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Association Between Calcium Intake Adequacy and Blood Pressure Among Pregnant Women: A Cross-Sectional Study in Makassar

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ABSTRACT

Hypertensive disorders of pregnancy remain a major cause of maternal morbidity and mortality worldwide. Inadequate calcium intake has been identified as a modifiable risk factor associated with elevated blood pressure during pregnancy. This study aimed to examine the association between calcium intake adequacy and blood pressure among pregnant women attending the Rappokalling Health Center, Makassar. This analytical observational study employed a cross-sectional design involving 50 pregnant women selected through accidental sampling. Calcium intake adequacy was assessed using a structured dietary questionnaire based on recommended daily calcium intake, while blood pressure was measured using a calibrated sphygmomanometer during antenatal care visits. Data were analyzed using the Chi-square test with a significance level of $p < 0.05$. The results showed that 50.0% of respondents had adequate calcium intake and 50.0% had inadequate intake. Most participants (70.0%) had normal blood pressure, while 30.0% had abnormal blood pressure. All pregnant women with adequate calcium intake had normal blood pressure (100.0%), whereas 60.0% of those with inadequate calcium intake experienced abnormal blood pressure. Statistical analysis revealed a significant association between calcium intake adequacy and blood pressure ($p < 0.001$). Adequate calcium intake was significantly associated with normal blood pressure during pregnancy. Strengthening nutritional counseling and calcium supplementation during antenatal care may help prevent hypertensive disorders of pregnancy.

INTRODUCTION

Maternal mortality remains a major global public health challenge. According to the World Health Organization (WHO), hypertensive disorders during pregnancy, particularly preeclampsia and eclampsia, contribute substantially to maternal and perinatal morbidity and mortality worldwide. In 2023, the global Maternal Mortality Ratio (MMR) was estimated at 197 deaths per 100,000 live births, while the Infant Mortality Rate (IMR) reached 37 deaths per 1,000 live births. The major causes of maternal mortality include hemorrhage, infection, hypertensive disorders, and complications during childbirth.

In Indonesia, maternal and infant mortality rates remain relatively high compared with the targets established under the Sustainable Development Goals (SDGs). The Ministry of Health of the Republic of Indonesia reported that the MMR reached 189 deaths per 100,000 live births in 2023, while the IMR was recorded at 16 deaths per 1,000 live births. Hypertension during pregnancy continues to be one of the leading contributors to maternal complications and adverse pregnancy outcomes (Laporan Kinerja Kementerian Kesehatan Republik Indonesia, 2023).

Worldwide, hypertension accounts for approximately 14% of all maternal deaths. Among the hypertensive disorders complicating pregnancy, preeclampsia and eclampsia are the leading causes of maternal and perinatal morbidity and mortality. One of the factors contributing to hypertension among pregnant women is calcium intake (Safitry et al., 2022).

According to data from the Ministry of Health of the Republic of Indonesia, the Maternal Mortality Ratio (MMR) reached 189 deaths per 100,000 live births in 2023. The Infant Mortality Rate (IMR) was reported as 17.6 deaths per 1,000 live births in 2023 and 16 deaths per 1,000 live births in 2024. These figures remain far from the Sustainable Development Goals (SDGs) 2030 targets, which aim to reduce the MMR to 70 deaths per 100,000 live births and the IMR to 12 deaths per 1,000 live births (Safitry et al., 2022).

A previous study investigating factors influencing antenatal care (ANC) visits found that knowledge significantly affects an individual's mindset. Knowledge plays an important role in determining ANC attendance, as an informed mindset can encourage mothers to adopt healthier behaviors. Women with adequate knowledge regarding pregnancy are better able to manage their pregnancy, whether it progresses normally or involves complications (Suryanti and Nurana, 2021; Nurana and S, 2023).

Hypertensive disorders during pregnancy are multifactorial conditions influenced by genetic, physiological, environmental, and nutritional factors. One important nutritional factor associated with blood pressure regulation is calcium intake. Calcium plays a crucial role in vascular smooth muscle contraction, endothelial function, and the maintenance of vascular resistance. Inadequate calcium intake may increase parathyroid hormone and renin secretion, leading to vasoconstriction and elevated blood pressure (Beto, 2015).

Data from five public health centers (Puskesmas) in Makassar—Barabaraya, Kassi-Kassi, Ujung Pandang Baru, Mamajang, and Batua Raya—indicate that the prevalence of hypertension among pregnant women remains relatively high. The recorded prevalence was 2.31% among 690 pregnant women at Kassi-Kassi, 2.87% among 769 pregnant women at Barabaraya, 3.02% among 790 pregnant women at Ujung Pandang Baru, 2.87% among 699 pregnant women at Mamajang, and 2.45% among 612 pregnant women at Batua Raya (Meldawati, 2020).

Preliminary data from several public health centers in Makassar indicated that hypertension among pregnant women remains relatively common. At the Rappokalling Public Health Center, approximately 246 pregnant women attended antenatal care services between January and April 2025, with several cases presenting elevated blood pressure during pregnancy. Therefore, this study aimed to analyze the association between calcium intake adequacy and blood pressure among pregnant women in Makassar using a cross-sectional study design.

METHODS

This study employed an analytical survey design with a cross-sectional approach to examine the association between calcium intake adequacy and blood pressure among pregnant women. The study population consisted of all pregnant women attending Integrated Antenatal Care (ANC) services at the Rappokalling Public Health Center, Makassar. The study sample was selected using a non-probability sampling method, specifically accidental sampling, whereby eligible pregnant women who attended ANC services during the data collection period and were willing to participate were recruited consecutively.

The inclusion criteria were pregnant women who attended ANC services during the study period, were willing to participate in the study, and were able to communicate effectively. The exclusion criteria included pregnant women with incomplete data records and respondents who withdrew from the study before completing the data collection process.

The independent variable in this study was calcium intake adequacy, while the dependent variable was blood pressure status. Calcium intake adequacy was assessed using a structured questionnaire designed to evaluate daily dietary calcium intake and the history of calcium supplementation. Calcium intake was categorized as adequate if respondents met the recommended calcium intake during pregnancy and inadequate if their intake was below the recommended level. Blood pressure was measured using a calibrated digital sphygmomanometer and classified as normal or abnormal according to established antenatal care guidelines.

The research instrument underwent validity assessment through expert review to ensure content appropriateness and relevance. Reliability testing demonstrated acceptable consistency for data collection purposes. Data collection was conducted by trained researchers during routine ANC visits to ensure standardized measurement procedures and data quality.

RESULTS

This study involved a total of 50 pregnant women as respondents. The data collected included information on calcium intake fulfillment, blood pressure status, and oral health conditions among the participants.

Table1. Distribution of Calcium Intake Adequacy and Blood Pressure Status Among Pregnant Women

Variable		Frequency (n)	Percentage (%)
Calcium Intake	Adequate	25	50
	Inadequate	25	50
Blood Pressure	Normal	35	70
	Abnormal	15	30

Source: Primary Data, 2025

Half of the respondents demonstrated adequate calcium intake, while the remaining half had inadequate intake. Most respondents had normal blood pressure (70%), whereas 30% experienced abnormal blood pressure.

Table 2. Relationship Between Calcium Intake Fulfillment and Blood Pressure Among Pregnant Women

Calcium Intake	Normal Blood Pressure	Abnormal Blood Pressure	Total	*p-value*
Adequate	25	0	25	0,000
Inadequate	10	15	25	
Total	**35**	**15**	**50**	

Source: Primary Data (Processed), 2025

The Chi-square test demonstrated a statistically significant association between calcium intake adequacy and blood pressure among pregnant women p= 0,000 (table 2)

DISCUSSION

The present study demonstrated a statistically significant association between calcium intake adequacy and blood pressure among pregnant women (p = 0.000). Pregnant women with inadequate calcium intake were more likely to experience abnormal blood pressure than those whose calcium intake met the recommended levels. These findings suggest that adequate calcium intake plays an important role in maintaining maternal vascular stability during pregnancy and may contribute to the prevention of hypertensive disorders, such as gestational hypertension and preeclampsia (Hofmeyr et al., 2018).

Physiologically, calcium is involved in vascular smooth muscle contraction, endothelial regulation, intracellular signaling, and the maintenance of electrolyte balance. Insufficient calcium intake may stimulate increased secretion of parathyroid hormone (PTH) and renin, leading to elevated intracellular calcium concentrations in vascular smooth muscle cells. This mechanism subsequently induces vasoconstriction and increases peripheral vascular resistance, resulting in elevated blood pressure (Beto, 2015). Furthermore, calcium deficiency has been associated with endothelial dysfunction, oxidative stress, inflammatory responses, and impaired placental perfusion, which are recognized pathways in the pathogenesis of preeclampsia (Redman and Staff, 2015; Rana et al., 2019).

The findings of this study are consistent with previous international evidence supporting the protective role of calcium during pregnancy. A systematic review and meta-analysis conducted by Hofmeyr et al. (2018) reported that calcium supplementation significantly reduced the risk of preeclampsia, particularly among women with low baseline calcium intake. Similarly, Imdad, Jabeen, and Bhutta (2011) found that adequate calcium supplementation during pregnancy lowered the incidence of gestational hypertension and improved maternal outcomes in low-resource populations. A study conducted by Khaing et al. (2017) also demonstrated that calcium supplementation combined with vitamin D significantly reduced the risk of hypertensive disorders during pregnancy.

In Indonesia, Kasanova (2022) reported that regular calcium consumption among second- and third-trimester pregnant women significantly reduced the occurrence of preeclampsia. Similar findings were also reported by Nurkhopipah (2022), who observed that pregnant women with adequate calcium intake had a lower risk of developing hypertension-related pregnancy complications. These consistent findings indicate that calcium intake may

serve as an important nutritional protective factor across different populations and healthcare settings.

However, several studies have shown variations in the magnitude of the association between calcium intake and hypertensive disorders during pregnancy. Cormick et al. (2019) suggested that the effectiveness of calcium intake in reducing hypertension risk may differ according to maternal nutritional status, dietary patterns, socioeconomic conditions, and adherence to supplementation programs. In populations with chronic nutritional deficiencies, calcium supplementation appears to provide greater protective effects than in populations with relatively adequate dietary intake. This variation may explain differences between the present findings and previous intervention studies.

Unlike intervention-based studies focusing mainly on calcium supplementation, the present study evaluated overall calcium intake adequacy among pregnant women attending routine antenatal care services in a primary healthcare setting. Therefore, this study contributes additional evidence that routine dietary calcium intake, not only supplementation, may influence maternal blood pressure regulation. This finding is important because dietary approaches are often more sustainable and accessible in low- and middle-income settings, where adherence to supplementation programs may be inconsistent (Cormick et al., 2023).

Another important aspect that should be highlighted is the role of maternal nutrition during pregnancy as part of comprehensive antenatal care (ANC). Adequate calcium intake during pregnancy not only supports maternal cardiovascular stability but also contributes to fetal bone development and placental function (Mousa, Naqash, and Lim, 2019). Therefore, nutritional assessment should become an integral component of ANC services.

Despite the significant findings, several methodological limitations should be acknowledged. First, the cross-sectional design limits causal interpretation because calcium intake and blood pressure were measured simultaneously. Consequently, temporal relationships between exposure and outcome cannot be definitively established. Second, the use of accidental sampling may introduce selection bias and reduce the representativeness of the study population. Third, calcium intake assessment relied on self-reported questionnaire data, which may increase the risk of recall bias and misclassification of dietary intake. In addition, several potential confounding variables, including sodium intake, maternal body mass index, stress level, physical activity, parity, and family history of hypertension, were not comprehensively controlled in this study. These factors may partially influence blood pressure status during pregnancy and should be considered in future longitudinal studies.

CONCLUSION

This study demonstrates that maternal calcium intake adequacy is closely associated with blood pressure regulation during pregnancy, highlighting the importance of maternal nutritional status in supporting cardiovascular adaptation and maintaining vascular stability. The findings contribute to growing evidence that inadequate calcium intake may increase the vulnerability of pregnant women to hypertensive disorders, including gestational hypertension and preeclampsia. By providing evidence from a primary healthcare setting, this study emphasizes the relevance of nutritional monitoring as an essential component of maternal

health services and reinforces the role of adequate calcium intake in supporting safer pregnancy outcomes.

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