sample size was calculated using Slovin's formula; from a population of 66, a total of 57 samples were obtained. The sampling method utilized consecutive sampling, as all eligible pregnant women who met the inclusion criteria and agreed to participate were recruited sequentially until the required sample size was achieved.

Research setting and timeline

The study was conducted at the Wonoayu Health Center. The research period spanned from August 2024 to January 2025, with data collection conducted from November 2024 to January 2025.

Instruments and materials

Secondary data were obtained from existing medical records. Primary data were collected using measurement instruments, including tools for height and weight measurement to calculate BMI, blood pressure monitors, proteinuria tests, and interviews assessing adherence to calcium lactate consumption using a compliance card.

Research variables

The independent variable was adherence to calcium consumption, measured based on how pregnant women consumed calcium according to the recommended dosage of 3×500 mg/day for 2 months. Adherence was categorized into three groups: non-adherent, partially adherent, and adherent. The dependent variable was the incidence of hypertension in pregnancy, defined as blood pressure $\geq 140/90$ mmHg appearing after 20 weeks of gestation, accompanied by proteinuria detectable through urinalysis.

Data analysis

The obtained data were analyzed using univariate, bivariate, and multivariate approaches. Univariate analysis was used to describe the frequency distribution and characteristics of each research

variable, including both independent and dependent variables. Bivariate analysis was conducted to examine the relationship between the dependent variable (incidence of hypertension in pregnancy) and the independent variable (adherence to calcium consumption) using the chi-square test as a non-parametric statistical technique, with a significance level of $\alpha = 0.05$, and processed using the Statistical Package for the Social Sciences (SPSS). Subsequently, multivariate analysis using binary logistic regression was performed to determine the strength of association between adherence to calcium consumption and the incidence of hypertension in pregnancy while controlling for potential confounding variables such as maternal age, parity, history of hypertension, and body mass index, thereby providing more accurate and clinically interpretable odds ratio estimates.

Ethical clearance

This study received ethical approval from the Health Research Ethics Committee of Universitas Noor Huda Mustofa prior to data collection, with ethical approval number 3028/KEPK/UNIV-NHM/EC/VIII/2024. All respondents received an explanation regarding the study objectives and data collection procedures before providing written informed consent. The confidentiality of respondents' identities was strictly maintained throughout the study. Participation in the study was voluntary, and respondents had the right to withdraw at any time without any consequences.

Results

Descriptive analysis

Table 1 presents the distribution of respondents according to age, parity, history of hypertension, history of hypertension in pregnancy, body mass index (BMI), pregnancy interval, adherence to calcium supplementation, and hypertension in pregnancy status.

Table 1 presents the baseline characteristics of the 57 pregnant women included in the study. Most respondents were aged 20–35 years (40 women; 70.2%), while 13 women (22.8%) were older than 35 years and 4 women (7.0%) were

younger than 20 years. In terms of parity, 36.8% (21 women) were primiparous and 63.2% (36 women) were multiparous. Only 7 women (12.3%) had a history of hypertension, whereas 50 women (87.7%) reported no previous hypertension. A history of hypertension in pregnancy was present in 6 women (10.5%), while 51 women (89.5%) had no such history. Based on body mass index, 9 women (15.8%) were classified as obese and 48 women (84.2%) were not obese. Regarding pregnancy interval, 21 women (36.8%) had an interval of 0 years (first pregnancy), 10 women (17.5%) had an interval of less than 2 years, and 26 women (45.6%) had an interval of 2 years or more. For adherence, 13 women (22.8%) were classified as adherent, 26 women (45.6%) as partially adherent, and 18 women (31.6%) were non-adherent. Finally, 21 women (36.8%) were diagnosed with hypertension in pregnancy, whereas 36 women (63.2%) did not experience hypertension in pregnancy.

Bivariate analysis

Table 2 shows the distribution of hypertension in pregnancy by maternal age group, parity (primiparous and multiparous), the presence or absence of a history of hypertension, previous history of hypertension in pregnancy, obesity status (based on BMI classification), pregnancy interval (primigravida, <2 years, ≥2 years), and calcium supplementation adherence status (adherent vs. non-adherent), analyzed using the chi-square test and contingency coefficient.

Table 2 presents the distribution of hypertension in pregnancy according to maternal age group. Of the 57 women included in the study, 21 (36.8%) experienced hypertension in pregnancy and 36 (63.2%) did not. Among respondents aged <20 years, all 4 women (100.0%) had hypertension in pregnancy**. In the 20–35-year age group, 14 of 40 women (35.0%) experienced hypertension in pregnancy, whereas 26 (65.0%) did not. In the >35-year group, 3 of 13 women (23.1%) had hypertension in pregnancy and 10 (76.9%) did not. The chi-square test showed that the difference in the proportion of hypertension in pregnancy across age categories was statistically significant ($p = 0.022$), indicating that maternal age is associated with the occurrence of hypertension in pregnancy in this

Table 1. Baseline characteristics of pregnant women at Wonoayu Health Center (n = 57)

Variable	Category	n	%
Age	< 20 years	4	7.0%
	20–35 years	40	70.2%
	> 35 years	13	22.8%
Parity	Primipara	21	36.8%
	Multipara	36	63.2%
History of hypertension	Yes	7	12.3%
	No	50	87.7%
History of hypertension in pregnancy	Yes	6	10.5%
	No	51	89.5%
BMI	Obese	9	15.8%
	Not Obese	48	84.2%
Pregnancy interval	0 years	21	36.8%
	< 2 years	10	17.5%
	≥ 2 years	26	45.6%
Adherence category	Adherent	13	22.8%
	Partially adherent	26	45.6%
	Non-adherent	18	31.6%
	Hypertension	21	36.8%
Hypertension in pregnancy diagnosis	No hypertension	36	63.2%

Table 2. Association between maternal age, parity, history of hypertension, history of hypertension in pregnancy, obesity, pregnancy interval, calcium supplementation adherence, and hypertension in pregnancy

Variable	Hypertension in pregnancy		Total, n (%)	p-value	Contingency coefficient
	Yes, n (%)	No, n (%)			
Age				0.022	0.350
<20 years	4 (100.0)	0 (0.0)	4 (100.0)		
20–35 years	14 (35.0)	26 (65.0)	40 (100.0)		
>35 years	3 (23.1)	10 (76.9)	13 (100.0)		
Parity				0.330	0.095
Primiparous	9 (42.9)	12 (57.1)	21 (100.0)		
Multiparous	12 (33.3)	24 (66.7)	36 (100.0)		
History of hypertension				0.514	0.047
Present	3 (42.9)	4 (57.1)	7 (100.0)		
Absent	18 (36.0)	32 (64.0)	50 (100.0)		
History of hypertension in pregnancy				0.613	0.025
Present	2 (33.3)	4 (66.7)	6 (100.0)		
Absent	19 (37.3)	32 (62.7)	51 (100.0)		
Obesity				0.276	0.130
Obese	2 (22.2)	7 (77.8)	9 (100.0)		
Not obese	19 (39.6)	29 (60.4)	48 (100.0)		
Pregnancy interval				0.240	0.116
Primigravida (0 years)	9 (42.9)	12 (57.1)	21 (100.0)		
<2 years	4 (40.0)	6 (60.0)	10 (100.0)		
>2 years	8 (30.8)	18 (69.2)	26 (100.0)		
Adherence				0.004	0.356
Adherent	3 (13.6)	19 (86.4)	22 (100.0)		
Non-adherent	18 (51.4)	17 (48.6)	35 (100.0)		
Total	21 (36.8)	36 (63.2)	57 (100.0)		

sample. The contingency coefficient was 0.350, suggesting a moderate strength of association between age group and hypertension in pregnancy status.

Furthermore, Table 2 presents the distribution of hypertension in pregnancy according to maternal parity. Among the 57 women studied, 21 (36.8%) were primiparous and 36 (63.2%) were multiparous. In the primiparous group, 9 of 21 women (42.9%) experienced hypertension in pregnancy, whereas 12 (57.1%) did not. In the multiparous group, 12 of 36 women (33.3%) had hypertension in pregnancy and 24 (66.7%) did not. The chi-square test yielded a p-value of 0.330, indicating that the difference in the proportion of hypertension in pregnancy between primiparous and multiparous women was not statistically significant at the 0.05 level. The contingency coefficient of 0.095 suggests a very weak association between parity and the occurrence of hypertension in pregnancy in this sample.

In addition, Table 2 shows the relationship between a history of hypertension and the occurrence of hypertension in pregnancy. Of the 57 women studied, 7 (12.3%) had a history of hypertension and 50 (87.7%) did not. Among those with a history of hypertension, 3 women (42.9%) developed hypertension in pregnancy and 4 (57.1%) did not. Among those without a history of hypertension, 18 of 50 women (36.0%) experienced hypertension in pregnancy, whereas 32 (64.0%) did not. The chi-square test produced a p-value of 0.514, indicating that the difference was not statistically significant. The contingency coefficient of 0.047 suggests a very weak association.

Similarly, Table 2 presents the association between a history of hypertension in pregnancy and the occurrence of hypertension in pregnancy in the current pregnancy. Of the 57 women studied, 6 (10.5%) had a previous history, while 51 (89.5%) did not. Among those with a history, 2 of 6 (33.3%) developed hypertension in pregnancy and 4 (66.7%) did not. Among those without a history, 19 of 51 (37.3%) experienced hypertension in pregnancy and 32 (62.7%) did not. The chi-square test yielded a p-value of 0.613, indicating no statistically significant association. The contingency coefficient of 0.025 suggests a very weak relationship.

Moreover, Table 2 presents the association between obesity and hypertension in pregnancy. Among the 57 women, 9 (15.8%) were obese and 48 (84.2%) were not. In the obese group, 2 of 9 (22.2%) developed hypertension in pregnancy, while 7 (77.8%) did not. In the non-obese group, 19 of 48 (39.6%) experienced hypertension in pregnancy and 29 (60.4%) did not. The chi-square test produced a p-value of 0.276, indicating no statistically significant difference. The contingency coefficient of 0.130 suggests a weak association.

Furthermore, Table 2 shows the distribution of hypertension in pregnancy according to pregnancy interval. Of the 57 women, 21 (36.8%) were primigravida (0-year interval), 10 (17.5%) had an interval of <2 years, and 26 (45.6%) had an interval of ≥ 2 years. Among primigravida women, 9 of 21 (42.9%) developed hypertension in pregnancy, while 12 (57.1%) did not. In women with an interval <2 years, 4 of 10 (40.0%) experienced hypertension in pregnancy and 6 (60.0%) did not. Among those with an interval ≥ 2 years, 8 of 26 (30.8%) had hypertension in pregnancy and 18 (69.2%) did not. The chi-square test yielded a p-value of 0.240, indicating no statistically significant association. The contingency coefficient of 0.116 suggests a weak relationship.

Finally, Table 2 illustrates the relationship between adherence and hypertension in pregnancy. Of the 57 women, 22 (38.6%) were adherent and 35 (61.4%) were non-adherent. Among adherent women, 3 of 22 (13.6%) developed hypertension in pregnancy, whereas 19 (86.4%) did not. Among non-adherent women, 18 of 35 (51.4%) experienced hypertension in pregnancy and 17 (48.6%) did not. The chi-square test yielded a p-value of 0.004, indicating a statistically significant association. The contingency coefficient of 0.356 suggests a moderate strength of association.

Multivariate analysis

Results of binary logistic regression in Table 3 showing the association between independent variables and hypertension in pregnancy, expressed as coefficients (B), standard errors (SE), p-values, odds ratios (Exp[B]), and 95% confidence intervals. Table 3 shows the multivariable logistic regression

Table 3: Multivariable logistic regression analysis of factors associated with hypertension in pregnancy

Variables in the equation		B	S.E.	Wald	df	Sig.	Exp(B)	95% C.I. for EXP(B)	
								Lower	Upper
Step 1 ^{a,b}	Age	2.472	1.082	5.222	1	0.022	11.848	1.422	98.739
	Parity	0.681	1.717	0.157	1	0.692	1.975	0.068	57.175
	History of hypertension	1.943	1.123	2.995	1	0.084	6.982	0.773	63.075
	History of hypertension in pregnancy	1.214	1.314	0.854	1	0.355	3.367	0.257	44.196
	Obesity	-1.711	1.346	1.616	1	0.204	0.181	0.013	2.527
	Pregnancy interval	-0.343	0.916	0.140	1	0.708	0.710	0.118	4.272
	Adherence	-0.992	0.428	5.366	1	0.021	0.371	0.160	0.858
	Constant	-5.752	4.920	1.367	1	0.242	0.003		

a) Variables entered in Step 1: age, parity, history of hypertension, history of hypertension in pregnancy, obesity, pregnancy interval, and adherence; b) Variables entered in Step 1: age, parity, history of hypertension, obesity, pregnancy interval, and adherence.

analysis of factors associated with hypertension in pregnancy. Age and adherence were found to be statistically significant predictors. After adjustment, age was positively associated with hypertension in pregnancy ($B = 2.472$, $p = 0.022$). The odds ratio (OR) of 11.848 (95% CI: 1.422–98.739) indicates that women in the higher age category had approximately 11.8 times higher odds of developing hypertension in pregnancy compared with the reference group.

Adherence showed a significant protective effect ($B = -0.992$, $p = 0.021$). The OR of 0.371 (95% CI: 0.160–0.858) indicates that adherent women had approximately 63% lower odds of developing hypertension in pregnancy compared with non-adherent women. Parity, history of hypertension, history of hypertension in pregnancy, obesity, and pregnancy interval all had p -values greater than 0.05, and their confidence intervals included 1.0, indicating that these variables were not statistically significant independent predictors of hypertension in pregnancy in this model.

Discussion

This study aimed to analyze maternal risk factors for hypertension in pregnancy using a quantitative study on the role of demographics, obesity, and healthcare compliance in the working area of Wonoayu primary health care. The findings indicate that the proportion of hypertension in pregnancy cases remains relatively high, highlighting that hypertension in

pregnancy continues to be a significant maternal health problem requiring attention from health workers. Theoretically, hypertension in pregnancy is a major contributor to maternal and perinatal morbidity and mortality, characterized by increased blood pressure accompanied by organ dysfunction.² Thus, the findings reinforce the importance of prevention and early detection strategies.

In terms of demographic characteristics, most respondents were within the healthy reproductive age group (20–35 years), although a proportion were in high-risk age groups (<20 and >35 years). Maternal age was found to be significantly associated with hypertension in pregnancy, consistent with previous studies showing that women in high-risk age categories have a greater likelihood of developing pregnancy complications.¹⁴ Adolescent pregnancy is associated with biological immaturity and limited psychosocial readiness, while advanced maternal age is often linked to comorbidities such as chronic hypertension and diabetes mellitus.¹⁵ These findings emphasize the importance of age-based risk screening and targeted antenatal care.

Regarding parity, although primigravida women are theoretically at higher risk due to immunological maladaptation to fetal antigens,¹ this study did not find a statistically significant association between parity and hypertension in pregnancy. However, this finding differs from the multicentre study conducted by Anto in Ghana, which identified primigravida as an independent

risk factor for hypertension in pregnancy. The difference between these findings may be related to variations in sample size, population characteristics, study setting, variable classification, and adjustment for confounding factors. Therefore, parity should not be interpreted as an isolated determinant of hypertension in pregnancy but should be considered together with other maternal and clinical factors, such as age, body mass index, history of hypertension, and previous hypertension in pregnancy.¹⁶⁻¹⁸

Similarly, history of hypertension, history of hypertension in pregnancy, obesity, and pregnancy interval were not significantly associated with hypertension in pregnancy in this study, although these factors are widely recognized as important risk factors. The lack of association may be attributed to the small sample size, low proportion of exposed respondents, or potential information bias in medical history reporting. Obesity, for instance, is known to contribute to hypertension in pregnancy through mechanisms such as chronic inflammation, insulin resistance, and endothelial dysfunction,⁸ but its role was not prominent in this population. These findings indicate that context-specific factors may influence the relative importance of classical risk factors.

A key finding of this study is the significant association between adherence to calcium supplementation and hypertension in pregnancy. Mothers who were non-adherent had a substantially higher proportion of hypertension in pregnancy compared with those who were adherent. This is consistent with previous evidence showing that calcium supplementation reduces the risk of hypertension in pregnancy, particularly in populations with low dietary calcium intake.¹⁹ Calcium plays a role in regulating vascular smooth muscle contraction and promoting vasodilation, thereby helping to control blood pressure.⁷ However, despite clear recommendations from the World Health Organization (WHO), adherence to calcium supplementation remains suboptimal in many settings.^{13,20,21}

The multivariate analysis further confirmed that maternal age and adherence to calcium supplementation are independent predictors of hypertension in pregnancy. Women in high-risk age groups had significantly higher odds of developing hypertension in pregnancy, while adherence to

calcium supplementation showed a protective effect. These findings highlight that both demographic and behavioral factors play crucial roles in the occurrence of hypertension in pregnancy. In contrast, other variables lost their significance after adjustment, suggesting that their effects may be mediated or confounded by stronger predictors such as age and adherence.

From a public health perspective, these findings underscore the importance of strengthening antenatal care programs, particularly through early risk screening and behavioral interventions. Health workers should prioritize counseling for pregnant women in high-risk age groups and improve strategies to enhance adherence to calcium supplementation, such as education, regular monitoring, and improved access to supplements.²² Improving adherence is essential, as the effectiveness of calcium supplementation largely depends on consistent consumption.

This study has several limitations. First, the study was conducted in a single primary healthcare center, which may limit the generalizability of the findings to broader populations. Second, the relatively small sample size reduces statistical power and may have limited the ability to detect weaker associations between risk factors and hypertension in pregnancy. Third, adherence to calcium supplementation was measured using self-reported compliance cards, which may be subject to recall bias and overestimation of adherence. Fourth, although multivariate analysis was performed, residual confounding may still exist due to unmeasured factors such as dietary calcium intake, physical activity, stress levels, and socioeconomic status. Finally, the observational design of the study limits the ability to establish causal relationships between exposure variables and hypertension in pregnancy.

Conclusion

In conclusion, hypertension in pregnancy remains a significant health concern among pregnant women in the Wonoayu Health Center area. Maternal age and adherence to calcium supplementation were identified as significant factors associated with its occurrence. Advanced maternal age increases the risk of hypertension in pregnancy, while good

adherence to calcium supplementation has a protective effect. However, BMI (obesity status) was not found to be significantly associated with hypertension in pregnancy. Based on these findings, the research hypothesis is partially accepted, as only maternal age and calcium supplementation adherence showed significant associations, while BMI did not demonstrate a statistically significant relationship. Strengthening early detection of high-risk pregnancies, particularly among older mothers, and improving adherence to calcium supplementation through structured counseling and routine monitoring are recommended to reduce the incidence of hypertension in pregnancy at the primary healthcare level.

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Conflict of interest

There are no potential conflicts of interest relevant to this article.

Data availability statement

The data underlying this article are available upon reasonable request from the corresponding author.

Contribution of authors

Conceptualization: Cholifah; Data curation: Cholifah; Formal analysis: Cholifah; Methodology: Cholifah, Djazuly Chalidyanto; Project management: Diah Indriani; Resources: Cholifah; Software: Cholifah; Supervision: Diah Indriani; Validation: Diah Indriani, Djazuly Chalidyanto; Drafting - original draft: Cholifah; Writing - proofreading and editing: Diah Indriani, Djazuly Chalidyanto

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