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# Analysis of Modifiable Factors of Maternal Mortality Based on AMP-SR in East Kalimantan Province, 2023–2024

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**ABSTRACT**

Maternal mortality remains a major public health concern in East Kalimantan Province, Indonesia, despite a decline in reported maternal deaths from 83 cases in 2023 to 74 cases in 2024. The implementation of Maternal and Perinatal Death Surveillance and Response (MPDSR), known in Indonesia as Audit Maternal Perinatal–Surveilans dan Respons (AMP-SR), aims to identify modifiable factors contributing to maternal deaths and inform targeted preventive interventions. This study aimed to examine the characteristics of maternal deaths according to the timing and location of death and identify contributing factors using the Three Delays Model. A descriptive-analytical case series design was employed using secondary data from the Maternal and Perinatal Death Notification (Maternal Perinatal Death Notification, MPDN) system for 2023–2024. The variables included maternal characteristics, pregnancy status at the time of death, location of death, antenatal care (ANC) attendance, birth attendants, and modifiable factors identified through AMP-SR reviews. The findings indicated that more than half of maternal deaths occurred during the postpartum period, while over 75% occurred in hospitals. These patterns highlighted the importance of examining third-delay factors related to the timely provision of appropriate care within healthcare facilities, although the location of death alone did not establish the presence of a third delay. Additionally, 44.6% of the women who died had not received ANC, indicating substantial gaps in antenatal healthcare utilization that may have contributed to delays in recognizing complications and seeking appropriate care. Approximately 6.8% of deaths occurred during referral transportation, suggesting potential challenges associated with the second delay, particularly timely access to appropriate healthcare facilities. Overall, the findings identified important opportunities to prevent maternal deaths by addressing modifiable factors across the continuum of maternal healthcare. Strengthening comprehensive emergency obstetric and neonatal care (Pelayanan Obstetri Neonatal Emergensi Komprehensif, PONEK), improving the quality of postpartum care, optimizing referral coordination, and increasing ANC coverage and continuity were identified as priority strategies for reducing maternal mortality in East Kalimantan Province.

## INTRODUCTION

Maternal mortality remains a pressing global public health challenge, reflecting persistent gaps in healthcare system performance and broader socioeconomic inequalities. Estimates from the World Health Organization (WHO) indicate that more than 700 women die each day from pregnancy- or childbirth-related causes, with a global maternal mortality ratio (MMR) of approximately 197 deaths per 100,000 live births. Despite an estimated 40% reduction in the global MMR since 2000, progress remains insufficient to achieve Sustainable Development Goal (SDG) Target 3.1, which aims to reduce the global MMR to fewer than 70 maternal deaths per 100,000 live births by 2030 (Organization, 2023a). Substantial geographical disparities also persist, with sub-Saharan Africa accounting for nearly two-thirds of maternal deaths worldwide (Khalil et al., 2023).

At the national and subnational levels, maternal mortality continues to pose a significant public health challenge in Indonesia. In East Kalimantan Province, the number of reported maternal deaths decreased from 83 cases in 2023 to 74 cases in 2024. Nevertheless, challenges remain in ensuring comprehensive maternal death investigations, identifying contributing factors, and implementing timely corrective actions based on surveillance findings (Syairaji et al., 2024). Regional evidence suggests that many maternal deaths are potentially preventable and are associated with a combination of healthcare system deficiencies, community-level barriers, and socioeconomic determinants (Syairaji et al., 2024).

Maternal mortality in East Kalimantan reflects the complex interaction of direct obstetric causes, including obstetric hemorrhage, hypertensive disorders of pregnancy, and maternal sepsis, as well as indirect medical causes and contributing health system factors, such as delayed referrals, inadequate antenatal care (ANC), and socioeconomic barriers to accessing healthcare services (Khalil et al., 2023; Souza et al., 2024). These factors may increase the risk of preventable maternal deaths, particularly when complications are not recognized promptly or appropriate emergency obstetric care is unavailable. Previous studies have emphasized that a substantial proportion of maternal deaths are associated with modifiable factors that can be addressed through improvements in healthcare quality, referral coordination, early complication detection, and multisectoral interventions (Souza et al., 2023; Souza et al., 2024).

Despite increasing national attention to maternal mortality prevention, provincial-level studies systematically examining modifiable factors through the Maternal and Perinatal Death Surveillance and Response (MPDSR) framework, implemented in Indonesia as Audit Maternal Perinatal–Surveilans dan Respons (AMP-SR), remain limited (Mathai, 2023). In particular, evidence regarding the contribution of preventable factors and healthcare access barriers to maternal deaths in East Kalimantan has not been comprehensively synthesized (Amalia et al., 2022; Organization, 2023b; Thaddeus & Maine, 1994; Vidler, 2023). The Three Delays Model provides a relevant analytical framework for identifying delays in deciding to seek healthcare (Delay I), reaching an appropriate healthcare facility (Delay II), and receiving timely and adequate care after arriving at a healthcare facility (Delay III). Examining these interconnected delays may provide valuable insights into weaknesses across the maternal healthcare continuum and identify opportunities for targeted interventions (Khalil et al., 2023; Syairaji et al., 2024).

Accordingly, this study aimed to describe maternal mortality patterns in East Kalimantan Province during 2023–2024 and identify modifiable factors contributing to maternal deaths using findings from AMP-SR reviews and the Three Delays Model. The urgency of this investigation arose from the continued occurrence of potentially preventable maternal deaths despite the reported decline in cases, as well as the need to strengthen the translation of maternal death surveillance findings into effective corrective actions (Hasjmy et al., 2022; Joseph et al., 2024; Kidanemariam et al., 2024; Lilis et al., 2023; Mary, 2024; Suparji et al., 2024). The study sought to contribute to the existing evidence by providing a province-specific assessment of maternal mortality characteristics and potentially modifiable factors across community, referral, and healthcare facility settings. From a policy perspective, the findings were expected to inform evidence-based planning, resource allocation, and targeted maternal mortality prevention strategies. From a clinical and healthcare management perspective, they were intended to support improvements in ANC utilization, emergency obstetric care, referral coordination, and the implementation of recommendations arising from maternal death reviews.

## METHOD

This study employed a descriptive case series design using secondary data from the Maternal and Perinatal Death Notification (MPDN) system in East Kalimantan Province, Indonesia. The study population comprised all maternal deaths reported between 2023 and 2024 that had undergone review through the Maternal and Perinatal Death Surveillance and Response (MPDSR) framework, locally known as Audit Maternal Perinatal–Surveilans dan Respons (AMP-SR). A total of 157 maternal deaths were analyzed, comprising 83 cases in 2023 and 74 cases in 2024. Cases were included if they had been documented in the MPDN system and reviewed through AMP-SR, while records with incomplete information required for analysis were excluded.

The variables examined included maternal characteristics (age and marital status), obstetric characteristics (gestational age and gravidity), timing of maternal death (during pregnancy, childbirth, or the postpartum period), location of death, antenatal care (ANC) attendance, delivery-related healthcare services, and modifiable factors identified through verbal autopsies and AMP-SR review findings. Data were analyzed using descriptive statistics and summarized as frequencies and percentages.

Modifiable factors were identified and categorized using the Three Delays Model, which encompassed delays in deciding to seek healthcare (Delay I), delays in reaching an appropriate healthcare facility (Delay II), and delays in receiving timely and appropriate care after arrival at a healthcare facility (Delay III). Ethical considerations were addressed by using anonymized secondary surveillance data without personally identifiable information.

## RESULTS AND DISCUSSION

A total of 157 maternal death cases were analyzed consisting of 83 cases in 2023 and 74 cases in 2024. The results describe key maternal death characteristics including demographic and clinical conditions, timing and place of death, antenatal care (ANC)

attendance, delivery service profiles, and modifiable factors identified through AMP-SR reviews.

**Table 1**. Characteristics of Maternal Death Cases in East Kalimantan, 2023–2024

| Characteristics | 2023 (n=83) | % | 2024 (n=74) | % |
|---|---|---|---|---|
| **Maternal Age (years)** | | | | |
| 10–19 | 4 | 4.8 | 5 | 6.8 |
| 20–35 | 48 | 57.8 | 44 | 59.5 |
| >35 | 31 | 37.3 | 25 | 33.8 |
| **Gestational Age** | | | | |
| <3 months | 4 | 4.8 | 4 | 5.4 |
| 4–6 months | 9 | 10.8 | 18 | 24.3 |
| 7–9 months | 58 | 69.9 | 21 | 28.4 |
| 10 months | 10 | 12.0 | 25 | 33.8 |
| Unknown | 2 | 2.4 | 6 | 8.1 |
| **Marital Status** | | | | |
| Married | 75 | 90.4 | 69 | 93.2 |
| Widow | 1 | 1.2 | 1 | 1.4 |
| Unknown | 7 | 8.4 | 4 | 5.4 |

Maternal characteristics are presented in Table 1. The majority of maternal deaths in both years occurred among women aged 20–35 years (57.8% and 59.5%, respectively), the age group categorized as lower-risk reproductive age in global maternal health standards (WHO, 2023). A shift in gestational age was observed, where most deaths in 2023 occurred during 7–9 months of gestation (69.9%), while in 2024 deaths at ≥10 months gestation increased (33.8%). More than 90% of the deceased women were married in both years, indicating that marital status alone does not serve as a protective factor against maternal mortality, consistent with previous findings in Indonesia (Suryati, 2021).

**Table 2.** Maternal Death Patterns Based on Clinical Events and Health Service Delivery in East Kalimantan, 2023–2024

| Variables | 2023 (n=83) | % | 2024 (n=74) | % |
|---|---|---|---|---|
| **Gravida** | | | | |
| 1 | 12 | 14.5 | 9 | 12.2 |
| 2 | 20 | 24.1 | 22 | 29.7 |
| 3 | 27 | 32.5 | 24 | 32.4 |
| 4 | 11 | 13.3 | 12 | 16.2 |
| >4 | 13 | 15.7 | 7 | 9.5 |

| Variables | 2023 (n=83) | % | 2024 (n=74) | % |
|---|---|---|---|---|
| **Timing of Death** | | | | |
| Pregnancy | 27 | 32.5 | 16 | 21.6 |
| During childbirth | 11 | 13.3 | 19 | 25.7 |
| Postpartum | 43 | 51.8 | 38 | 51.4 |
| Unknown | 2 | 2.4 | 1 | 1.4 |
| **Place of Death** | | | | |
| Home | 9 | 10.8 | 7 | 9.5 |
| In transit | 9 | 10.8 | 5 | 6.8 |
| Midwife practice | 0 | 0.0 | 1 | 1.4 |
| Clinic | 0 | 0.0 | 1 | 1.4 |
| Primary health center | 3 | 3.6 | 3 | 4.1 |
| Hospital | 62 | 74.7 | 57 | 77.0 |
| **Cause of Death** | | | | |
| Abortus complications | 1 | 1.2 | 3 | 4.1 |
| Hypertensive disorders | 20 | 24.1 | 15 | 20.3 |
| Hemorrhage | 21 | 25.3 | 18 | 24.3 |
| Infection | 3 | 3.6 | 3 | 4.1 |
| Other obstetric complications | 4 | 4.8 | 14 | 18.9 |
| Non-obstetric complications | 17 | 20.5 | 21 | 28.4 |
| Unknown | 17 | 20.5 | 0 | 0.0 |

Maternal death patterns related to reproductive history, timing of death, and place of death are shown in Table 2. More than half of maternal deaths occurred during the postpartum period (51.8% in 2023; 51.4% in 2024), highlighting the critical vulnerability of the first 42 days after delivery (WHO, 2023). The majority of deaths occurred in hospitals (>74%), suggesting that although most women eventually reached health facilities, timely and effective management remained insufficient to prevent deterioration (Say, 2022; Willcox, 2022). Hemorrhage, hypertensive disorders, and non-obstetric complications were the leading causes

of death, consistent with global maternal health patterns reported by WHO (2023), with non-obstetric causes showing a notable increase in 2024.

**Table 3.** Antenatal Care (ANC) Attendance Among Maternal Death Cases in East Kalimantan, 2023–2024

| ANC Frequency | 2023 (n=83) | % | 2024 (n=74) | % |
|---|---|---|---|---|
| Never attended ANC | 47 | 56.6 | 33 | 44.6 |
| 1–3 visits | 6 | 7.2 | 8 | 10.8 |
| 4–6 visits | 16 | 19.3 | 16 | 21.6 |
| >6 visits | 14 | 16.9 | 17 | 23.0 |

ANC attendance is illustrated in Table 3. A considerable proportion of deaths occurred among women with no ANC visits, although the percentage declined from 56.6% in 2023 to 44.6% in 2024. Additionally, an increase in deaths among mothers with >6 ANC visits was observed (from 16.9% to 23.0%), suggesting persistent gaps in the quality of ANC services rather than merely contact coverage (Suryati et al., 2021).

**Table 4.** Providers of Antenatal Care (ANC) Services Among Maternal Death Cases in East Kalimantan, 2023–2024

| ANC Provider | 2023 (n=46)* | % | 2024 (n=41)* | % |
|---|---|---|---|---|
| Nurse | 12 | 26.1 | 0 | 0.0 |
| Midwife | 2 | 4.3 | 21 | 51.2 |
| General Practitioner | 12 | 26.1 | 5 | 12.2 |
| Obstetrician-Gynecologist (SpOG) | 0 | 0.0 | 15 | 36.6 |
| Unknown | 10 | 21.7 | 0 | 0.0 |

Providers of ANC services are shown in Table 4. In 2024, more than half of mothers received ANC from midwives (51.2%) followed by obstetricians (36.6%), indicating improvements in access to skilled maternal healthcare providers aligned with international recommendations for maternal health services (WHO, 2023). Documentation quality also improved, as shown by the reduction in "unknown provider" cases compared to 2023.

**Table 5.** Delivery Place, Delivery Method, and Birth Attendants Among Maternal Death Cases in East Kalimantan, 2023–2024

| Delivery Characteristics | 2023 (n=32)* | % | 2024 (n=33)* | % |
|---|---|---|---|---|
| **Place of Delivery** | | | | |
| Home | 3 | 9.4 | 0 | 0.0 |
| Private midwifery clinic | 1 | 3.1 | 2 | 6.1 |
| Primary health center | 3 | 9.4 | 1 | 3.0 |

| **Delivery Characteristics** | **2023 (n=32)*** | **%** | **2024 (n=33)*** | **%** |
|---|---|---|---|---|
| Auxiliary PHC | 0 | 0.0 | 1 | 3.0 |
| Hospital | 25 | 78.1 | 29 | 87.9 |
| **Delivery Method** | | | | |
| Cesarean section | 13 | 40.6 | 14 | 42.4 |
| Vaginal delivery | 19 | 59.4 | 18 | 54.5 |
| Assisted delivery (vacuum/forceps) | 0 | 0.0 | 1 | 3.0 |
| **Birth Attendants** | | | | |
| Family | 2 | 6.3 | 0 | 0.0 |
| Traditional birth attendant | 1 | 3.1 | 0 | 0.0 |
| Midwife | 14 | 43.8 | 13 | 39.4 |
| General practitioner | 2 | 6.3 | 0 | 0.0 |
| Obstetrician-gynecologist (SpOG) | 13 | 40.6 | 20 | 60.6 |

Delivery characteristics of the maternal death cases are depicted in Table 5. Most deliveries were facility-based (78.1% in 2023; 87.9% in 2024), reflecting increased access to institutional childbirth as recommended by global maternal health standards (WHO, 2023). Deliveries attended by obstetricians increased substantially from 40.6% to 60.6%, yet maternal deaths remained high, suggesting persistent failures in early recognition of complications and delayed emergency response within health facilities (Say et al., 2022; Willcox et al., 2022).

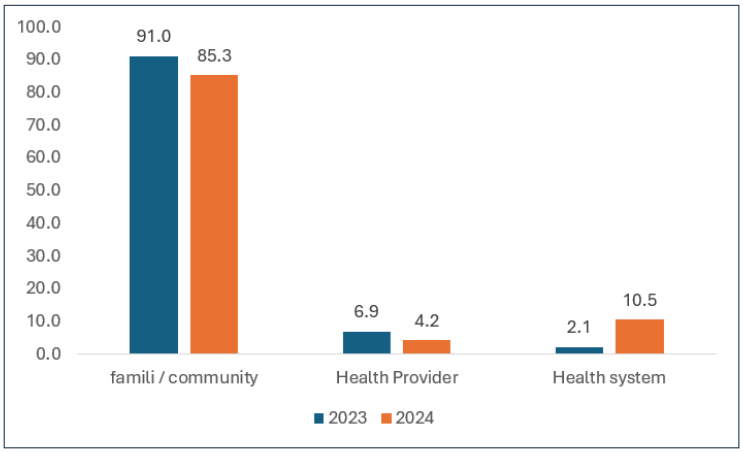



**Figure 1.** Comparison of Modifiable Factors Identified in AMP-SR Reviews of Maternal Deaths in East Kalimantan, 2023–2024.

Modifiable factors identified through AMP-SR reviews are presented in Figure 1. Family and community-related delays were dominant in both 2023 and 2024 (91.0% and 85.3%, respectively), confirming that Delay I remains the most significant contributor to maternal mortality in East Kalimantan (Say et al., 2022). Provider-related delays decreased from 6.9% to 4.2%, while system-related delays increased from 2.1% to 10.5%.

These findings indicate that delayed recognition of danger signs and late decision-making at the household level continue to drive preventable maternal deaths in the province, consistent with previous studies highlighting the influence of community behavior and low maternal health literacy (Suryati et al., 2021). Although less prevalent, Delay II was evident through the presence of deaths during transportation. Geographic barriers and suboptimal coordination in referral networks still hinder equitable and timely access to emergency obstetric services in remote regions (Maharani, 2023; Rahmawati, 2022).

Meanwhile, despite being smaller in proportion, Delay III cannot be disregarded due to the high concentration of deaths in hospital settings, indicating shortcomings in emergency obstetric readiness and timely clinical response (Willcox et al., 2022; WHO, 2023). Taken together, the results demonstrate that reducing maternal mortality in East Kalimantan requires integrated efforts across all three delays, with priority on improving community health literacy and ANC utilization to reduce Delay I, strengthening referral coordination and transportation systems to minimize Delay II, and enhancing the quality and timeliness of facility-based care to mitigate Delay III (WHO, 2023). Strengthening postpartum surveillance, including routine follow-up and early detection of complications in the early puerperal period, is also crucial to reduce the persistent postpartum mortality burden.

## CONCLUSION

The findings indicated that many maternal deaths in East Kalimantan Province during 2023–2024 were potentially preventable and associated with modifiable factors at the family, community, referral, and healthcare facility levels. Although most maternal deaths occurred in hospitals and during the postpartum period, delays in recognizing maternal complications and seeking appropriate healthcare may have contributed to adverse outcomes. Strengthening community health literacy, antenatal care (ANC) utilization, and birth preparedness is essential to reducing delays in deciding to seek care (Delay I). Improving referral coordination and access to reliable emergency transportation is equally important for minimizing delays in reaching appropriate healthcare facilities (Delay II). Furthermore, enhancing healthcare facility readiness, emergency obstetric care quality, and timely clinical management is necessary to address delays in receiving appropriate treatment (Delay III). Effective implementation of Audit Maternal Perinatal–Surveilans dan Respons (AMP-SR) should be supported by systematic follow-up actions, continuous quality improvement, and strengthened clinical governance to ensure that maternal death review findings are translated into measurable improvements across all levels of maternal healthcare.

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The author(s) declared that this work was conducted in the absence of any commercial or financial relationships that could be construed as a potential conflict of interest.

**AUTHOR CONTRIBUTIONS**

If applicable, the Author's Contribution Statement.

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The author(s) declared that generative AI was used in the creation of this manuscript. The author(s) wish to acknowledge the use of Generative AI for refining the language clarity and grammatical structure of this manuscript. This application was conducted in adherence to established ethical guidelines regarding the use and disclosure of generative AI in scholarly research. Each author has provided substantial intellectual contributions to the work, which has been rigorously vetted for accuracy, and the author(s) assume full responsibility for the integrity and final contentofthemanuscript.

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