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## Determinants of maternal mortality: Analysis of maternal characteristics and health service factors

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### ABSTRACT

Maternal health is a key indicator of public health status and a global priority in achieving the Sustainable Development Goals (SDGs), which aim to reduce the Maternal Mortality Ratio (MMR) to less than 70 per 100,000 live births by 2030. In Indonesia, the MMR remains high at 305 per 100,000 live births (SUPAS 2020). Maternal deaths are commonly caused by postpartum hemorrhage, hypertensive disorders of pregnancy, infections, and other comorbidities. Pekalongan Regency, Central Java, has shown fluctuating maternal mortality trends influenced by complex factors, including delays in medical treatment and limited health services. This study aimed to describe the determinants and causes of maternal mortality in Pekalongan Regency in 2024. A descriptive analytic design was used involving 18 maternal death cases. Data were collected through interviews with family members and health workers and through document reviews from the District Health Office, then analyzed using univariate analysis with SPSS version 23. The results showed that most maternal deaths occurred during the postpartum period (72%). The majority of mothers were aged 20–35 years (89%), had grand multiparity (50%), and had  $\geq 6$  antenatal care visits (67%). Comorbidities included hypertension (11%), infection (6%), and diabetes mellitus (6%). The leading cause of maternal death was severe preeclampsia (39%), followed by hemorrhage (11%) and infection (11%). Maternal mortality in Pekalongan Regency is influenced by both medical and non-medical factors; therefore, improving the quality of antenatal care, strengthening early risk detection, and enhancing the maternal referral system are essential strategies to reduce maternal mortality.



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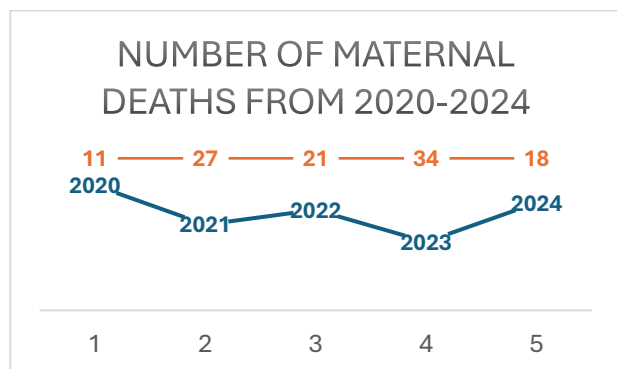
### 1. INTRODUCTION

Mothers have a strategic role in shaping the quality of human resources as the next generation of the nation. Optimal maternal health contributes to the birth of healthy and intelligent children, thereby impacting national development. In the health care system, mothers and children are priority groups that require continuous monitoring. This is important considering that the Maternal Mortality Rate (MMR) is one of the main indicators reflecting the health and welfare of a nation [1]. Maternal mortality remains one of the global health issues that receives significant attention in the context of achieving the Sustainable Development Goals (SDGs). The third SDG emphasizes the target of reducing maternal mortality to less than 70 per 100,000 live births by 2030. In Indonesia, despite various programs and policies being implemented to address it, maternal mortality rates remain at a high level. Data from the 2020 Intercensal Population Survey (SUPAS) shows that the national

maternal mortality rate reached 305 deaths per 100,000 live births, a figure that is still far from the expected target [2,3].

According to the definition of the World Health Organization (WHO), maternal death is a death that occurs during pregnancy up to 42 days after the end of the delivery period caused by conditions related to the pregnancy or its management, and not due to accidents or injuries [4]. In general, maternal mortality is divided into two categories, namely direct deaths and indirect deaths. Direct deaths are caused by complications that arise during pregnancy, childbirth, or the postpartum period, including as a result of improper medical actions or treatment during that period. Meanwhile, indirect deaths are caused by diseases that already existed before pregnancy or diseases that emerge during pregnancy, which worsen the mother's condition and affect the pregnancy [5].

Most maternal deaths are related to complications during pregnancy, childbirth, or the postpartum period. About 80% of maternal deaths are caused by complications such as postpartum hemorrhage, postpartum infection, hypertension during pregnancy (preeclampsia and eclampsia), and unsafe abortion. In Indonesia, the dominant causes of maternal death include postpartum hemorrhage, hypertension during pregnancy, and infection [1,6].



**Figure 1.** Number of Maternal Deaths in Pekalongan Regency from 2020 to 2024

Pekalongan Regency, as part of Central Java Province, faces maternal mortality issues similar to challenges in other regions. The annual report from the Pekalongan Regency Health Office shows that in recent years, maternal mortality rates have experienced fluctuating patterns with causes that are complex and multidimensional. Dominant medical factors include postpartum hemorrhage, eclampsia, infection, and various other obstetric complications. In addition, non-medical factors such as low maternal education levels, lack of awareness regarding the importance of antenatal care, limited access to health facilities, as well as economic and cultural factors also contribute to the high risk of maternal death [7,8].

One of the main problems often encountered is delays in medical care, known as the concept of the three delays, which are delays in recognizing danger signs, delays in reaching health facilities, and delays in receiving appropriate treatment. This condition shows that systemic factors in health services, such as the distribution of healthcare workers, availability of facilities, and effectiveness of the referral system, also play an important role in maternal mortality incidents [9].

Although various studies have examined the causes of maternal death, information describing maternal characteristics, the frequency of antenatal care (ANC) visits, pregnancy-related risks, direct causes of death, and comorbidities in maternal death cases in Pekalongan Regency remains limited. A more comprehensive study on the factors contributing to maternal death is needed to provide a clearer understanding of the conditions underlying these events. An analysis that includes maternal characteristics, antenatal care history, pregnancy risks, and comorbidities is expected to provide important information for planning interventions and

improving the quality of maternal health services at the regional level. This study aims to describe the factors that contribute to maternal mortality in Pekalongan Regency, which include age, parity, frequency of antenatal care (ANC) visits, risks during pregnancy, as well as the direct causes of maternal death.

Despite numerous studies on maternal mortality in Indonesia, most have focused on national trends or specific medical causes, while district-level studies providing a comprehensive description of maternal characteristics, ANC utilization, pregnancy-related risks, direct causes of death, and comorbidities remain scarce. Particularly, evidence from Pekalongan Regency is still limited. Therefore, a research gap exists regarding the lack of local and multidimensional evidence on factors contributing to maternal mortality. The novelty of this study lies in providing a comprehensive district-level description of maternal mortality cases in Pekalongan Regency by simultaneously analyzing maternal characteristics, antenatal care utilization, pregnancy-related risks, direct causes of death, and comorbidities. This multidimensional approach offers local evidence that may facilitate more targeted maternal mortality prevention strategies.

## 2. METHODS

### 2.1 Study Design

This study used a descriptive analytic design aimed at describing the determinants of maternal mortality in a district in Central Java Province, Indonesia, in 2024. The study analyzed various characteristics of maternal death cases based on data obtained from both primary and secondary sources to provide an overview of factors contributing to maternal mortality.

### 2.2 Setting and Participants

The study was conducted in a district located in Central Java Province, Indonesia. The study population consisted of all maternal death cases recorded in 2024 in the study area. The sample was selected using a total sampling technique, in which all maternal death cases that met the inclusion criteria were included in the study, resulting in a total of 18 cases.

The inclusion criteria included all maternal deaths occurring during pregnancy, childbirth, or within 42 days postpartum in 2024 with complete data records. Cases with incomplete or unverifiable data were excluded from the study.

### 2.3 Instruments and Measures

The instruments used in this study included a structured questionnaire and a checklist to collect information regarding maternal characteristics, pregnancy history, frequency of antenatal care (ANC) visits, pregnancy risk factors, and causes of maternal death. Data collection was also supported by a review of official documents obtained from maternal health

reports provided by the regional health authority. The collected data were categorized based on the study variables to facilitate data analysis and interpretation.

#### 2.4 Data Collection Procedure

Data collection was conducted in several stages. The first stage involved retrieving secondary data from maternal health reports available at the regional health authority. Subsequently, structured interviews were conducted with family members of the deceased and healthcare workers involved in the management of the cases, including those from primary healthcare facilities and referral hospitals. The data collection process was carried out systematically using questionnaires and checklist forms to ensure completeness and consistency of the required information.

#### 2.5 Data Analysis

The collected data were analyzed using univariate analysis to describe the frequency distribution of each study variable. The results were presented in the form of tables and graphs to facilitate interpretation. Data analysis was performed using the Statistical Package for the Social Sciences (SPSS) version 23.

### 3. RESULTS

**Table 1.** Maternal Deaths by Time of Occurrence

| Time of Death    | Frequency | Percentage (%) |
|------------------|-----------|----------------|
| During Pregnancy | 4         | 22             |
| During Labor     | 1         | 6              |
| Post Partum      | 13        | 72             |

Table 1 shows that the majority of maternal deaths (72%) occurred during the postpartum period.

**Table 2.** Maternal Deaths by Parity

| Parity          | Frequency | Percentage (%) |
|-----------------|-----------|----------------|
| Primigravida    | 3         | 17             |
| Multigravida    | 6         | 33             |
| Grandemultipara | 9         | 50             |

Table 2 shows that based on parity, half of the maternal deaths (50%) occurred among grand multiparous mothers.

**Table 3.** Maternal Deaths by Age

| Age         | Frequency | Percentage (%) |
|-------------|-----------|----------------|
| 20-35 years | 16        | 89             |
| >35 years   | 2         | 11             |

Table 3 shows that most maternal deaths (89%) occurred among mothers aged 20–35 years.

**Table 4.** Maternal Deaths by Frequency of Antenatal Care (ANC)

| ANC Frequency | Frequency | Percentage (%) |
|---------------|-----------|----------------|
| < 6           | 6         | 33             |
| ≥ 6           | 12        | 67             |

Table 4 shows that maternal deaths also occurred among mothers with ANC visits ≥6 times (67%).

**Table 5.** Maternal Deaths by ANC Risk Factors

| ANC Risk                                                  | Frequency | Percentage (%) |
|-----------------------------------------------------------|-----------|----------------|
| No risk identified                                        | 14        | 78             |
| Hypertension                                              | 2         | 11             |
| Infection (Tuberculosis, UTI, fever, breast cancer, etc.) | 1         | 6              |
| Diabetes Mellitus                                         | 1         | 6              |

Table 5 shows that most maternal deaths (78%) occurred among mothers with no identified risk during ANC visits.

**Table 6.** Maternal Deaths by Cause

| Cause of Maternal Death                  | Frequency | Percentage (%) |
|------------------------------------------|-----------|----------------|
| Hemorrhage                               | 2         | 11             |
| Severe Preeclampsia                      | 7         | 39             |
| Infection                                | 2         | 11             |
| Tuberculosis                             | 1         | 6              |
| Illeus                                   | 1         | 6              |
| Embolism                                 | 1         | 6              |
| ODUC (Obstetric Direct Underlying Cause) | 1         | 6              |
| Unclassified                             | 3         | 17             |

Table 6 shows that nearly half of maternal deaths (39%) were caused by severe preeclampsia.

### 4. DISCUSSION

#### Maternal Death Based on Its Timing

Research results show that the majority of maternal deaths occur during the postpartum period, totaling 13 people (72%), followed by the pregnancy period with 4 people (22%), and the least during labor with 1 person (6%). These findings indicate that the postpartum period is the most vulnerable phase for complications leading to maternal death. The postpartum period still contributes the most to maternal mortality due to the high cases of postpartum hemorrhage, infections, and delays in handling. Other studies show that continuous midwifery care can reduce maternal mortality during this period [10]. Other research shows that continuous midwifery care can reduce maternal mortality during this period [11].

Deaths during pregnancy (22%) are usually associated with chronic conditions such as

hypertension in pregnancy, preeclampsia-eclampsia, anemia, and complications from comorbid diseases. Analysis of the 2023 Indonesian health survey data confirms that pregnancy complications are greatly influenced by social, economic, and access to quality antenatal care factors (Bella Safhira & Nurmalia Ermi, 2024). Meanwhile, although the percentage of deaths at the time of delivery is relatively low (6%), this phase remains a critical period because complications can develop very quickly and be fatal. The effectiveness of the maternal referral system becomes a determining factor in the success of case management during delivery [12]. However, the implementation of health policies in Indonesia still faces challenges, particularly in the equitable distribution of skilled health workers in delivery facilities [13].

Overall, these findings reinforce the importance of interventions at three critical phases: before pregnancy (preconception care), during pregnancy (quality ANC), and especially after childbirth (postnatal care). Increasing intensive monitoring during the postpartum period, educating families about danger signs, and strengthening the referral system are strategic measures to reduce maternal mortality in Indonesia [14].

#### **Maternal Death Based on Parity**

The distribution of maternal deaths in this study shows that half of the cases occurred in the grand multipara group (50%), while multigravida accounted for one-third of the cases (33%), and the least in primigravida (17%). These findings confirm that the higher the parity, the greater the mother's vulnerability to complications. Grand multiparas are at high risk because repeated pregnancies can weaken the condition of the uterus and increase the chances of bleeding and placental disorders [15]. Meanwhile, multigravida faces risks that are influenced by previous obstetric experiences, such as a history of delivery with complications [11]. Primigravidas, although having fewer death cases, still have specific risks such as preeclampsia and prolonged labor due to physiological and psychological factors [16]. These results emphasize the importance of risk screening based on parity from the early stages of pregnancy, as well as family planning counseling to prevent the high number of grand multiparas that could potentially increase maternal mortality rates [12].

#### **Maternal Death by Age**

Research results reveal that the majority of maternal death cases occur in the 20–35 age group at 89%, while only 11% occur in the age group over 35 years. The 20–35 age group is generally considered the optimal reproductive age because the reproductive organs are in their best condition, with relatively lower risk of complications [17]. However, the high proportion of deaths in this age group indicates that simply being at a 'safe' age is not enough—other factors such as limited quality of

healthcare services, comorbidities, and delays in treatment also contribute [18].

Meanwhile, although the number of deaths at age >35 years is smaller, this group still has a significant risk—advanced maternal age is associated with an increased risk of hypertension, gestational diabetes, severe bleeding, and other delivery complications, especially if not accompanied by adequate antenatal monitoring [19]. Therefore, although the optimal reproductive age is the safest period, mitigating the risk of maternal death needs to emphasize the importance of service quality and quick response to complications, regardless of age.

#### **Maternal Death Based on ANC (Antenatal Care) Frequency**

Research results show that the majority of maternal deaths occurred in the group that made ANC visits  $\geq 6$  times (67%), while the group with  $< 6$  visits contributed 33% of cases. Ideally, a high frequency of ANC should provide a greater opportunity for early detection of complications—but this data shows that the number of visits alone is not enough [20]. The focus needs to shift to the quality of ANC services, ranging from physical examinations, laboratory tests, to nutritional counseling and preeclampsia detection. Studies show that factors such as physical access to facilities, ownership of health insurance, and mothers' knowledge about pregnancy issues have a significant influence on the completeness and usefulness of ANC, even in groups that have made  $\geq 6$  visits [21].

Other findings show that although the frequency of ANC is high, the incompleteness of service components—for example, hemoglobin checks, hypertension screening, and education on danger signs—can lead to missed risk detection, which ultimately affects pregnancy outcomes including maternal and infant mortality [22]. This is in line with research that emphasizes the importance of integrating the quality and completeness of ANC as an effort to prevent maternal and perinatal complications [23]. Thus, the results of this study reinforce that an increase in the number of ANC visits must be accompanied by an improvement in service quality, as well as strengthening the maternal referral system so that complications can be handled quickly and appropriately [20].

Many pregnancy risks require patients to be referred to higher-level healthcare facilities. Antenatal care (ANC) is one of the efforts to prevent undesirable health conditions by providing health promotion and information related to health during pregnancy, such as giving patients the opportunity to recognize danger signs of pregnancy. In addition, neonatal infection issues in developing countries are the second largest cause of high maternal mortality rates in the world. This is due to suboptimal management of conditions during pregnancy, both medical and non-medical, which can interfere with fetal development. Therefore, knowledge related to early detection of high-risk pregnancies should be possessed by



midwives so that high-risk pregnancy cases can be detected early [24].

#### **Maternal death based on risk during ANC**

Research results show that the majority of maternal deaths (78%) occurred in groups where no medical risks were found during antenatal care (ANC) examinations. This condition indicates that even if a mother does not show clinical risk factors, maternal death can still occur due to other factors that are often undetected during routine ANC screenings, such as delays in decision-making, delays in referrals, or limited access to health facilities. These findings are in line with other studies that confirm that the quality of ANC is not only determined by the frequency of visits, but also by the effectiveness in detecting both medical and non-medical risks that can affect pregnancy [25].

In addition, around 11% of maternal death cases are associated with hypertension during pregnancy. Hypertension is one of the main complications that can lead to preeclampsia or eclampsia, both of which contribute significantly to maternal mortality rates in Indonesia. Infection factors, such as tuberculosis, urinary tract infections, fever, or chronic diseases like breast cancer, were found in 6% of cases. Although the percentage is relatively small, infection conditions can worsen the health status of pregnant women by reducing body immunity and increasing the risk of obstetric complications. Global studies also emphasize that perinatal infections remain one of the significant causes of maternal mortality in developing countries [26].

Meanwhile, cases of diabetes mellitus were found in 6% of respondents. Both gestational and pregestational diabetes can increase the risk of complications in both mothers and babies, including macrosomia, preterm delivery, and perinatal death. This emphasizes the importance of monitoring blood glucose from early pregnancy and integrating chronic disease management into ANC services. This finding is reinforced by the increasing prevalence of non-communicable diseases, including diabetes, among pregnant women in Indonesia [17]. Thus, although most cases of maternal death in this study did not detect medical risks during ANC, it is important to broaden the perspective in antenatal services. The quality of ANC must be improved, not only for clinical screening but also to include social and behavioral aspects, as well as access to health services. Efforts to improve the quality of ANC, education on danger signs, and strengthening the referral system are strategic steps to reduce maternal mortality in Indonesia [27].

#### **Maternal Death Based on Its Causes**

Research results show that the leading cause of maternal death is severe preeclampsia, reaching 39%. This figure is much higher compared to the global average according to WHO, which is only around 14% [4]. These findings indicate that hypertension in pregnancy remains a serious health problem in the research area and requires more attention, especially in terms of early detection and management of

preeclampsia. This condition is also in line with research stating that preeclampsia is one of the leading causes of maternal mortality in Indonesia and needs to be managed comprehensively, from primary care to referral services [28]. Meanwhile, the proportion of deaths due to hemorrhage was 11%, which is actually lower than the global average of 27%. This difference can be explained by efforts to improve basic emergency obstetric services (PONED) as well as comprehensive ones (PONEK), which have been running quite well in several healthcare facilities. This is in line with research findings showing that the readiness of referral facilities plays an important role in reducing mortality from obstetric hemorrhage [28].

Maternal infections in this study were found to be 11%, almost the same as the global figure reported by the WHO, which is 10%. Pregnancy-related infections can include sepsis, tuberculosis, and undetected urinary tract infections. Research shows that tuberculosis in pregnant women contributes to serious obstetric complications and can worsen the prognosis for both mother and fetus. This underscores the importance of early detection of infections, especially in areas with a still high burden of infectious diseases. In addition, there is a proportion of other causes such as tuberculosis, ileus, embolism, and ODUK (Obstetric Direct Underlying Cause) totaling 24%. This figure is relatively higher compared to global reports, which are generally less than 5%. This difference may reflect local epidemiological variations as well as limitations in diagnosing maternal death causes in the field. Interestingly, there are still 17% of maternal death cases whose causes cannot be examined. This indicates limitations in the recording and reporting of maternal deaths.

#### **Implications and Future Research**

The findings of this study have several practical and policy implications. For healthcare professionals, particularly midwives and physicians, strengthening the early detection of preeclampsia through regular blood pressure monitoring, proteinuria screening, and education regarding pregnancy danger signs is essential. At the policy level, the local Health Office should prioritize hypertension prevention programs during pregnancy and ensure adherence to the 10T antenatal care (ANC) standards. In addition, strengthening the Maternal Perinatal Audit (MPA) system is necessary to improve the identification of causes of maternal death and support evidence-based interventions aimed at reducing maternal mortality. Future research should focus on identifying specific risk factors associated with the high incidence of preeclampsia among Indonesian women. Analytical studies involving biological, behavioral, socioeconomic, and health service factors are needed to provide a more comprehensive understanding of maternal mortality. Furthermore, multicenter studies involving several districts or provinces are recommended to compare maternal mortality patterns and generate broader evidence to support maternal health policies in Indonesia.

## 5. CONCLUSION

This study shows that maternal deaths most frequently occur during the postpartum period (72%), with the majority aged 20–35 years (89%), being grand multiparas (50%), and most having attended ANC visits  $\geq 6$  times (67%). Nevertheless, there are still risk factors such as hypertension (11%), infection (6%), and diabetes mellitus (6%), with the main cause of death being severe preeclampsia (39%), followed by hemorrhage and infection (each 11%). These findings confirm that a high frequency of ANC visits does not necessarily guarantee the prevention of complications, because the quality of care, particularly in early detection and management of preeclampsia, plays a greater role. The implication is the need to strengthen the quality of ANC based on the 10T standard, focusing on hypertension screening, education on danger signs, as well as optimizing maternal and perinatal audits to improve data accuracy and the effectiveness of interventions.

## DATA AVAILABILITY STATEMENT

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

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## CONFLICT OF INTEREST

The authors declare no competing interests.

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