



Factor Related to Maternal Mortality in Karawang District in Indonesia: Case-Control Study

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ABSTRACT

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Improving maternal health by reducing maternal mortality is one of the Millennium Development Goals. The goal is to significantly reduce maternal mortality. This study aimed to recognize risk factors for maternal mortality in Karawang Regency. A case-control study was conducted analyzing data from 108 maternal deaths (cases) and 216 pregnancies. Multiple logistic regression was used to identify significant risk factors. Research shows several risk factors for maternal death. Women aged 20 to 35 or older have a 2.55 times greater risk of death than women aged 20-34. Furthermore, delay in seeking help increased the risk by 6.21 times (ORA = 6.21, 95% CI = 2.17–17.77, P = 0.001). Furthermore, delay in coming to the community health center increases the risk by 5.35 times. This research highlights the importance of reducing maternal mortality rates in Karawang Regency, addressing the risks associated with increasing age, and reducing delays in seeking help and reaching health facilities. The finding of this research can help improve maternal health outcomes and form the basis of strategies to achieve the Millennium Development Goals.

1. INTRODUCTION

The National Long-Term Development Plan (NLTPD) in 2005 - 2025, that health development was carried out based on the empowerment of independence, fairness, and equitable, as well as prioritizing and benefiting mothers, infants, children, elderly people, and poor families [1]. The health improvement targets to be achieved by 2025 include: increasing life expectancy, reducing maternal mortality, reducing child mortality, and improving public health by reducing the prevalence of malnutrition among children under five. The National Medium-Term Development Plan (NMTDP) for 2020–2024 is the abbreviation for the National Medium-Term Development Plan; We have added an explanation of NMTDP, it is a five-year development planning document that elaborates on the elected president's vision, mission, and program under the guidance of the NLTPD for 20 years. Health promotion is an effort made by all elements of the nation, which aims to increase the awareness, willingness, and ability of every person to live healthily, to achieve the highest level of public health. In the national health system, health development managed sustainably is said to be successful in improving the level of public health [2].

SDG Target 3.1 is, by 2030, to reduce the maternal mortality ratio to less than 70 per 100,000 live births [3]. The maternal mortality rate in Indonesia shows a downward trend from 1992 to 2020. The results of the 2020 population census show that

the MMR is 189 per 100,000 live births [4-6].

Maternal mortality remains a problem and a challenge for health. The main targets of MDG 5 are to reduce maternal mortality by 75% between the years 1990-2015. Maternal Mortality rate (MMR) in Indonesia from 1992 to 2007 showed a decline, which in 1992 amounted to 425 per 100,000 live births to be at 228 per live births in 2007. However, it is still far from the target of the Ministry of Health the maternal mortality rate in 2015 to 102 per 100,000 live births. The Major causes of maternal mortality can be classified into direct causes and indirect causes of mortality, indirect and occur without foreseeable. The immediate cause of mortality is usually due to obstetric complications or chronic diseases that become more severe during pregnancy and end in mortality.

In the NMTDP Attachment, 2020 – 2024, it is stated that in fulfilling basic services, the level of health and education has improved, but has not yet reached the entire population. Maternal and infant mortality is still high. The capacity of health workers, maternity referral procedures and maternal and child healthcare and reproductive health care management is still not satisfactory.

Based on the Ministry of Health, 2021, In Indonesia, the MMR in 2019-2020 increased from 87.9 per 100,000 live births to 97.6 per 100,000 live births.

Based on National Health Research (Riskesdas), 2010, 55.4 percent of deliveries occurred in health facilities, 43.2 percent gave birth at home. Pregnant women who gave birth at home,

51.9 percent were helped by midwives, 40.2 percent by birth attendants. By province, the lowest birth attendance by health workers was in Southeast Sulawesi (8.7%), and the highest was in the Yogyakarta Special Region (94.5%). There is a very wide gap in the percentage of mothers giving birth in health facilities between urban and rural areas (74.9% versus 35.2%), as well as the level of expenditure, 37.9 percent of deliveries carried out in health facilities for quintile 1 compared to 80 percent for quintile [7]. Based on Riskesdas, 2018, 77.1 percent of deliveries occurred in health facilities, and 12.8 percent gave birth at home. Pregnant women who gave birth, 93.1% helped by health workers [8].

Besides, the cause of mortality background of the low levels of socio-economic, low levels of education, women's status, socio-cultural, and transportation, things that affect the appearance of unfavorable circumstances known to the three overdue is too late in seeking help; too late in reaching health facilities/issues transportation; late getting adequate service from the concierge and health facilities [9].

Maternal perinatal audit is an activity to retrace cause morbidity and maternal perinatal mortality to prevent morbidity and mortality in the future. Maternal and Perinatal Audit Program (MPA) is the program established to reduce maternal mortality and infant mortality rates by exploring preventable causes of death. MPA can be used to explore problems that contribute to the incidence of morbidity and mortality based on patients, families, health workers, service management, and service policies [10]. MPA programs in the Karawang district have been implemented since 1994, but there is still high maternal mortality and it is still concentrated in issue and strategic issues in the Karawang regency. Therefore, it is necessary to increase efforts to accelerate the decline in maternal mortality, one of them with the identification of risk factors for maternal mortality [11].

The Childbirth Planning and Complication Prevention (CPCP) program is an effort to accelerate the reduction in maternal and newborn mortality rates by increasing access and quality of antenatal services, birth assistance, prevention of complications, and family planning by midwives.

Studies in the district of Rajasthan India, with a cases control study, obtained that the maternal mortality rate was estimated at 519 (95% CI 477-651). Bleeding causes 31% of maternal mortality, other causes are jobs, anemia, sepsis, and abortion. Complications during the antenatal period are an important predictor for maternal mortality (OR = 2.5, 95% CI= 1.6 -3.4). Childbirth at home (OR= 4.4, 95% CI= 3.3 - 5.5) is associated with the risk of maternal mortality.

According to Sample Registration System (SRS), the major cause of maternal mortality hyperdense in pregnancy (37,4%), maternal hemorrhage (16.9%), and maternal sepsis and maternal infections (11.5%) [12]. This study aims to identify factors related to maternal mortality in Karawang district.

1.1 Maternal mortality in Indonesia and Karawang district

Maternal mortality is still an urgent public health problem in Indonesia, especially in rural and underdeveloped areas. According to the World Health Organization (WHO), Indonesia's maternal mortality ratio (MMR) was 184 deaths per 100,000 live births in 2020. Karawang district, located in West Java province, had a higher death rate of 211 per 100,000 live births, which exceeds the national average [13].

1.1.1 National priorities and targets

The Indonesian government has set ambitious targets to

reduce maternal mortality through the National Long-Term Development Plan (RPJP) 2005-2025 and the Medium-Term Development Plan (RPJMN) 2020-2024. Specifically, the RPJMN aims to reduce MMR to 135 deaths per 100,000 births by 2024. However, to achieve this goal, it is necessary to address the main causes of maternal death, especially in high-risk areas such as Karawang [14].

1.1.2 The burden of maternal mortality

Karawang Regency recorded 43 maternal deaths in 2020 accounting for 12% of all maternal deaths in West Java province. The maternal mortality rate in this district has gradually decreased, from 240 per 100,000 births in 2015 to 211 in 2020. The main causes of maternal death in Karawang Regency are postpartum hemorrhage (35%), hypertension (25%), and complications during childbirth (20%) [15].

1.2 Background and problem statement

Maternal mortality is an urgent public health problem worldwide, especially in low- and middle-income countries. Indonesia, with a maternal mortality rate (MMR) of 184 deaths per 100,000 live births (2020), faces significant challenges in reducing maternal mortality. Karawang Regency, located in West Java Province, has one of the highest MMR districts in the region, with 211 deaths per 100,000 births (2020). These alarming statistics underscore the need for targeted interventions to address the leading causes of maternal death [16].

1.3 Rationale and significance

The World Health Organization (WHO) has estimated that although most maternal deaths are preventable, delays in access to health services, access to health facilities, and access to quality services are the main drivers. In Indonesia, the leading causes of maternal death are postpartum hemorrhage, high blood pressure, and obstetric complications. Understanding the risk factors associated with maternal death is essential to formulating effective strategies to reduce maternal death [17].

1.4 Research objectives

This study aims to bridge the knowledge gap by identifying risk factors affecting maternal mortality in Karawang Regency. Specifically, this study attempts [18]:

- To identify socioeconomic and clinical risk factors associated with maternal mortality in Karawang Regency
- To determine the relationship between delays in seeking help, delays in reaching the health center and maternal death.
- Provide evidence-based recommendations to improve maternal health outcomes in Karawang district.

2. METHODS

This study used a case-control design and was done retrospectively, with interview respondents representing the case and control groups. Case-control design can be used to assess how a factor is a risk to the event to study and evaluate the strength of the relationship from a risk factor for the dependent variable). In this research, characteristics of maternal, age of the mother, three delays in seeking health

facilities, and education are risk factors, whereas maternal mortality is a dependent variable [19, 20].

According to the report of the District Health Office, it was defined as maternal deaths that occurred in Karawang district between January 1 and December 31, 2020. Maternal mortality was defined according to World Health Organization (WHO) criteria as: "Death of a woman while pregnant or within 42 days of pregnancy termination, regardless of the duration and place of pregnancy, regardless of the duration and place of pregnancy [21].

Controls were defined as women who gave birth and survived during the same period (January 1, 2020, to December 31, 2020) in Karawang Regency. Controls were selected from the same health facility using a random sampling method [22].

The group of cases of maternal mortality was obtained from verbal autopsy data in the MPA program in Karawang district in 2009-2010 [23]. The control group is women who are pregnant, gave birth in the same period by case, live in the same village, is nearest neighbors of cases of maternal mortality are experiencing pregnancy, childbirth, and postpartum at the same time with the mortality and it is still alive to this research.

Limitations of cases and control were women who died in the process of pregnancy, childbirth, and 42 days after postpartum, known through verbal autopsy data, maternal mortality in Karawang district from January 2009 up to December 2010. While the controls are mothers still alive to this research, fieldwork and experience the process of pregnancy, childbirth, and 42 days after postnatal in the same period in the event of maternal mortality in the case, lived in the same village with the case, and was selected as a control.

The study was conducted in Karawang district, with cases of maternal mortality across 39 primary health centers and in 30 districts for 6 months. Maternal mortality data in Karawang district from January 2009 to December 2010 there were 108 maternal mortality and conducted searches and interviews of the whole case, and conducted to control as much as 2 times the number of cases at 216 controls [24, 25]. Thus, the total MPA of 324 respondents.

Data Collection and Sources: Information was collected through oral autopsy interviews, household surveys, and medical record reviews. The data sources were oral autopsy data from the Karawang District Health Office, the MPA program, and household surveys conducted by trained field officers. By clearly defining and managing the independent variables, the purpose of this study was to provide a reliable and generalizable picture of the risk factors associated with maternal mortality in Karawang District [26].

The sample size was calculated using the formula for case-control studies. Assuming a 1:2 case-to-control ratio, a significance level of 0.05, and a power of 80%, we estimated a minimum sample size of 108 cases and 216 controls to detect an odds ratio of 2.0 [27].

Inclusion criteria were maternal mortality contained in the verbal autopsy data MPA in the period January 2009 to January 2010, the maternal mortality that occurs during pregnancy, childbirth, and postpartum, is willing to be the subject of research. Whereas exclusion criteria were maternal deaths are caused by accidents and other incidental events that are not related to the cause of mortality either directly or indirectly, during pregnancy, childbirth, and postpartum resulting in mortality, was not willing to be the subject of research [28].

To reduce misclassification, multiple respondents, including family members and caregivers, were interviewed to triangulate information and increase accuracy. Causes of death were coded using the International Classification of Diseases (ICD-10) to ensure consistency and comparability. Additionally, sensitivity analyses were performed to assess the impact of potential misclassification on study outcomes, and causes of death were reviewed and validated by an expert panel [29].

Despite these measures, limitations of the VA data remain, including subjective reporting and information bias caused by social and cultural factors. VA data were compared with facility records to verify accuracy when available. Recognizing these limitations and implementing data quality assurance measures, this study aims to provide reliable estimates of maternal mortality in Karawang district [30].

Data quality measurements were performed by the World Health Organization (WHO) Oral Autopsy Standards. The validity of the VA method has been demonstrated in previous studies [31]. Sulaiman Using these steps, this study aims to reduce potential bias and provide an accurate picture of the maternal mortality rate in Karawang Regency.

Data were analyzed to determine the relationship between risk factors and maternal mortality. Logistic regression was used to analyze the relationship between individual risk factors and maternal mortality [32].

The data analysis was carried out in two phases. Initially, several analyses were performed to calculate odds ratios (OR) and determine the degree of association between risk factors and maternal mortality. Next, a multivariate analysis was performed using multiple logistic regression to identify significant risk factors associated with maternal mortality, considering variables with p less than 0.25 [33].

In the bivariate analysis, variables with a p -value below 0.25 were included in the multivariate analysis. This threshold was chosen based on the empirical experience of previous studies, which shows that a p -value of 0.05 cannot capture significant independent variables [34].

2.1 Variable measurement and operationalization

2.1.1 Independent variables

This study tested several independent variables to assess their relationship with maternal mortality. Maternal age was classified into three groups: adolescents (< 20 years), adults (20-34 years), and advanced maternal age (≥ 35 years). Education was divided into low (not only formal education or primary education), middle (secondary) and high (high or tertiary education) [35].

Economic status is measured using a composite index that includes monthly family income, property ownership, and occupation of the household head. Principal component analysis (PCA) is used to classify economic conditions into low, medium and high. Parity was defined as the number of previous births and included primiparous (1-2 previous births), multiparous (3-4 previous births) and primary multiparous (≥ 5 previous births) [36].

Antenatal care (ANC) visits were categorized as sufficient (< 4 visits), inadequate (4-7 visits), and excessive (≥ 8 visits). The distance to the health center was measured in kilometers and classified as < 5 km, 5-10 km and > 10 km. Three delays (seeking health services, reaching a health center and receiving services) were measured as binary variables (yes/no) [37].

Verbal autopsy (VA) data used to identify maternal deaths

in this study have been widely used to determine reasons of death in low- and middle-income countries. However, there are concerns about data quality and potential misclassification. To overcome this problem, trained interviewers conducted VA interviews using standardized questionnaires, and the information was verified by experienced researchers [38].

2.1.2 Statistical analysis

Data is entered into the computer after being edited and verified by the researcher. Data is processed using a computer with Logistic Regression analysis to see the relationship between risk factor variables and outcome variables (maternal mortality). Then the data is processed with Multiple Logistic Regression. Data analysis was carried out in stages from the bivariate and multivariate analysis. In the bivariate analysis, an output in the odds ratio (OR) will be presented. OR is a measure obtained from a study with a case-control design and the results as a risk of obtaining an outcome when exposed to the independent variable. This bivariate analysis aims to find out the magnitude of the relationship between the odds ratio. Then data analysis by Multivariate Analysis, from the results of a bivariate analysis, candidates will be known to be included in multivariate analysis. Multivariate analysis (MVA) techniques allow more than two variables to be analyzed at once. Two general types of MVA techniques: Analysis of dependence & Analysis of interdependence. The technique is selected depending on the type of data and the reason for the analysis. The independent variables included in the multivariate analysis are variables that have a p-value of 0.25. Factor Related of $p < 0.25$ based on empirical experience from various previous studies, where the value of entering $p, 0.05$ is often not successful in identifying independent variables that are considered important [39, 40]. This study uses logistic regression analysis to examine the relationship between risk factor variables and maternal mortality. The model-building process involved a stepwise selection process where variables were selected according to the results of bivariate analysis (p -value < 0.25), theoretical significance for maternal mortality, and absence of multicollinearity (variables), inflation factor < 5) [41].

2.1.3 Variable selection criteria

In the bivariate analysis, variables with a p -value < 0.25 were considered for inclusion in the multivariate model. This threshold was chosen based on empirical experience from previous studies, which showed that a p -value of 0.05 may not capture important independent variables. Variables with a p -value ≥ 0.25 were eliminated [42].

2.1.4 Model building and fit

Multivariate analysis was performed using multiple logistic regression. Model fit was assessed using the Hosmer-Lemeshow goodness-of-fit test and the receiver operating characteristic curve (AUC-ROC). Diagnostic statistics include odds ratios (OR) with 95% confidence intervals and coefficient estimates with standard errors [43].

2.1.5 Model diagnostics

The efficiency of the final model was evaluated using diagnostic statistics, including Akaike Information Criteria (AIC) and Bayesian Information Criteria (BIC). This measure helps identify the most parsimonious model and adequately explains the association between risk factors and maternal mortality [44].

2.1.6 Ethical approval

This study was approved by the Research Expert Committee and Research Ethics, Public Health Faculty, the University of Indonesia with reference number no. 022/HF10/PPM.00/365.

3. RESULTS

Distribution of maternal mortality characteristics as shown in Table 1, the total number of maternal mortality examined in Karawang regency over 2 years (2009 – 2010) were all 108 maternal deaths, sourced from verbal autopsy data from the Maternal Perinatal Audit (MPA) program. While the control is 2 times, so the number of respondents for control is 216 respondents. Control can be obtained by asking the respondent who represents the case, the closest neighbor who experienced pregnancy, childbirth, and postpartum at the same time as the maternal mortality event and was justified by the local village midwife. Overall respondents in this study amounted to 324 which included 108 maternal mortality cases and 216 controls. Maternal mortality cases are very widespread in various regions in Karawang regency, spread in 30 sub-districts and 39 primary health care [45].

3.1 Bivariate analysis

Maternal mortality risk factors as shown in Table 2. subgroup compared with each group, less educated mothers, less educated husbands, and those with low economic status appear to have a greater risk of maternal mortality. The situation here is nearly identical to that of seven low-income nations: the probability of maternal death decreases with education level [46]. Sociological variables for group membership family member and maternal parity, it appears that women who experienced maternal death and maternal death are not distributed equally in terms of family planning and parity.

Mother's education is the highest education based on the certificate. High education includes University and High school and Low education includes no school, elementary school, or middle school. Economic status is a general description of the respondent's family economy which is measured based on ownership of several household items. The equipment is home ownership (score 2) Land ownership (score 2), Car ownership (score 1), Motorbike ownership (score 1), Electricity (score 1), and Telephone (score 1). Ordinal scale: Category: Low Economy include [0 = low (score 0-1) and 1 = moderate (score 2-3)] and high economy include [2 = high (score 4-6)]. Family planning participation means the mother was a family planning participant before her last pregnancy.

Table 3 shows that for subjects who suffer pregnancy complications when compared with labor if reference each group, mothers who experienced complications seem to have a greater risk of maternal mortality. Mothers who did not do antenatal care (ANC), and no Childbirth Planning and Complication Prevention (CPCP) get a referral CPCP, get a referral, where no health facilities delivery and delayed health services appear to have a higher risk of maternal death. The danger of maternal death due to ANC visits < 4 times is 2 times greater than conditions in LMICs which have an OR of 1.3 times compared to mothers with ANC visits ≥ 4 times. Frequency ANC, CPCP, and variable references between cases and controls was no difference between cases and controls.

Table 1. Distribution of maternal mortality characteristic

No.	Sub Districts	Primary Health Care	Cases	Control
1	Karawang Timur	Plawat	8	16
		Adiarsa	4	8
		Majalaya	1	2
2	Batu Jaya	Batu Jaya	6	12
		Klari	8	16
4	Rengasdengklok	Rengasdengklok	4	8
		Medang Asem	1	2
		Kalangsari	1	2
5	Cibuaya	Cibuaya	6	12
6	Tegalwaru	Loji	2	4
7	Karawang Barat	Karawang Kulon	1	2
		Tunggakjati	1	2
		Karawang	1	2
		Nagasari	1	2
8	Jayakarta	Jayakarta	2	4
9	Pakisjaya	Pakis Jaya	6	12
10	CikMPAek	CikMPAek	3	6
11	Gempol	Gempol	2	4
12	Banyusari	Cilamaya	2	4
13	Lemah abang	Lemah abang	5	10
14	Telagasari	Telagasari	3	6
15	Cilamaya wetan	Sukatani	1	2
16	Anggadita	Anggadita	3	6
17	Kotabaru	Kotabaru	1	2
18	Cilamaya kulon	Pasir ukem	2	4
		Bayur Lor	3	6
		Curug	2	4
19	Klari	Curug	2	4
20	CikMPAek	Tirtamulya	2	4
21	Teluk jambe timur	Teluk jambe	3	6
22	Kutawaluya	Kutamukti	2	4
		Kutowaluya	4	8
23	Pedes	Pedes	3	6
24	Tempuran	Tempuran	1	2
25	CiMPAel	CiMPAel	5	10
26	Jatisari	Jatisari	2	4
27	Rawamerta	Rawamerta	2	4
28	Teluk jambe timur	Wadas	2	4
29	Teluk jambe barat	Wanakerta	1	2
30	Tirtamulya	Tirtamulya	1	2
Total number of case-control respondents			108	216

Source: Prepared by the author, (2024)

Table 2. Several demographic, characteristics and risks of maternal mortality

	Control (n=216)		Case (n=108)		Crude Odd Ratio	95% Confidence Interval	P
	N	%	n	%			
Mother age							
21-34 year	43	47.3	48	52.7	0.430	Reference	
< 20 and > 30 year	64	27.85	166	72.2	1.00	0.260-0.710	0.001
Education of Mother							
High	100	46.3	38	35.2	1.00	Reference	
Low	116	53.7	70	64.8	1.59	0.99-2.56	0.074
Education of Father							
High	105	48.6	34	31.5	1.00	Reference	
Low	111	51.4	74	68.5	2.05	1.27-3.35	0.005
Economic Status							
High	63	29.2	21	19.4	1.00	Reference	
Low	153	70.8	87	80.6	1.71	0.98-2.99	0.080
Family planning							
Yes	134	62.0	64	59.3	1.00	Reference	
No	84	38.0	44	40.7	1.12	0.70-1.80	0.717
Parity						Reference	
2-3	113	52.6	51	47.2	1.00	0.70-3.70	0.455
1 & > 4	103	40.3	57	52.8	0.89		

Source: Prepared by the author, (2024)

Table 3. Factors associated with maternal mortality

Factor	Control (n=216)	Case (n=108)	Crude OR (95% CI), p-Value
		Complication ¹	
No.	155 (71.8%)	19 (17.6%)	Reference
Yes	61 (28.2%)	89 (82.4%)	11.9 (6.68-21.20), p < 0.001
		Frequency of ANC ²	
≥4 times	183 (84.7%)	22 (40.3%)	Reference
<4 times	33 (15.3%)	86 (79.7%)	3.05 (1.22-3.74), p = 0.011
		CPCP ³	
Yes	59 (27.3%)	18 (16.7%)	Reference
No	156 (72.7%)	90 (83.3%)	1.88 (1.04-3.38), p = 0.047
		Referral ⁴	
No	87 (40.3%)	10 (9.3%)	Reference
Yes	129 (59.7%)	98 (90.7%)	6.61 (3.27-13.38), p < 0.001
		Birth Attendance ⁵	
Health Worker	200 (92.6%)	95 (88.0%)	Reference
Non-Health Worker	16 (7.4%)	13 (12.0%)	1.71 (0.79-3.70), p = 0.042
		Place of Maternity ⁶	
Health Facility	174 (80.6%)	103 (95.4%)	Reference
Non-Health Facility	42 (19.4%)	5 (4.6%)	0.20 (0.07-0.53), p = 0.001

*Note: 1: Complication: No; 2: Frequency of ANC: ≥4 times; 3: CPCP: Yes; 4: Referral: No; 5: Birth Attendance: Health Worker; 6: Place of Maternity: Health Facility
Source: Prepared by the author, (2024)

3.2 Multivariate analysis

Table 4 shows factors too late in seeking help and not too late in seeking help between cases and controls have value OR 6.21, meaning that women who delayed seeking help than those who are not a too late cause of maternal mortality 6.21 times

As for the late in reaching health facilities and are not too late in reaching health facilities, between cases and control had an OR of 5.35 means that mothers who are late in reaching health facilities than those not too late in reaching health facilities cause of maternal mortality risk 5.35 times.

Table 4, which is the final model shows that in terms of maternal age, mothers aged < 20 years and ≥ 35 years had a higher risk of maternal mortality compared to mothers aged 20-34 years, having a risk respectively 2.55 times lead to maternal mortality. If the terms of a delay in seeking help, the subjects were too late to get help than those who were not late to get help at the risk of 6.21 times result in maternal mortality. If the terms of the delay in reaching health facilities, whose mother late than those who were no too late in reaching health facilities at risk 5.35 times result in maternal mortality.

Limited data are sourced on maternal mortality from the data of MPA programs, likely underreported, which means not all maternal mortality was reported. Selection bias may occur in the selection of controls, controls selected from the same population as the case, exposed to a similar risk with the case and stay in the same area as the cases. To gain control compared with the case should be traced to a hospital or other medical facility, to get the control that has the same characteristics with the case, but it certainly takes effort and more power. Because of the limitations in the research, both personal and other efforts, resulting in the selection of limited control by asking the respondents representing cases, the nearest neighbor whose experience of pregnancy, childbirth and postpartum at the same time with the mortality, stay the same village territory and still live up to this study. Recall bias may occur due to exposure to the subjects forgetting about the variables in question. This could happen if the distance to the timing of the exposure time is too long, resulting in respondents forget. In this study, conducted restrictions interval between exposure to the exposure time is the time span of 1 to 2 years [47].

Table 4. Factors associated with maternal mortality

Factor	Control (n=216)	Case (n=108)	Adjusted OR (95% CI)	p-Value
		Age of Mother ¹		
21-34	167 (77.3%)	64 (59.3%)	1.00	Reference
20 & > 35	49 (22.7%)	44 (40.7%)	2.55 (1.27-5.10)	0.008
		Complication ²		
No	155 (71.8%)	19 (17.6%)	1.00	Reference
Yes	61 (28.2%)	89 (82.4%)	6.03 (2.98-12.24)	0.000
		Referral ³		
No	87 (40.3%)	10 (9.3%)	1.00	Reference
Yes	129 (59.7%)	98 (90.7%)	2.85 (1.18-6.89)	0.020
		Late in Seeking Help ⁴		
No	210 (97.2%)	59 (54.6%)	1.00	Reference
Yes	6 (2.8%)	49 (45.4%)	6.21 (2.17-17.77)	0.001
		Late in Reaching Health Facilities ⁵		
No	192 (88.9%)	45 (41.7%)	1.00	Reference
Yes	24 (11.1%)	63 (58.3%)	5.35 (2.45-11.62)	0.000

*Note: 1: Age of Mother: 21-34 years; 2: Complication: No; 3: Referral: No; 4: Late in Seeking Help: No; 5: Late in Reaching Health Facilities: No
Source: Prepared by the author, (2024)

4. DISCUSSION

4.1 Study results in context

The results of the study on the association between maternal age, education and economic conditions with maternal mortality are in accordance with existing literature. The danger of maternal death in adolescents and women aged ≥ 35 years is in line with previous studies. In addition, studies conducted in low- and middle-income countries have found a protective effect of higher education and economic conditions on maternal mortality [48].

4.2 Potential explanations

The association between maternal age and maternal mortality may be due to physiological changes during pregnancy, inadequate prenatal care, and underlying health conditions. The educational gradient in maternal mortality rates may be due to better health knowledge, better healthcare-seeking behavior, and increased autonomy of educated women. Economic conditions can also affect the danger of maternal death, as a condition for access to quality health services [49].

4.2.1 Comparison with previous studies

In contrast to previous studies, this research did not find a significant association among equity and maternal mortality. These differences may be due to differences in study design, demographic characteristics, or health system factors. However, our findings on the importance of antenatal check-up visits in reducing the risk of maternal death are consistent with studies in similar areas [50].

4.2.2 Contributions to existing literature

This study helps the literature because it provides evidence of a relationship between socioeconomic factors and maternal mortality rates in the Karawang area. The findings of this study highlight the need for targeted interventions to improve education, economic empowerment, and access to quality health services for vulnerable groups [51].

In several studies conducted, including that done by Supratikto et al. [52], the 2-year period to conduct the interview is still quite valid. In addition, various studies reveal that the length of the period to remember something (recall period) is highly variable. In Guinea - Bissau, where the verbal autopsy was performed up to 8 years since the mortality, the length of the period does not affect the quality of medical information that was reported. The research was conducted in 2013, and also looked at the current situation according to the 2020-2024 NMTDP, where maternal mortality is still a problem until now. However not recommended to include this in the memory limitation period of more than 5 years [53].

Age of mothers with a range of < 20 years and ≥ 35 years, an age group who are at risk for pregnancy and childbirth and is a risk factor for maternal mortality. According to many studies, age as one of the risk factors for maternal death plays an important role and triggers maternal death, based on research conducted in India in 1998, maternal age is one of the risk factors for maternal death. The results of the study showed that the highest maternal mortality rate occurred in mothers with the highest percentage, namely school mortality and low basic education. This suggests that education is an important enough factor to maternal mortality. But the education of

mother does not enter the final model that influences maternal mortality [54].

Delay factors are non-medical factors, which are usually low level of socio-economic background, level of education, the position and role of women, socio-cultural factors and transport factors, which all have an impact on the less favorable circumstances, that is a good delay in seeking help, too late in reaching health facilities, nor too late to get adequate care in health facilities [55-57].

Study the determinants of maternal mortality among all three delay factors, namely delay in seeking help, too late in reaching health facilities and delay in health care. The results showed that the delay seeking in help has a relationship with maternal mortality, because the value of $p = 0.001$, with OR values of 6.21, meaning that mothers who were late in seeking help resulted in a mortality of 6.21 times compared to mothers who are not late in seeking help. Being late in seeking help is different from being late in getting adequate health services. This relates to the delay theory according to Thadeus and Maine [58] delay in deciding and seeking services from individuals and families. Meanwhile, delays in receiving adequate services at facilities are factors that play a role in service quality, including the competence of the referral system, lack of equipment and trained personnel, and the competency of available personnel. While too late reaching health facilities also showed a significant association with maternal mortality, $p = 0.000$ and OR of 5.59 means that mothers who were late to reach health facilities resulted in 5.59 times maternal mortality than mothers who were not too late to reach health facilities. Delay in reaching health facilities is an influential factor in maternal mortality, this may be caused by a lack of public awareness to quickly reach health facilities and the factor of access to health facilities. Access in the event of unavailability of transportation, lack of price of transport to a health facility, or other possibilities such as the unavailability of interruption or cost of communication for delivery.

In conclusion, mothers aged < 20 years and ≥ 35 years had a higher risk of maternal mortality compared to mothers resulted from aged 20-34 years, who are at risk of respectively 2.55 times maternal mortality. If the terms of a delay in seeking help, the subjects were too late to get help than those who were not late to get help cause a mortality risk 6.21 times.

4.3 Limitations and future directions

This research has several limitations. Based on the oral autopsy data, there may be recall and selection bias in previous designs. Verbal autopsy methods and self-reported information may also be subject to error due to interview quality, familiarity of responses, and cultural influences. The logistic regression assumptions about linearity and independence may not be true. Quality issues and problems such as missing data, errors and inconsistencies can affect the accuracy of the analysis [59]. This study's reliance on health benefit records may not have captured all maternal deaths. Future research should use feasible designs, multiple data sources, and rigorous data validation methods to increase validity and accuracy. Additionally, advanced troubleshooting methods and data quality analysis can increase the reliability of the results. Despite limitations, this study helps to understand the risk factors for maternal mortality in Karawang and provides information on interventions to improve maternal health outcomes [60].

4.3.1 Future directions

Future studies should employ prospective designs to minimize recall bias and improve data accuracy, utilizing multiple data collection methods to triangulate findings and enhance validity. Rigorous validation and cleaning procedures are crucial to address data quality issues. While this study provides valuable insights, its limitations, including reliance on verbal autopsy data and potential information bias, should be acknowledged. Building on these findings, future research should explore the mechanisms underlying the observed associations and investigate effective interventions to address maternal mortality in this setting, ultimately informing evidence-based policies and programs to progress maternal health outcomes.

5. CONCLUSION

This research investigated the risk influences associated with maternal mortality in Karawang district, Indonesia, and found that maternal age, education, and economic status were important predictors of maternal mortality. In particular, girls and young women aged ≥ 35 years, those with low education, and those with poor economic conditions were more likely to die from maternal mortality.

Mothers aged < 20 years and ≥ 35 years had a higher risk of maternal mortality compared to mothers resulted from aged 20-34 years, who are at risk of respectively 2.55 times maternal mortality. If the terms of a delay in seeking help, the subjects were too late to get help than those who were not late to get help causing a mortality risk 6.21 times. Maternal mortality is affected by complications of pregnancy/childbirth, late finding birth attendants, Maternal mortality is affected by complications of pregnancy/childbirth, late finding birth attend-ants, maternal age, complications, late finding help late reaching health facilities, maternal age, complications, late finding help, late reaching health facilities and referrals.

5.1 Implications and recommendations

The results of this research have significant suggestions for policy, practice, and future research. To reduce maternal mortality, we recommend that politicians develop interventions that target the education and economic empowerment of the most vulnerable groups in society. Health professionals should prioritize antenatal care and emergency delivery services for high-risk groups. Future researchers should investigate effective interventions to address maternal mortality in similar settings.

Policy and Practice Recommendations:

-Establish educational and economic empowerment programs for women.

-Increase access to prenatal care and emergency maternity services.

-Health systems must be strengthened to prevent maternal deaths.

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