

Quality of Antenatal Care and Maternal Mortality: A Mixed-Methods Study in Purwakarta District, Indonesia

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Abstract

Background

Maternal health plays a key role in fostering a healthy and high-quality generation within a nation. One indicator of a nation's health status is the maternal and infant mortality rates. Maternal and infant deaths can be prevented through high-quality antenatal care (ANC). In Indonesia, integrated ANC programs have been implemented; however, the number of visits alone is insufficient, and the quality of care is a critical determinant of maternal outcomes. This study aimed to assess the role of antenatal care quality in reducing maternal mortality and to explore underlying factors influencing care quality.

Methods

A mixed-methods study using an explanatory sequential design was conducted in a district in West Java, Indonesia. The quantitative method used a case-control design with 90 participants (24 maternal deaths and 66 controls), and analyses were conducted using chi-square tests and logistic regression. The qualitative method involved in-depth interviews with 13 informants to provide contextual explanations for the quantitative findings.

Results

High-quality ANC was significantly associated with reduced maternal mortality ($p < 0.001$; OR = 0.10; 95% CI: 0.001–0.158). Factors influencing maternal mortality prevention included clinical management ($p < 0.001$; OR = 7.692; 95% CI: 0.278–72.87) and pregnancy complications ($p < 0.001$; OR = 193.857; 95% CI: 8.71–251.78). Qualitative findings indicated that ANC quality was influenced by healthcare provider competence, facility availability, the effectiveness of the referral system, maternal health programs, and maternal education and family support.

Conclusion

Improving ANC quality and strengthening the referral system are key strategies for reducing maternal mortality. A comprehensive evaluation within the Maternal and Perinatal Death Surveillance and Response (MPDSR) system is needed to identify root causes and ensure appropriate follow-up.

Background

Maternal health is a key indicator of a nation's overall health status and plays a key role in fostering a healthy, high-quality population. One of the primary indicators is the maternal mortality rate, which reflects the healthcare system's ability to provide optimal preventive and curative interventions. In low- and middle-income countries, the majority of maternal deaths occur during pregnancy, childbirth, and the

postpartum period; however, the vast majority of these cases are actually preventable through effective healthcare services, including antenatal care (ANC) (Liu et al., 2016).

Globally, maternal mortality remains a major public health issue. Although the maternal mortality ratio decreased from approximately 385 to 216 per 100,000 live births between 1990 and 2015, this figure has yet to meet the targets set by the Sustainable Development Goals (SDGs) (Mumtaz et al., 2019). Most maternal deaths occur in developing countries, reflecting inequalities in access to and the quality of maternal healthcare services (Mwakawanga et al., 2025). The WHO emphasizes that maternal deaths can be prevented through evidence-based interventions, particularly through high-quality ANC services (World Health Organization, 2016).

The disparity in maternal mortality rates between developed and developing countries remains significant. Developed countries report relatively low maternal mortality rates, ranging from 3 to 12 per 100,000 live births, whereas developing countries continue to experience significantly higher rates. This disparity is linked to limited access to and poor quality of healthcare services, a high disease burden, and weaknesses in health recording and reporting systems (Geller et al., 2018; Girmu & Wasie, 2017).

ANC services are a key component for reducing maternal morbidity and mortality and improving pregnancy outcomes. They provide an opportunity for early detection of complications, the implementation of preventive interventions, and the delivery of health promotion during pregnancy (World Health Organization, 2016). Several studies indicate that adequate use of ANC is associated with improved maternal and perinatal outcomes, including reduced complications and low birth weight (Tuladhar & Dhakal, 2011). However, increased ANC coverage does not necessarily translate into improved health outcomes.

This situation reflects a gap between service coverage and health outcomes (the coverage–outcome gap). Evidence from Ghana indicates that increased ANC coverage does not correlate significantly with improvements in pregnancy outcomes, suggesting that the quality of ANC services is a critical yet frequently overlooked factor (Amponsah-Tabi et al., 2022). Therefore, focusing solely on the number of visits is insufficient without also considering the quality of care provided.

The WHO emphasizes that ANC must be oriented towards the quality of care, not merely the quantity of visits. ANC is positioned as a platform for comprehensive care encompassing health promotion, risk detection, and timely, evidence-based interventions (World Health Organization, 2016). This approach highlights the importance of service quality dimensions, including clinical effectiveness, safety, and patient experience, in improving maternal and infant health outcomes.

In low- and middle-income countries, various challenges continue to hinder the optimization of ANC quality. Studies indicate that only a small proportion of women receive high-quality ANC, despite the majority having access to such services (Mandiwa & Namondwe, 2024). Furthermore, social factors such as education, geographical access, economic conditions, as well as perceptions of service quality

and family support, also influence the utilization and quality of ANC services (Mumtaz et al., 2019; Jones et al., 2021)

In Indonesia, maternal mortality remains a concern in efforts to achieve the SDGs. Research indicates that the coverage of maternal health services, including ANC, is associated with maternal mortality rates (Christiawan et al., 2023). However, high coverage does not fully guarantee a reduction in maternal mortality, suggesting the need for improved service quality within the health system.

Although various studies have evaluated the coverage and utilization of ANC, there remains a lack of evidence regarding the relationship between the quality of ANC services and maternal mortality, particularly at the district or city level in Indonesia. Most studies have focused on the number of visits or access to services, whereas aspects of service quality have not been comprehensively analyzed. However, evidence suggests that the quality of ANC plays a crucial role in preventing pregnancy complications and improving maternal and perinatal outcomes (Fonseca et al., 2014).

Against this background, this study aims to analyze the relationship between the quality of antenatal care (ANC) services and the incidence of maternal mortality in Purwakarta District. The findings of this study are expected to contribute to the development of policies and interventions to improve the quality of ANC services as an effective strategy for reducing maternal mortality rates.

Methods

Study design

This study employed a mixed-methods approach with an explanatory sequential design, comprising an analytical observational quantitative study using a case-control design, followed by a qualitative study via in-depth interviews.

The case-control design was chosen because maternal deaths are relatively rare events; therefore, this approach is more efficient for identifying risk factors with a limited sample size. Furthermore, this design allows for a retrospective analysis using available medical records, enabling the study to be conducted within a shorter timeframe and with more efficient use of resources.

This study was reported in accordance with the STROBE guidelines (EQUATOR Network, n.d.) for observational studies and followed the GRAMMS recommendations for reporting mixed-methods research (O'Cathain et al., 2008).

Study setting

The study was conducted in Purwakarta District, West Java Province, Indonesia, which is one of the regions with fluctuating maternal mortality rates in recent years. Quantitative and qualitative data collection took place between 2023 and 2024.

Study population

1. Quantitative methods

The study population comprised all pregnant women receiving antenatal care at community health centers in Purwakarta District in 2023. Data were obtained from the medical records of mothers with maternal mortality events and favorable outcomes.

Inclusion criteria (cases)

Mothers with recorded maternal deaths at the community health centers and a history of antenatal check-ups.

Inclusion criteria (controls)

Mothers with favorable maternal and neonatal outcomes and a history of antenatal care.

Exclusion criteria

Mothers with incomplete medical records, who did not give birth in a health facility, or who did not have a history of antenatal care.

2. Qualitative Method

The population in this qualitative study comprised all individuals with direct involvement in antenatal care (ANC) services and maternal mortality in 2023. The study subjects were 13 informants selected through purposive sampling based on their involvement and experience. These included healthcare workers (doctors and midwives), maternal health program managers, patients' families, and pregnant women.

Inclusion criteria

Informants who were directly involved in antenatal care or the management of maternal mortality cases in 2023, were willing to participate, and provided relevant information in line with the research objectives.

Exclusion criteria

Informants who were unwilling to be interviewed, unable to communicate effectively, or who provided incomplete data.

Sample size

The sample size for this study was calculated using Fleiss's formula with continuity correction for an unpaired case-control study with a significance level of 5% ($\alpha = 0.05$), a power of 80% ($1 - \beta = 0.80$), and a case-to-control ratio of 2:1

The formula used is as follows:

$$\frac{n_1}{n_{\text{cases-Fleiss-cc}}} = \frac{2 \times (r + 1)}{4 \left[1 + \sqrt{1 + \frac{1}{n_1 \times r \times |p_1 - p_0|}} \right]}$$

Notes:

$n_{\text{cases-Fleiss}}$ = sample size

n_1 = the result of the calculation without correction, using the formula:

$$n_1 = \frac{[Z_{\alpha/2} \sqrt{(r + 1) \times p \times (1 - p)} + Z_{1-\beta} \sqrt{r \times p_0 \times (1 - p_0) + p_1 \times (1 - p_1)}]^2}{r \times (p_0 - p_1)^2}$$

Notes:

$Z_{\alpha/2}$ = Z-score 1.96 for a significance level of $\alpha = 0.05$

Z_{β} = Z-score 0.84 for a power level of 80%

p_0 = the proportion of controls exposed, i.e., 50%.

p_1 = proportion of cases exposed, i.e., 17.65% (Oktavianisya, 2016)

r = the ratio of controls to cases, which is 2.0

Based on the calculations, the minimum sample size for the case group was 28 subjects. However, only 24 cases were available, so total sampling was used. A total of 66 subjects were selected for the control group, bringing a total sample of 90 participants. The limited number of available cases may have affected the test power and the precision of the estimates.

Research Variables

The variables in this study consisted of a dependent variable, an independent variable, and covariates. The dependent variable was the incidence of maternal mortality. The main independent variable was the quality of antenatal care. The covariates included maternal age, parity, educational level, socioeconomic status, and comorbidities.

Operational Definition

The quality of antenatal care was defined as pregnancy check-ups that meet specific standards for monitoring the health of the mother and fetus. The components assessed included a minimum of six antenatal visits, the first visit before 12 weeks' gestation, at least two consultations with a doctor, physical examinations, supporting tests (routine blood tests, random blood glucose, and triple screening), education, and management. ANC was categorized as "good quality" if all components were fulfilled and "poor quality" if one or more components were not met. This approach was used to reflect adherence to standard antenatal care service requirement (Ministry of Health Republic of Indonesia, 2020).

Data Collection

1. Quantitative data

Quantitative data were obtained from medical records and the KIA booklet, recorded using data collection forms, and entered into spreadsheet software for further analysis. The data extraction form is provided as Supplementary File 1.

2. Qualitative Data

Qualitative data were obtained through in-depth interviews using a semi-structured guide developed specifically for this study, guided by the World Health Organization quality of care framework and Donabedian's structure-process-outcome model of healthcare quality assessment (Donabedian, 1988; World Health Organization, 2016). Interviews were conducted in person by trained researchers, and each interview was recorded (with permission) and transcribed verbatim. The English version of the interview guide is provided as Supplementary File 2.

Data Analysis

1. Quantitative Analysis

Data were analyzed using statistical software, including descriptive analysis, bivariate tests (chi-square), and multivariate analysis using logistic regression. Results were presented as odds ratios (OR) with 95% confidence intervals.

2. Qualitative Analysis

Qualitative data were analyzed using thematic analysis. The analysis process was supported by NVivo 12 Plus software for data management, theme grouping, and drawing conclusions. Interview recordings were transcribed verbatim and reviewed to gain a comprehensive understanding of the data. The analysis process involved initial coding, grouping codes into categories, and developing key themes. The qualitative findings were subsequently used to explain and elaborate on the quantitative results during the data integration stage.

Control of bias

To minimize potential bias, several steps were taken in this study. Selection bias was reduced by applying clear inclusion and exclusion criteria for the case and control groups. Information bias was minimized by using routinely documented medical records and standardized data extraction forms. To control confounding factors, multivariate analysis was performed using logistic regression adjusted for relevant covariates, such as maternal age, parity, educational level, and socioeconomic status

Data integration (Mixed-methods integration)

Data integration was carried out during the interpretation stage by comparing and linking quantitative and qualitative results. Qualitative findings were used to explain, deepen, and provide context for the statistically derived relationships. Subsequently, both sets of results were synthesized to construct a comprehensive conceptual model.

Ethical approval

This study received ethical approval from the Ethics Committee of the Faculty of Medicine, Public Health, and Nursing, Gadjah Mada University. All participants were provided with an explanation of the study, signed an informed consent form, and were assured of confidentiality.

Results

1. Participant Characteristics

A total of 90 study subjects were analyzed, comprising 24 cases and 66 controls. Participant characteristics are presented in Table 1 and include age, parity, educational level, and socioeconomic status. The distribution of characteristics showed variations across both groups.

Table 1. Participant characteristics

Category	f (n=90)	%
Age		
<20 years	7	7.8
20–35 years	61	67.8
>35 years	22	24.4
Education		
Did not complete primary school	0	0
Primary school	22	24.4
Lower secondary	23	25.6
Upper secondary	36	40.0
Academy/College	8	8.9
University	1	1.1
Employment		
Unemployed	70	77.8
Civil servants/Military/Police	4	4.4
Private sector employees	7	7.8
Self-employed	0	0
Farmers	0	0
Others	9	10.0
Husband's Education		
Did not complete primary school	0	0
Primary school	20	22.2
Lower secondary	20	22.2
Upper secondary	40	44.4
Academy/College	8	8.9
University	2	2.2
Husband's occupation		
Unemployed	0	0
Civil servants/Military/Police	2	2.2

Category	f (n=90)	%
Private sector employees	27	30
Self-employed	19	21.1
Farmers	1	1.1
Others	41	45.6
Economic Status		
<4,500,000	55	61.1
≥4,500,000	35	38.9
Parity		
Primipara	23	35.6
Multiparous	67	74.4
Delivery History		
Normal	62	68.9
CS (Caesarean section)	28	31.1

2. Characteristics of antenatal care

The characteristics of antenatal care are presented in Table 2 and include the frequency of visits, timing of the first visit, contact with healthcare workers, and the comprehensiveness of examinations and management. There were variations in the fulfilment of antenatal care standards between the case and control groups. A total of 60 respondents (66.7%) attended ANC visits at least 6 times during pregnancy. Furthermore, 65 respondents (72.2%) had contact with a doctor ≥2 times, while 55 respondents (61.1%) underwent ultrasound examinations ≥2 times during pregnancy. Regarding the provision of supplements or vaccinations ≥3 times, 52 respondents (62.7%) received them.

Table 2. Characteristics of Antenatal Care

Category	f (n=90)	%
ANC During Pregnancy		
<6 times	30	33.3
≥6 times	60	66.7
First ANC Visit		
First trimester	75	83.3
Second Trimester	12	13.3
Third trimester	3	3.3
Contact with Doctor		
<2 times	25	27.8
≥2 times	65	72.2
Physical Examination		
Yes	90	100
No	0	0
Supporting Tests		
Yes	78	86.7
No	12	13.3
Triple Elimination Test		
Yes	85	94.4
No	5	5.6
Ultrasound Scan		
<2 times	23	25.6
≥2 times	67	74.4
Supplementation & Vaccination		
<3 times	35	38.9
≥3 times	55	61.1
Administration of Treatment		
Yes	46	51.1
No	44	48.9

Category	f (n=90)	%
Counselling		
Yes	90	100
No	0	0
Other	41	45.6

3. Pregnancy Complications and Maternal Outcomes

The characteristics of pregnancy complications and maternal outcomes among respondents are presented in Table 3. The study results indicated that the maternal mortality rate among respondents was 24 cases (26.7%). This figure was associated with the high incidence of pregnancy complications, with 30 respondents (33.3%) experiencing such complications. The most common complication was pre-eclampsia, affecting 15 respondents (16.7%), followed by postpartum hemorrhage in 10 respondents (11.1%), eclampsia in 4 respondents (4.4%), and maternal infection in 3 respondents (3.3%).

Table 3. Pregnancy Complications and Maternal Mortality

Category	f (n=90)	%
Maternal Mortality		
Yes	24	26.7
No	66	73.3
Pregnancy Complications		
Yes	30	33.3
No	60	66.7
Pre-eclampsia		
Yes	15	16.7
No	75	83.3
Eclampsia		
Yes	4	4.4
No	86	95.6
Postpartum Hemorrhage		
Yes	10	11.1
No	80	88.9
Maternal Infection		
Yes	3	3.3
No	87	96.7

4. Bivariate Analysis

The results of the bivariate analysis using the chi-square test are presented in Table 4. This analysis was conducted to assess the relationships between the quality of antenatal care and management, pregnancy complications, and the incidence of maternal mortality. The results of the analysis indicated that the quality of antenatal care was significantly associated with maternal mortality ($p < 0.001$; OR 0.10; 95% CI 0.001–0.158). Respondents who received antenatal care in accordance with service standards had a lower risk of maternal mortality than those who did not meet the standards. Furthermore, the management variable also showed a statistically significant association with maternal mortality ($p < 0.001$; OR 7.692; 95% CI 0.278–72.87). Respondents who received substandard management had a higher risk of maternal mortality.

Pregnancy complications also showed a significant association with the incidence of maternal mortality ($p < 0.001$; OR 193.857; 95% CI 8.71–251.78). Respondents with pregnancy complications had a significantly higher risk of maternal mortality compared to those without complications. Other variables that did not show a statistically significant association were still considered in the multivariate analysis based on clinical and theoretical relevance.

Table 4. Chi-square Test Results

Variable	Maternal Mortality				Total	p	OR (95% CI)
	Yes		No				
	n	%	n	%			
Age							
Low risk	14	58.3%	47	71.2%	61 (67.8%)	0.248	0.566 (0.214–1.494)
High risk	10	41.7	19	28.8%	29 (32.2%)		
Economic Status							
< 4,500,000	17	70.8	38	57.6%	55 (61.1%)	0.254	1.789 (0.654–4.896)
≥ 4,500,000	7	29.2%	28	42.4%	35 (38.9%)		
Parity History							
Primipara	6	25%	17	25.8	23 (25.6%)	0.942	0.961 (0.328–2.818)
Multiparous	18	75%	49	74.2%	67 (74.4%)		
Delivery History							
Normal	13	54.2	49	74.2%	62 (68.9%)	0.069	0.410 (0.155–1.086)
SC	11	45.8%	17	25.8%	28 (31.1%)		
Comorbidities							
Yes	6	25%	6	9.1%	12 (13.3%)	0.076	3.333 (0.957–11.613)
No	18	75%	60	90.9%	78 (86.7%)		
Quality of ANC							
Good	2	8.3%	56	84.8%	58 (62.2%)	<0.001	0.016 (0.004–0.080)
Poor	22	91.7%	10	15.2%	32 (37.8%)		
Management							
Yes	20	83.3%	26	39.4%	46 (51.1%)	<0.001	7,692 (2,360–25,074)
No	4	16.7%	40	60.6%	44 (48.9%)		
Complications							
Yes	23	95.8	7	10.6%	30 (33.3%)	<0.001	193,857 (22,582–1,664,185)
No	1	4.2%	59	89.4%	60 (66.7%)		

5. Multivariate Analysis

The quality of antenatal care was significantly associated with maternal mortality ($p < 0.001$; OR = 0.10; 95% CI: 0.001–0.158) after controlling for other variables. The management variable did not show a statistically significant association ($p = 0.099$; OR = 4.50; 95% CI: 0.278–72.87). Pregnancy complications were significantly associated with the incidence of maternal mortality ($p < 0.001$; OR = 145.8; 95% CI: 8.71–251.78). The results of the multivariate logistic regression are presented in Table 5.

Table 5. Results of the Regression Correlation Test

Variable	P	OR	95% CI
Good ANC quality	0.001	0.10	0.001 – 0.158
Suboptimal management	0.099	4.50	0.278–72.87
Complications	<0.001	145.8	8. - 251.78

6. Qualitative Findings

A total of 13 informants participated in the in-depth interviews, comprising healthcare workers (doctors and midwives), maternal health program managers, family members of patients, and pregnant women. The characteristics of the informants are presented in the Table 6. The qualitative analysis identified several key themes influencing the quality of antenatal care. A summary of the themes and sub-themes is presented in the Table 7.

Table 6. Characteristics of Informants in In-depth Interviews

Informant	Education	Occupation
A1	Master's degree	Head of the Health Department
A2	Master's degree	Head of Community Health Centre
A3	Diploma 4	Head of Community Health Centre
A4	Bachelor's Degree	Community Health Centre Doctor
A5	Bachelor's degree	Community Health Centre Doctor
A6	Bachelor's degree	Community Health Centre Doctor
A7	Diploma 4	Midwife
A8	Diploma 4	Midwife
A9	Diploma 4	Midwife
A10	Lower Secondary School	Housewife
A11	Primary school	Housewife
A12	Upper secondary school	Housewife
A13	Upper Secondary School	Housewife

Table 7. Summary of Themes and Subthemes from the Qualitative Research

Theme	Subtheme	Quote	Notes
Health Resources	1. Human resources 2. Training and competence 3. Health facilities 4. Access	"As for training, I don't think there is any; awareness-raising occurs whenever a new edition of the MCHB is released" (A7)	Health workers' competencies were not yet optimal due to limited training.
ANC Services	1. Service location 2. Guidelines 3. Service process 4. Satisfaction evaluation	"There are no specific guidelines; everything is just done according to procedure, in line with the SOP" (A6)	ANC services were not yet consistently standardized.
Programme	1. Classes for expectant mothers 2. <i>Puskesmas</i> innovations 3. Health department program	"Well, thank God, this is a program we've been planning for a very long time—the <i>Indung Rahayu</i> program. <i>Indung Rahayu</i> protects pregnant women, newborns, and toddlers, and the 'yu' part stands for ' <i>Purwakarta Unggul</i> '" (A1)	The program was available but did not yet cover all aspects of ANC services
Management and Referral	1. Management of high-risk cases and emergencies 2. Referral and reverse referral systems	"So far, there haven't been any reverse referrals, have there, doctor?" (A4)	Management and referral still faced obstacles.
External Factors	1. Economic factors 2. Administrative factors 3. Social factors 4. Educational factors 5. Cultural factors 6. Cross-sectoral support and local policies	"Sometimes patients' willingness to attend a check-up or be referred depends on their husband's or family's permission; if it isn't approved, they postpone it" (A8) "Some families still believe that giving birth at home is more natural and safer" (A5)	External factors influenced access to and utilization of services.

These themes indicated that the quality of antenatal care was influenced by healthcare personnel, the healthcare system, and social factors that interacted with one another.

7. Integration of Quantitative and Qualitative Findings

Quantitative and qualitative findings were integrated to gain a more comprehensive understanding of the factors influencing maternal mortality. The integrated results are presented in the Table 8.

Table 8. Integration of quantitative and qualitative findings

Variable	Quantitative	Qualitative	Integration
Quality of ANC	Significant (p < 0.001)	Care was not up to standard	Suboptimal ANC increased the risk of death
Management	Significant (p < 0.001)	Management was suboptimal	Inadequate management increased the risk of death
Complications	Significant (p < 0.001)	Late detection	Complications increased the risk of death
Referral	-	Barriers to referral	Delayed referral worsened the condition
External factors	-	Low family knowledge and support	Affected access to services

Discussion

This study shows that the quality of antenatal care (ANC) is strongly associated with maternal mortality. Mothers who received high-quality ANC had a significantly lower risk of death compared with those who received low-quality ANC (p<0.001; OR = 0.10; 95% CI: 0.001–0.158). These findings suggest that the quality of care is a key determinant of maternal outcomes, rather than the number of ANC visits alone. In this study, the quality of ANC was assessed not only by the frequency of visits but also by the comprehensiveness of the care components received, including clinical examinations, diagnostic tests, education, and management. Thus, service quality in this context reflects a combination of structural, process, and clinical accuracy aspects in antenatal care.

These findings are consistent with previous research indicating that inadequacies in ANC components, including clinical and laboratory examinations, are associated with an increased risk of poor maternal and perinatal outcomes (Fonseca et al., 2014; Tuladhar & Dhakal, 2011). Other studies have also highlighted a gap between ANC service coverage and quality, where increased coverage does not necessarily lead to improved pregnancy outcomes (Amponsah-Tabi et al., 2022; Mandiwa & Namondwe, 2024).

In addition to ANC quality, pregnancy complications in this study were strongly associated with maternal mortality (p<0.001; OR = 193.857; 95% CI: 8.71–251.78). This substantially elevated odds ratio indicates

that mothers with complications face a markedly increased risk of death. However, these results should be interpreted with caution, given the wide confidence interval, which is likely influenced by the limited sample size and an unbalanced data distribution.

Although the wide confidence interval indicates variability in the estimates, the lower limit of the CI remains well above 1, supporting the strength of the association. These findings are consistent with the literature, indicating that obstetric complications, such as postpartum hemorrhage and anemia, are the leading causes of maternal mortality, particularly in developing countries (Nigussie et al., 2022; Lakew et al., 2024; Geller et al., 2018; Girum & Wasie, 2017).

On the other hand, clinical management was also found to influence the incidence of maternal mortality ($p < 0.001$; OR = 7.692; 95% CI: 0.278–72.87). Although the confidence interval crosses 1, indicating limitations in the precision of the estimate, the direction of the relationship suggests that inadequate management increases the risk of death. However, in multivariate analysis, the management variable did not show a statistically significant relationship. This may indicate that the effect of management likely interacts with or is mediated by other factors, particularly pregnancy complications. This suggests that maternal outcomes are determined not only by the presence of complications but also by the healthcare system's ability to respond to these complications appropriately and promptly. This is supported by research emphasizing the importance of the quality of the healthcare system and continuity of care in determining maternal outcomes (Shibanuma et al., 2021; Shiferaw et al., 2025).

These findings are reinforced by qualitative results indicating that the quality of ANC services is influenced by healthcare workers' competence, facility availability, and the effectiveness of the referral system. Furthermore, social, cultural, and perceptual factors regarding services also play a role in the utilization of ANC services (Jones et al., 2021), whereas limited access, education, and economic conditions also influence the utilization of maternal healthcare services (Mumtaz et al., 2019). Low awareness of obstetric danger signs also remains a challenge in efforts to prevent complications (Yunitasari et al., 2023).

If the three main factors in this study are considered together, it becomes apparent that maternal mortality results from a complex interaction among service quality, clinical conditions, and the health system's response. Poor-quality ANC can delay early detection of risks, leading to complications that are not optimally identified or managed. When complications do occur, outcomes are highly dependent on the quality of management and the effectiveness of the referral system.

The integration of quantitative and qualitative findings in this study reveals an interlinked mechanism, wherein suboptimal ANC quality contributes to delays in risk detection, which in turn increases the likelihood of complications and ultimately elevates the risk of maternal mortality.

To understand the interactions between clinical factors, the health system, and social factors identified in this study, these findings can be interpreted using the *Three Delays Model* framework (Thadeus & Maine, 1994). The study results indicate that mothers' low knowledge of danger signs, their perceptions

of services, and family support contribute to delays in decision-making (delay 1). Geographical barriers, transport limitations, and an underdeveloped referral system contribute to delays in reaching healthcare facilities (delay 2). Meanwhile, limitations in service quality, including the competence of healthcare workers and the availability of facilities and infrastructure, reflect delays in receiving adequate care (delay 3).

From a health system perspective, the findings of this study indicate that increasing service coverage alone is insufficient to reduce maternal mortality rates. Interventions that focus solely on improving access without addressing service quality may not yield optimal outcomes. Instead, more targeted efforts are required, including standardizing ANC services in accordance with guidelines, enhancing healthcare workers' competence through continuous training, and strengthening an effective, integrated referral system. This is also supported by research showing that technological interventions in ANC can improve risk detection but do not always lead to improved maternal outcomes unless accompanied by adequate service quality (Goldenberg et al., 2018; Mwakawanga et al., 2025). Conversely, community-based approaches have been shown to increase maternal and family engagement and the quality of the service experience (Jakubowski et al., 2024; Soepnel et al., 2024; Gebretsadik et al., 2025).

This study has several limitations that must be considered when interpreting the results. The use of quantitative data from medical records means that the completeness of the information is heavily influenced by the quality of healthcare workers' documentation, potentially introducing information bias. Furthermore, social variables and family support were not fully documented in the quantitative data and were explored more extensively through qualitative approaches. This study did not quantitatively analyze the referral system and access to healthcare facilities, nor did it distinguish between specific types of obstetric interventions, which may influence the interpretation of the results. Therefore, the findings of this study should be interpreted with care.

Overall, the findings of this study indicate that reducing maternal mortality requires a comprehensive approach encompassing clinical, health system, and social factors. Strengthening maternal mortality audits, improving the quality of ANC services, optimizing the referral system, and enhancing family education and involvement are important strategies for reducing maternal mortality.

Conclusion

The quality of antenatal care (ANC) plays a crucial role in reducing the risk of maternal mortality, with pregnancy complications being the primary clinical determinant. The findings of this study indicate that maternal mortality results from a complex interaction among clinical factors, the health system, and social factors, which can be explained by the *Three Delays Model* framework. Therefore, efforts to reduce maternal mortality require a comprehensive approach that not only increases service coverage but also focuses on service quality, strengthens the referral system, and raises family awareness and involvement.

Declarations

Human Ethics and Consent to Participate

This study was approved by the Ethics Committee of the Faculty of Medicine, Public Health, and Nursing, Universitas Gadjah Mada. All participants were informed about the study objectives and procedures, and written informed consent was obtained prior to participation. Confidentiality and anonymity of participants were strictly maintained throughout the study. All methods were performed in accordance with relevant guidelines and regulations, including the Declaration of Helsinki.

Conflict of Interest/Competing Interest

The authors declare that they have no competing interests.

Availability of Data and Materials

The datasets used and/or analyzed during the current study are available from the corresponding author on reasonable request.

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Consent for Publication

Not applicable

Authors Contribution

S.Z. and E.P. conceptualized and designed the study. S.Z. developed the methodology, performed the software-related work, conducted the formal analysis and investigation, managed resources, carried out project administration, and prepared the original draft of the manuscript. E.P. was responsible for validation, data curation, and study supervision. S.Z. also prepared the visualizations. All authors read and approved the final manuscript.

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