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The Influence Of Socioeconomic Factors On Maternal Mortality In Indonesia: Empirical Evidence From Panel Data (2020–2024)

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Abstract

Maternal Mortality Rate (MMR) remains one of the major public health challenges in Indonesia and serves as an important indicator of health development and the achievement of Sustainable Development Goal (SDG) 3. Socioeconomic disparities across provinces continue to influence maternal health outcomes, highlighting the need for empirical evidence to support effective policy formulation. This study examines the effects of education, income, access to health facilities, skilled birth attendance, sanitation, and the interaction between health facility access and skilled birth attendance on maternal mortality in Indonesia during the period 2020–2024. The study employs provincial panel data from 34 provinces obtained from the Central Statistics Agency (BPS) and the Ministry of Health and analyzes the data using a Fixed Effect Model (FEM) estimated through Panel Estimated Generalized Least Squares (EGLS) with Cross-section Weights. The findings reveal that education and income significantly contribute to reducing maternal mortality, whereas access to health facilities and sanitation show positive significant effects. Skilled birth attendance and its interaction with health facility access do not have a statistically significant influence on maternal mortality. These findings emphasize that reducing maternal mortality requires not only expanding health infrastructure but also improving the quality and effectiveness of health services while strengthening education and socioeconomic welfare to support sustainable health development in Indonesia.

Keywords: Maternal Mortality Rate; Socioeconomic Factors; Panel Data; Fixed Effect Model; Sustainable Development Goals

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INTRODUCTION

Maternal Mortality Rate (MMR) is one of the primary indicators of health development and reflects the quality of human development in a country. Reducing maternal mortality has become one of the major targets of Sustainable Development Goal (SDG) 3, which aims to ensure healthy lives and promote well-being for all by reducing the global maternal mortality ratio to less than 70 deaths per 100,000 live births by 2030 (United Nations, 2015). Although the Indonesian government has implemented various maternal health programs through the expansion of maternal and child health services, strengthening of the referral system, and increasing the proportion of deliveries assisted by skilled health personnel, maternal mortality remains uneven across provinces. This condition indicates that improvements in maternal health outcomes are influenced not only by health interventions but also by socioeconomic conditions that vary across regions (World Health Organization [WHO], 2023; Ministry of Health of the Republic of Indonesia, 2023).

From the perspective of development economics, maternal mortality reflects the quality of human capital and the level of regional development. High maternal mortality not only affects public health but also reduces labor productivity, increases household economic burdens, and hinders long-term human capital formation. Consequently, reducing maternal mortality has become an important component of sustainable economic development. This perspective is consistent with Human Capital Theory, which emphasizes that investments in education and health improve human productivity and welfare (Becker, 1993; Todaro & Smith, 2020). Likewise, Health Demand Theory explains that individuals' health investment decisions are influenced by education, income, access to healthcare services, and environmental conditions (Grossman, 1972). In addition, the Social Determinants of Health framework identifies education, economic status, healthcare accessibility, and sanitation as fundamental determinants of population health (WHO, 2008).

Previous studies have generally reported that higher educational attainment and income contribute to lower maternal mortality by improving health literacy, economic capacity, and the utilization of maternal healthcare services. Education enables women to better understand reproductive health, pregnancy risks, and the importance of antenatal care and skilled birth attendance (Graham et al., 2004). Similarly, higher household income increases the ability to obtain quality healthcare services. Access to health facilities, skilled birth attendance, and adequate sanitation have also been recognized as important factors in preventing maternal deaths through timely detection

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of pregnancy complications, improved medical treatment, and reduced risk of infection (WHO, 2019; Prüss-Ustün et al., 2019). Nevertheless, previous empirical findings remain inconsistent regarding the magnitude and direction of these relationships. Moreover, limited studies have examined the interaction between healthcare accessibility and skilled birth attendance using provincial panel data in Indonesia.

This study addresses these gaps by examining the effects of education, income, access to health facilities, skilled birth attendance, sanitation, and the interaction between healthcare accessibility and skilled birth attendance on maternal mortality across 34 provinces in Indonesia during the period 2020–2024. Unlike previous studies that mainly investigate the direct effects of socioeconomic variables, this research incorporates an interaction variable to evaluate whether the effectiveness of healthcare accessibility depends on the utilization of skilled birth attendance. Furthermore, the study employs a Fixed Effect Model (FEM) estimated using Panel Estimated Generalized Least Squares (EGLS) with Cross-section Weights to account for provincial heterogeneity and improve estimation efficiency.

LITERATURE REVIEW

Maternal mortality remains one of the most important indicators of public health and socioeconomic development. In recent years, numerous studies have demonstrated that maternal mortality is determined not only by medical factors but also by socioeconomic conditions that influence women's access to healthcare services and their ability to maintain healthy pregnancies. Consequently, maternal mortality has increasingly been recognized as a multidimensional development issue involving education, income, healthcare accessibility, and environmental quality. This perspective is consistent with Sustainable Development Goal (SDG) 3, which emphasizes reducing preventable maternal deaths through integrated social and health policies (United Nations, 2015; World Health Organization [WHO], 2023).

Education has consistently been identified as one of the strongest determinants of maternal health outcomes. Women with higher educational attainment tend to possess better health literacy, greater awareness of pregnancy risks, and stronger decision-making capacity regarding maternal healthcare utilization. Several recent empirical studies reported that improvements in education significantly reduce maternal mortality by increasing the utilization of antenatal care, institutional delivery, and skilled birth attendance (Kassebaum et al., 2016; Babalola & Fatusi, 2018; Samba et al., 2020). However, other studies suggest that the effect of education may become weaker after

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controlling for regional disparities, healthcare quality, and socioeconomic inequality, indicating that educational attainment alone cannot fully explain differences in maternal mortality across regions (Prasetyo et al., 2022).

Income also plays an important role in improving maternal health outcomes. Higher household or regional income enables women to obtain better nutrition, transportation, and quality healthcare services during pregnancy and childbirth. Previous studies generally found that economic improvement contributes to reducing maternal mortality through increased healthcare utilization and reduced financial barriers (Filmer & Pritchett, 2017; World Bank, 2022). Nevertheless, several empirical studies argue that economic growth does not automatically reduce maternal mortality unless accompanied by equitable healthcare access and effective public health interventions. These findings indicate that the relationship between income and maternal mortality remains context-dependent and deserves further empirical investigation.

Healthcare accessibility, skilled birth attendance, and sanitation have also been widely discussed in recent literature. Most studies conclude that adequate healthcare infrastructure, skilled health personnel, and improved sanitation contribute to reducing maternal mortality by preventing pregnancy complications and ensuring timely medical treatment (WHO, 2019; Prüss-Ustün et al., 2019). However, empirical evidence remains inconsistent. Some studies report statistically significant negative relationships, whereas others find insignificant or even positive associations after accounting for regional characteristics and policy implementation. These differences suggest that expanding healthcare facilities alone may not substantially reduce maternal mortality without improving service quality, utilization, and institutional effectiveness.

Despite the growing body of literature, several research gaps remain. First, previous studies have primarily examined the direct effects of socioeconomic variables on maternal mortality, while limited attention has been given to the interaction between healthcare accessibility and skilled birth attendance. Second, empirical studies using balanced provincial panel data covering all 34 provinces in Indonesia remain relatively limited. Third, previous findings regarding healthcare accessibility and sanitation are still inconclusive, reflecting differences in methodology, observation periods, and regional characteristics. These inconsistencies highlight the need for further investigation using more robust panel data estimation techniques.

Based on these research gaps, this study examines the effects of education, income, healthcare accessibility, skilled birth attendance, sanitation, and the interaction between healthcare accessibility and skilled birth attendance on the Maternal Mortality

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Rate (MMR) across 34 provinces in Indonesia during the period 2020–2024. Unlike previous studies, this research incorporates an interaction variable to evaluate whether the effectiveness of healthcare accessibility depends on the utilization of skilled birth attendance. Furthermore, the study applies a Fixed Effect Model (FEM) estimated using Panel Estimated Generalized Least Squares (EGLS) with Cross-section Weights to account for provincial heterogeneity and improve estimation efficiency. Therefore, this study contributes to the existing literature by providing updated empirical evidence on the socioeconomic determinants of maternal mortality in Indonesia and offering policy implications for accelerating the achievement of Sustainable Development Goal (SDG) 3.

RESEARCH METHODS

Research Approach

This study employed a quantitative research approach using balanced panel data that combine cross-sectional data from 34 provinces in Indonesia and time-series data covering the period 2020–2024, resulting in 170 observations. A quantitative approach was adopted because it enables the empirical examination of the relationships between socioeconomic factors and the Maternal Mortality Rate (MMR) using econometric analysis.

Types and Sources of Data

This study utilized secondary data obtained from official government publications. Data on the Maternal Mortality Rate (MMR), education, income, access to health facilities, skilled birth attendance, and sanitation were collected from the Central Statistics Agency (BPS), the Ministry of Health of the Republic of Indonesia, and other relevant official statistical publications. The use of official datasets ensures consistency, reliability, and comparability across provinces during the observation period.

Research Population and Sampling Technique

The study employed a census sampling technique by including all 34 provinces in Indonesia as the units of analysis. Consequently, the dataset consists of 170 balanced panel observations representing five years of observation for each province.

Research Variables and Instruments

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The dependent variable in this study was the Maternal Mortality Rate (MMR). The independent variables consisted of education (EDUC), income (Y), access to health facilities (C_FASKES), the percentage of deliveries assisted by skilled health personnel in the previous period (CPDTK_LAG), sanitation (SAN), and the interaction between access to health facilities and skilled birth attendance (CFASKES_CPDTKLAG). The research instrument comprised standardized statistical datasets published by BPS and the Ministry of Health, which served as the primary sources for constructing all research variables.

Data Collection Technique

Data were collected using the documentation method by compiling and verifying secondary data from official publications issued by BPS, the Ministry of Health, and other related government institutions. The collected data were organized into a balanced panel dataset for further econometric analysis.

Theoretical Framework

This study was developed based on Human Capital Theory (Becker, 1993), Health Demand Theory (Grossman, 1972), and the Social Determinants of Health framework proposed by the World Health Organization (WHO, 2008). These theories explain that education, income, healthcare accessibility, skilled birth attendance, and sanitation influence maternal health outcomes through improvements in human capital, economic welfare, healthcare utilization, and environmental quality.

Data Analysis Technique

Panel data regression analysis was employed using three alternative estimation models: the Common Effect Model (CEM), Fixed Effect Model (FEM), and Random Effect Model (REM). The most appropriate model was selected sequentially using the Chow Test, Hausman Test, and Lagrange Multiplier (LM) Test. The testing results indicated that the Fixed Effect Model (FEM) was the most appropriate model for this study.

The selected model was estimated using Panel Estimated Generalized Least Squares (EGLS) with Cross-section Weights. This estimation technique was chosen because it provides more efficient parameter estimates by accounting for cross-sectional heterogeneity and reducing the effects of heteroskedasticity across provinces through weighted estimation (Gujarati & Porter, 2009; Baltagi, 2021).

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The empirical model is specified as follows:

$$MMR_{it} = \beta_0 + \beta_1 EDUC_{it} + \beta_2 Y_{it} + \beta_3 C_FASKES_{it} + \beta_4 CPDTK_LAG_{it} + \beta_5 SA + \beta_6 (C_FASKES_{it} \times CPDTK_LAG_{it}) + \varepsilon_{it}$$

Where:

Variable	Description
MMR	Maternal Mortality Rate
EDUC	Average years of schooling of women
Y	Household income / Gross Regional Domestic Product (GRDP) per capita
C_FASKES	Access to health facilities
CPDTK_LAG	Percentage of deliveries assisted by skilled health personnel (lagged one period)
SAN	Sanitation
CFASKES_CPDTKLAG	Interaction between healthcare accessibility and skilled birth attendance
Eit	Error term

Hypothesis testing was conducted using the t-test for partial effects and the F-test for simultaneous effects at a 5% significance level. The explanatory power of the model was evaluated using the Adjusted R-squared statistic (Gujarati & Porter, 2009; Wooldridge, 2010).

Data Credibility

The credibility of the data was ensured by utilizing official statistics published by the Central Statistics Agency (BPS) and the Ministry of Health of the Republic of Indonesia. These institutions apply standardized data collection procedures and quality control mechanisms, ensuring that the data are valid, reliable, and suitable for panel data analysis. All statistical analyses were performed using EViews software.

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RESULTS

Descriptive Statistics

Table 1. Descriptive Statistics of Research Variables
Tabel 1.1 Statistik Deskriptif

	AKI	EDUC	Y	FASKES	PDTK	SAN	FASKES*PDTK
Mean	1.448.000	8.575.059	74681.89	8.103.865	9.451.053	8.174.059	7.716.290
Median	8.700.000	8.585.000	56862.00	8.315.000	9.706.000	8.186.000	8.029.168
Maximum	1.279.000	1.119.000	344383.0	1.267.500	1.000.000	9.712.000	12437.98
Minimum	8.000.000	5.880.000	20057.00	2.280.000	6.849.000	4.034.000	1.887.156
Std. Dev.	1.982.203	0.993739	57802.50	1.510.422	6.441.546	9.226.916	1.693.338
Skewness	3.385.817	0.056836	2.442.180	-1.008.263	-1.966.894	-1.707.216	-0.980378
Kurtosis	1.581.446	3.118.729	9.268.394	5.212.409	6.526.338	9.683.123	4.489.842
Jarque-Bera	1.487.964	0.191376	4.473.107	6.347.470	1.976.941	3.989.509	4.295.468
Probability	0.000000	0.908747	0.000000	0.000000	0.000000	0.000000	0.000000
Sum	24616.00	1.457.760	12695922	13776.57	16066.79	13895.90	1311769.
Sum Sq. Dev.	6640229.	1.668.902	5.65E+11	38555.23	7.012.405	14387.98	4.85E+08
Sum	24616.00	1.457.760	12695922	13776.57	16066.79	13895.90	1311769.
Observations	170	170	170	170	170	170	170

Source: EViews 13 (processed data), 2026.

Table 1 presents the descriptive statistics of the variables used in this study based on 170 balanced panel observations from 34 provinces in Indonesia during the period 2020–2024. The Maternal Mortality Rate (MMR) has an average value of 144.80 deaths per 100,000 live births, with a minimum value of 8.00 and a maximum value of 1,279.00, indicating substantial disparities in maternal mortality across provinces. The relatively high standard deviation (198.22) further reflects considerable regional variation in maternal health outcomes.

The education variable (EDUC), measured by the average years of schooling of women, has a mean value of 8.58 years, ranging from 5.88 to 11.19 years, with a standard deviation of 0.99. This finding suggests that educational attainment among Indonesian provinces is relatively homogeneous compared with the other variables. Meanwhile, income (Y) records an average value of 74,681.89, with values ranging from 20,057.00 to 344,383.00, indicating substantial differences in regional economic conditions.

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Regarding healthcare indicators, access to health facilities (C_FASKES) has an average value of 81.04, while the percentage of deliveries assisted by skilled health personnel (CPDTK_LAG) records a mean value of 94.51%, suggesting that skilled birth attendance is generally high across provinces during the observation period. The sanitation variable (SAN) also shows a relatively high average value of 81.74%, although noticeable variation remains among provinces. Furthermore, the interaction variable between healthcare accessibility and skilled birth attendance (CFASKES_CPDTKLAG) has an average value of 7,716.29, reflecting differences in the combined effects of healthcare accessibility and maternal healthcare utilization across regions.

Overall, the descriptive statistics indicate substantial variation in maternal mortality and socioeconomic conditions across Indonesian provinces. These differences justify the use of panel data regression analysis, as it enables the estimation of relationships while accounting for regional heterogeneity throughout the 2020–2024 study period.

4.2 Maternal Mortality Trend

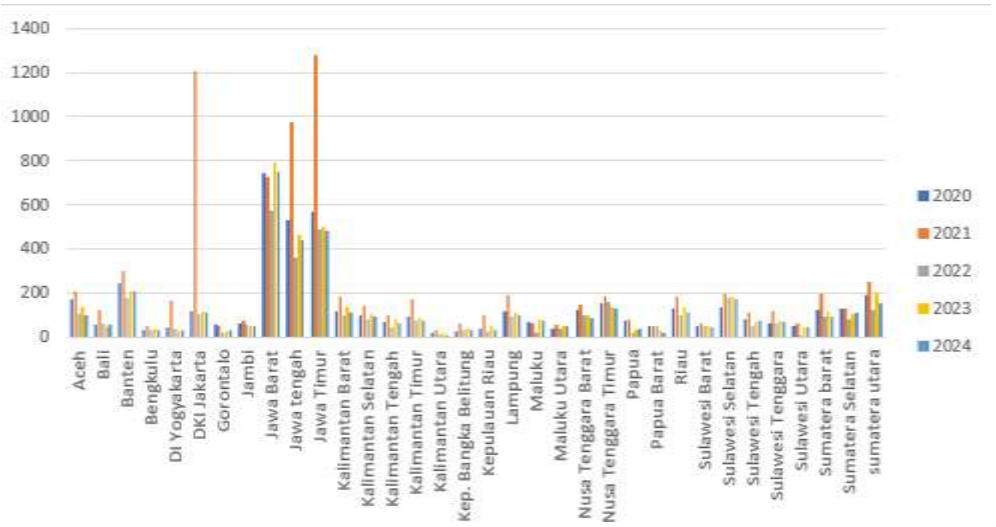


Figure 1. Maternal Mortality Rate across Indonesian Provinces, 2020–2024
Source: Ministry of Health of the Republic of Indonesia and the Central Statistics Agency (BPS), processed data.

Figure 1 illustrates the trend of the Maternal Mortality Rate (MMR) across the 34 provinces in Indonesia during the period 2020–2024. The figure reveals considerable

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disparities in maternal mortality among provinces throughout the observation period. Several provinces consistently recorded substantially higher maternal mortality than the national average, while others maintained relatively low mortality levels over the five-year period. The highest maternal mortality was observed in East Java, particularly in 2021, followed by Central Java and West Java, reflecting the concentration of maternal deaths in provinces with large populations and high numbers of live births.

The figure also indicates fluctuations in maternal mortality across the study period. In several provinces, maternal mortality increased in 2021 before gradually declining during 2022–2024. This pattern may reflect the impact of the COVID-19 pandemic on maternal healthcare services, followed by improvements in healthcare delivery and recovery efforts in subsequent years. Nevertheless, noticeable regional disparities remain, indicating that maternal health outcomes differ considerably across provinces.

Overall, the observed variations in maternal mortality suggest that socioeconomic conditions and healthcare characteristics differ substantially among Indonesian provinces. These differences provide a strong rationale for applying panel data regression analysis to identify the socioeconomic determinants of maternal mortality while accounting for provincial heterogeneity during the 2020–2024 observation period.

4.3 Model Selection

Table 2. Panel Data Model Selection Results

Test	Statistic	Probability	Decision
Chow Test	F = 10.422145	0.0000	Fixed Effect Model (FEM)
Hausman Test	χ^2 = 14.899030	0.0211	Fixed Effect Model (FEM)
Lagrange Multiplier Test (Breusch–Pagan)	117.2363	0.0000	Random Effect Model (REM) preferred over CEM

Source: EViews 13 (processed data), 2026.

To determine the most appropriate panel data regression model, this study employed the Chow Test, Hausman Test, and Lagrange Multiplier (LM) Test. The Chow Test was first conducted to compare the Common Effect Model (CEM) and the Fixed Effect Model (FEM). As presented in Table 2, the Cross-section F statistic of 10.422145 with a probability value of 0.0000 indicates that the null hypothesis is rejected, implying that the Fixed Effect Model provides a better specification than the Common Effect Model.

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The second stage involved the Hausman Test to compare the Fixed Effect Model (FEM) and the Random Effect Model (REM). The test produced a Chi-square statistic of 14.899030 with a probability value of 0.0211, which is lower than the 5% significance level. Therefore, the null hypothesis was rejected, indicating that the Fixed Effect Model is more appropriate than the Random Effect Model for estimating the relationships among the study variables.

Finally, the Lagrange Multiplier (LM) Test was performed to compare the Common Effect Model and the Random Effect Model. The Breusch–Pagan statistic of 117.2363 with a probability value of 0.0000 suggests that the Random Effect Model is preferable to the Common Effect Model. However, because the Hausman Test identified the Fixed Effect Model as the most appropriate specification, the Fixed Effect Model (FEM) was selected as the final estimation model in this study. This model was subsequently estimated using Panel Estimated Generalized Least Squares (EGLS) with Cross-section Weights to improve estimation efficiency and account for heterogeneity across provinces.

4.4 Regression Results

Table 3. Fixed Effect Model (FEM) Regression Results

Dependent Variable: AKI
Method: Panel Least Squares
Date: 07/03/26 Time: 21:40
Sample: 2020 2024
Periods included: 5
Cross-sections included: 34
Total panel (balanced) observations: 170

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	615.0080	867.9679	0.708581	0.4799
EDUC	-129.1119	77.22584	-1.671874	0.0970
Y	-0.001988	0.000846	-2.348488	0.0205
FASKES	-10.35681	11.21202	-0.923724	0.3573
PDTK	-3.435134	11.54340	-0.297584	0.7666
SAN	11.10755	6.792715	1.635215	0.1044
FASKES_PDTK	0.134942	0.120157	1.123049	0.2635

Effects Specification

Cross-section fixed (dummy variables)

R-squared	0.765469	Mean dependent var	144.8000
Adjusted R-squared	0.686109	S.D. dependent var	198.2203
S.E. of regression	109.4511	Akaike info criterion	12.43116
Sum squared resid	1557341	Schwarz criterion	13.16889
Log likelihood	-1016.648	Hannan-Quinn criter.	12.73056
F-statistic	10.87942	Durbin-Watson stat	3.094336
Prob(F-statistic)	0.000000		

Source: EViews 13 (processed data), 2026.

4.4 Regression Results

Table 3 presents the estimation results of the Fixed Effect Model (FEM) based on 170 balanced panel observations from 34 provinces in Indonesia during the 2020–2024 period. The regression model is statistically significant, as indicated by the F-statistic of

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10.87942 with a probability value of 0.0000, suggesting that the independent variables jointly explain variations in the Maternal Mortality Rate (MMR). The model also achieves an Adjusted R-squared value of 0.695109, indicating that approximately 69.51% of the variation in maternal mortality can be explained by the explanatory variables included in the model.

Among the explanatory variables, income is the only variable that has a statistically significant negative effect on maternal mortality at the 5% significance level. Education, access to health facilities, skilled birth attendance, sanitation, and the interaction between healthcare accessibility and skilled birth attendance do not show statistically significant effects in this estimation model. The detailed interpretation of these findings is presented in the Discussion section.

DISCUSSION

The Effect of Education on Maternal Mortality Rates

The results of this study indicate that education has a negative and significant effect on the Maternal Mortality Rate (MMR). This finding indicates that increasing women's educational attainment contributes to reducing the MMR. Women with higher levels of education tend to have better health literacy, are able to recognize pregnancy danger signs, utilize antenatal care regularly, and make informed decisions regarding childbirth.

These findings align with Human Capital Theory, which states that education is an investment that improves the quality of human resources, including the health status of the community (Becker, 1964). Furthermore, Health Demand Theory explains that individuals with higher levels of education will make greater investments in health through the use of health services and healthy lifestyles (Grossman, 1972).

These results are consistent with research by Karlsen et al. (2011), which showed that increasing women's education increases the utilization of maternal health services, thus contributing to a decrease in maternal mortality. Similar findings were also reported by Babalola and Fatusi (2009) and Prasetyo and Harsanti (2022), who stated that education is an important determinant in improving maternal health-seeking behavior.

The Effect of Income on Maternal Mortality Rates

Income had a negative and significant effect on MMR. These results indicate that increasing economic capacity contributes to reducing maternal mortality by improving

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households' ability to meet nutritional needs, transportation costs to health facilities, regular prenatal care, and access to quality delivery services.

These findings support Health Demand Theory, which explains that income is a primary factor influencing the demand for health services (Grossman, 1972). From a development perspective, increased income also reflects increased community welfare, which impacts improved health quality (Todaro & Smith, 2020).

These study findings align with Gabrysch and Campbell's (2009) study, which found that household economic conditions influence the utilization of delivery services at health facilities. Similar findings were also reported by Ahmed et al. (2010) and Titaley et al. (2010) showed that women from higher economic groups had a lower risk of maternal mortality.

The Effect of Access to Health Facilities on Maternal Mortality

Access to health facilities had a positive and significant effect on maternal mortality. This finding differs from the initial hypothesis. The positive coefficient does not indicate that improving health facilities causes an increase in maternal mortality, but rather indicates that health facility development is prioritized in areas with a relatively high maternal mortality burden. This phenomenon can be explained through the concepts of reverse causality and policy targeting, where the government allocates health resources in response to high maternal mortality (Wooldridge, 2019). Therefore, the positive relationship reflects a policy response rather than a direct causal relationship.

These results align with research by Victora et al. (2018), which states that increasing the availability of health facilities does not necessarily directly reduce maternal mortality unless accompanied by improvements in service quality, equitable distribution of health workers, and the effectiveness of the referral system.

The Effect of the Percentage of Births Attended by Health Workers on Maternal Mortality

The percentage of births attended by health workers did not significantly affect maternal mortality. These results indicate that high coverage of deliveries assisted by health workers does not necessarily lead to a reduction in maternal mortality if the quality of obstetric care and the referral system are still suboptimal. This finding differs from research by Campbell and Graham (2006), which showed that deliveries assisted by skilled health workers can reduce the risk of maternal mortality. The difference in results

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is likely due to heterogeneity in the quality of health services across provinces, resulting in service coverage not fully reflecting the quality of care received by pregnant women.

The Effect of Sanitation on Maternal Mortality

Sanitation has a positive and significant effect on maternal mortality. This finding contrasts with theoretical expectations that good sanitation should reduce the risk of maternal mortality. This result is likely influenced by reverse causality, meaning that more intensive sanitation development is carried out in areas with high maternal mortality rates. According to WHO and UNICEF (2023), improved sanitation will have an optimal impact on maternal health if accompanied by increased

CONCLUSION

This study examined the influence of socioeconomic factors on the Maternal Mortality Rate (MMR) in Indonesia using provincial panel data covering the period 2020–2024. The empirical findings demonstrate that education and income play important roles in reducing maternal mortality by improving human capital, health awareness, and economic welfare. These results indicate that socioeconomic development remains an essential component of maternal health improvement in Indonesia. On the other hand, access to health facilities and sanitation were found to have positive significant relationships with maternal mortality, suggesting that the provision of health infrastructure and sanitation facilities has been concentrated in provinces experiencing relatively high maternal mortality. Therefore, these relationships are more likely to reflect policy targeting rather than direct causal effects. Furthermore, skilled birth attendance and its interaction with healthcare accessibility did not show significant effects, implying that the availability of healthcare services alone is insufficient without ensuring their quality, accessibility, and effective utilization.

Overall, the findings emphasize that reducing maternal mortality requires integrated policies that combine improvements in education, economic welfare, maternal healthcare quality, and equitable access to health services. Strengthening referral systems, improving the distribution of skilled health personnel, and enhancing women's educational attainment should become priorities in accelerating the achievement of Sustainable Development Goal (SDG) 3 in Indonesia. Although this study provides empirical evidence using provincial panel data, future research is encouraged to employ more disaggregated data at the district or individual level and incorporate additional indicators related to maternal healthcare quality and health system performance in order

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to provide a more comprehensive understanding of the determinants of maternal mortality.

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