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A Multilevel Analysis to Uncover the Drivers of Infant Mortality in Indonesia

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ABSTRACT

Introduction: Infant mortality remains a critical concern in Indonesia due to its large population and regional health disparities. This study investigates the factors associated with infant mortality in Indonesia by considering the hierarchical data structure, in which individuals are nested within provinces. This study addresses a gap in previous research that has overlooked regional-level variation.
Method: This study utilized data from the 2017 Indonesian Demographic and Health Survey (IDHS). A multilevel mixed-effects logistic regression model was employed to account for both individual- and provincial-level variations in infant mortality. The multilevel approach allows for more accurate estimation by capturing unobserved heterogeneity across provinces. Adjusted Odds Ratios (AORs) with 95% Confidence Intervals (CIs) were reported to assess the strength and significance of associations between explanatory variables and infant mortality risk.
Result: The results indicate that mother's age at first childbirth (Adjusted Odds Ratio (AOR) = 1.262; 95% CI 1.180 - 1.350), marital status (AOR = 0.688; 95% CI 0.549 - 0.852), health insurance (AOR = 0.982; 95% CI 0.972 - 0.991), maternal occupation (AOR = 0.982; 95% CI 0.973 - 0.993), maternal education level (AOR = 1.147; 95% CI 1.103 – 1.192) household head's age (AOR=0.713; 95% CI 0.654 – 0.777), and the birth order (AOR = 1.171; 95% CI 1.117 – 1.227) have significant impact on the risk of infant mortality.
Conclusion: Both maternal and household characteristics play an important role in driving infant mortality risks in Indonesia. The findings highlight the importance of considering regional heterogeneity in policy design. It is recommended that the government and relevant institutions prioritize efforts aimed at reducing infant mortality.

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INTRODUCTION

Infant mortality is a crucial indicator for measuring the health and well-being of infants in a country (Kelleher et al., 2023; Park & Won, 2024). The infant mortality rate is an important indicator of national health as it is related to several factors, including maternal health, the quality and accessibility of health services, socioeconomic conditions, and public health practices. A family's socioeconomic status has a greater influence on a baby's survival than other age groups in the population (Faruk et al., 2025; Ward et al., 2025). Infant mortality is calculated as the number of babies who die before reaching one year of age per 1,000 live births in a given year. The lower the infant mortality rate, the better the quality of health services, accessibility to healthcare, and other factors that contribute to improving infant health (Khan et al. 2022).

Over the past two decades, there has been significant progress in efforts to reduce infant mortality in Indonesia and worldwide (Octavius et al., 2024; Langlois et al., 2025). In 2021, more than 5 million children under the age of 5 died, including 2.3 million newborns and 2.1 million children and adolescents aged 5 to 24 years. As many as 43 percent of this number were adolescents (UN IGME, 2023). Infant mortality is a serious global public health problem with an infant mortality rate of 144 per 1,000 live births based on research in 56 countries (Tekeba et al., 2024). Results from the 2017 Indonesian Demographic and Health Survey (IDHS) showed that the infant mortality rate in Indonesia was 48 deaths per 1,000 live births in children with a birth interval of less than 2 years. Meanwhile, in children with a birth interval of 4 years or more, the infant mortality rate was 23 deaths per 1,000 live births (Statistics Indonesia et al., 2018).

The infant mortality rate under one year in Indonesia continues to decline from year to year. Currently, the infant mortality rate under one year in Indonesia is 15,920 deaths per 1,000 live births. This shows a decrease of 3.62% from 2022. However, Indonesia still ranks sixth with the highest infant mortality rate among ASEAN countries. Indonesia has also not yet achieved the Sustainable Development Goals (SDGs) target, which is an infant mortality rate of 12 per 1000 live births (OECD, 2020). Thus, despite a decline in the infant mortality rate in Indonesia, further efforts are needed to achieve the SDGs target and improve Indonesia's position in the ranking of ASEAN countries regarding infant mortality rates.

Previous study in Ethiopia indicated that important factors for infant mortality risk included child's sex, multiple births, duration of pregnancy, and type of residence (Baraki et al., 2020). In addition, there were also differences in the risk of infant mortality between different regions. The study conducted in Ethiopia found important factors that influence infant mortality. However, each country has unique characteristics and contexts. Therefore, it is important to conduct a similar study in Indonesia to gain a deeper understanding of the factors that contribute to infant mortality in this country. By conducting a study focused on Indonesia, it will be possible to unearth specific and relevant information for the Indonesian context, thus enabling the formulation of more appropriate and effective strategies and interventions in an effort to reduce infant mortality under one year of age.

Although research on the risk factors for infant mortality under one year has been conducted previously, earlier studies were limited to individual-level factors (Irawaty et al., 2020) and often only considered one variable such as birth spacing (Ahmad & Dewi, 2020). Additionally, previous studies still had limitations in terms of the variables used. Variables such as health insurance, marital status, mother's age at first childbirth, household head's age, tetanus toxoid (TT) vaccination status, and twin births were not included in these studies. Furthermore, the use of a multilevel multivariable logistic regression method is expected to yield more accurate results in this study.

This study examines the factors influencing infant mortality under one year in Indonesia using data from the 2017 IDHS. The IDHS is a survey conducted by Statistics Indonesia (BPS) in collaboration with the National Population and Family Planning Board (BKKBN) and the Ministry of Health (Kemenkes) of Indonesia. This survey provides comprehensive data on health and demographics in Indonesia, including information on infant mortality, sociodemographic factors, maternal health status, and more.

By using a multilevel mixed-effect analysis approach, this study aims to identify contributing factors and understand how regional variation affects infant mortality in Indonesia. By using valid and representative data from the 2017 IDHS, this study is expected to provide a better understanding of the factors that play a role in infant mortality in Indonesia and provide a strong basis for the development of more effective policies and interventions in an effort to reduce the infant mortality rate under one year of age.

METHOD

Data Source

The data used in this study was obtained after obtaining permission from the International Demographic and Health Survey (DHS) Program via https://dhsprogram.com/. Variable of interest is infant mortality, which refers to cases of infant death that occur before reaching one year of age. Infant mortality estimates are based on data collected through the birth history section of the questionnaire given to female respondents aged 15-49 years. The variable was coded as binary variable, where infants who died between birth and its first birthday were coded as '1', and infants who were still alive between birth and its first birthday were coded as '0'.

Study Variables

This study also involved fifteen independent variables categorized as individual-level factors and community-level factors as predictor variables or risk factors. The selection of these variables was based on considerations of their theoretical relevance and practical significance to infant mortality under one year. Variables included in the analysis include the mother's age at first birth, the age of the household head at the time of the research data collection, the marital status of the parents, the status of the baby's birth (whether the baby is a single or a twin), the interval between marriage and the first child's birth, the household wealth index, the mother's education level, the mother's employment status, the child's gender, birth order, the status of receiving tetanus toxoid (TT) injections during pregnancy, the presence of health insurance, and the number of births in the last year. In addition, this study also considers community-level factors such as region, which in this context includes 34 provinces in Indonesia, as a relevant variable in the analysis.

Statistical Analysis

Descriptive analysis was carried out using frequencies and percentages to show the distribution of respondents based on the selected variables. A Chi-square test was performed for all categorical independent variables to check the assumption of independence (McHugh, 2013). In the context of this study, the Chi-square test was used to check whether there was a relationship or association between the independent variables (such as household head's age, mother's education level, mother's employment status, etc.) and the dependent variable (namely infant mortality before the first birthday.

Model Development

A two-level multilevel logistic regression was employed to assess how both individual and provincial characteristics influence infant mortality in Indonesia and to evaluate the extent to which these factors explain the variation in mortality before the age of one. The reason for using a multilevel logistic regression model is to consider the hierarchical and correlated structure of the data, where individuals are nested within community (province). The model can be written with the following equation (Fenta et al., 2022):

$$\log\left(\frac{\pi_{ij}}{1-\pi_{ij}}\right) = \beta_0 + \sum_{k=1}^{K}\beta_k X_{kij} + \sum_{l=1}^{L}\gamma_l Z_j + u_j + e_{ij} \quad (1)$$

where π_{ij} is the probability of a binary response for individual i in group j, β is the coefficient of the fixed effect with β_0 being the intercept, which is the impact on the probability of infant mortality when there is no influence from other predictors, γ is the coefficient of the random effect u_j is the random effect of group j on the intercept, and e_{ij} indicates is the random error at the individual level.

In this study, two models were used to identify factors related to infant mortality at the community and individual levels. The first model, called Model I, only considers individual-level variables to evaluate their effects at the individual level. The second model, Model II, is a complete model that includes all individual and community-level variables in a multilevel analysis. Variables with a p-value < 0.2 from the bivariate analysis were included in the final multivariate model (Baraki et al., 2020; Gontie et al., 2020). Variables with a p-value < 0.05 from the multivariate model were considered to have a significant

relationship with infant mortality. Fixed effects are presented in the form of odds ratios with 95% confidence intervals.

Model Evaluation

Random effect variation was examined using the Intraclass Correlation Coefficient (ICC) and the Median Odds Ratio (MOR). ICC measures how much of the total variability is attributable to differences between individuals within the same cluster, and is calculated as follows (Fenta et al., 2022):

$$ICC = \frac{V_A}{V_A + \pi^2/3} \quad (2)$$

Meanwhile. MOR represents the degree of unexplained heterogeneity between clusters. It expresses the variation by comparing the odds of an outcome for two individuals randomly drawn from different clusters, and is computed as follows (Fenta et al., 2022):

$$MOR = exp\left(0{,}95\sqrt{V_A}\right) \quad (3)$$

with V_A is the between-clusters variance. Model fit was tested using Deviance, Akaike Information Criterion (AIC), and Bayesian Information Criterion (BIC). A model with a lower Deviance, AIC, and BIC value is the best model.

Ethical Consideration

This study used publicly available secondary data from the DHS Program. Ethical approval for the original survey was obtained by the DHS Program and relevant national ethical review boards. The dataset used in this study contained no personally identifiable information, and permission to access and analyze the data was obtained through the DHS Program.

RESULTS AND DISCUSSION

Results

Of the 86,265 live births included in the analysis, 44,938 (52.1%) occurred in rural areas, while 41,327 (47.9%) occurred in urban areas (Table 1). More than half of the households belonged to the lower socioeconomic groups, with 24,015 (27.8%) classified as very poor and 16,833 (19.5%) as poor. During pregnancy and childbirth, 54,996 (63.8%) mothers were covered by health insurance. Most mothers were employed (51,815; 60.1%). Regarding educational attainment, the largest proportion of mothers had completed elementary school (32,683; 37.9%), followed by senior high school (22,470; 26.0%) and junior high school (18,774; 21.8%), whereas only 6,912 (8.0%) had attained a university degree. Most household heads were between 25–44 years (40,546; 47.0%) and 45–64 years (40,646; 47.1%) of age. In addition, the majority of respondents were married (80,216; 93.0%).

Table 1. Socio-demographic characteristics of 2017 IDHS research respondents

Variable	Category	Frequency	Percentage (%)
Type of Residence	Urban	41,327	47.9
	Rural	44,938	52.1
Household Wealth Index	Very Poor	24,015	27.8
	Poor	16,833	19.5
	Middle	15,567	18.0
	Rich	15,171	17.6
	Very Rich	14,679	17.0
Health Insurance	No	31,264	36.2
	Yes	54,996	63.8
Marital Status	Never Married	55	0.1
	Married	80,216	93.0
	Living with Partner	576	0.7
	Divorced/ Widowed	2,729	3.2
	Separated	2,420	2.8
	Not Living Together	269	0.3
Mother's Employment Status	Not Working	34,394	39.9
	Working	51,815	60.1
Mother's Education level	No Education	2,912	3.4
	Elementary School	32,683	37.9
	Junior High School	18,774	21.8
	Senior High School	22,470	26.0
	Academy/DI/DII/DIII	2,514	2.9
	DIV/ University	6,912	8.0
Household Head's Age	15-24	566	0.7
	25-44	40,546	47.0
	45-64	40,646	47.1
	65+	4,507	5.2

Table 2 shows that a total of 36,458 mothers (41.3%) gave birth to their first child between the ages of 20 and 24 years. More than half of the baby population, namely 44,568 babies, were born male. In terms of single births, as many as 85,053 babies (98.6%) were born without a twin, while 39,480 babies (45.8%) were the second and third children in the family.

In the context of maternal health care, it can be seen that 62,905 mothers (72.9%) received Tetanus Toxoid (TT) immunization during pregnancy, which is an important step in preventing tetanus. The majority of the mother population who were respondents had an interval between marriage and the birth of their first child of 0 to 11 months, which was 32,902 (38.1%) mothers. In addition, it was found that as many as 77,561 mothers, or almost 90% of the total respondents, did not give birth in the last year before the data was taken.

Table 2. Obstetric characteristics of 2017 IDHS research respondents

Variable	Category	Frequency	Percentage (%)
Mother's Age at First Birth	10-14	3,259	3.8
	15-19	30,555	35.4
	20-24	36,458	42.3
	25-29	12,842	14.9
	30-34	2,653	3.1
	35+	498	0.6
Birth Order	1	34,199	39.6
	2-3	39,480	45.8
	4-6	11,170	12.9
	7+	1,416	1.6
Twin Birth	No	85,053	98.6
	Yes	1,212	1.4
Child's Gender	Male	44,568	51.7
	Female	41,697	48.3
Tetanus Toxoid Injection	No	23,360	27.1
	Yes	62,905	72.9
Interval Between Marriage and First Birth	0-11 Months	32,902	38.1
	12-23 Months	32,663	37.9
	24-35 Months	9,236	10.7
	36+ Months	11,464	13.3
Number of Births in the Last Year	No Births	77,561	89.9
	1	8,617	10.0
	2	87	0.1

Based on the bivariate analysis in Table 3, it was revealed that as many as 3,465 individuals or about 4% of the sample experienced infant mortality under one year of age. Some of the variables that show a significant relationship include the mother's age at first birth, the presence of health insurance, the mother's employment status, marital status, the mother's education level, the age of the household head, birth order, the interval between marriage and the first child's birth, the status of the baby's birth, and receiving tetanus toxoid injections. Furthermore, these variables were entered into a multivariate logistic regression model for further analysis.

Table 3. Bivariate analysis of risk factors for infant mortality in Indonesia

Variable	Category	Infant Mortality Rate	Chi - Square	P- value	COR* (95% CI)
Mother's Age at First Birth	10-14	0,010	336.640	<0.0001	1
	15-19	0,030			0.12 (0.07 - 0.19)
	20-24	0,043			0.34 (0.25 - 0.47)
	25-29	0,058			0.50 (0.36 - 0.69)
	30-34	0,064			0.68 (0.49 - 0.95)
	35+	0,082			0.77 (0.54 – 1.10)
Type of Residence	Urban	0,041	0.639	0.424	1
	Rural	0,040			0.97 (0.91 - 1.04)
Household Wealth Index	Very Poor	0,038	4.020	0.403	1
	Poor	0,042			0.95 (0.86 - 1.06)
	Middle	0,040			1.05 (0.94 - 1.17)
	Rich	0,041			1.01 (0.90 - 1.13)
	Very Rich	0,040			1.03 (0.92 - 1.15)
Health Insurance	No	0,037	9.815	0.002	1
	Yes	0,042			1.12 (1.04 - 1.21)
Marital Status	Never Married	0,182	285.058	<0.0001	1
	Married	0,041			3.29 (1.42 - 7.65)
	Living with Partner	0,130			0.64 (0.39 - 1.05)
	Divorced/Widowed	0,005			2.22 (1.28 - 3.84)
	Separated	0,015			0.07 (0.03 - 0.15)
	Not Living Together	0,063			0.22 (0.12 - 0.40)
Mother's Employment Status	Not Working	0,066	954.88	<0.0001	1
	Working	0,023			0.34 (0.32 - 0.37)
Twin Birth	No	0,040	0.969	0.300	1
	Yes	0,035			1.17 (0.86 - 1.59)
Gender	Male	0,040	0.199	0.656	1
	Female	0,040			0.99 (0.92 - 1.05)
Mother's Education level	No Education	0,017	655.50	<0.0001	1
	Elementary School	0,023			0.23 (0.17 - 0.30)
	Junior High School	0,040			0.32 (0.28 - 0.35)
	Senior High School	0,054			0.55 (0.49 - 0.61)
	Academy/DI/DII/DIII	0,078			0.75 (0.67 - 0.84)
	DIV/ University	0,071			1.12 (0.94 - 1.33)
Household Head's Age	15-24	0,171	464.30	<0.0001	1
	25-44	0,045			2.92 (2.28 - 3.74)
	45-64	0,030			0.67 (0.59 - 0.76)
	65+	0,066			0.44 (0.39 - 0.50)
Birth Order	1	0,032	90.05	<0.0001	1
	2-3	0,045			0.80 (0.61 - 1.05)
	4-6	0,046			1.13 (0.86 - 1.47)
	7+	0,040			1.16 (0.88 - 1.54)
Interval Between Marriage and First Birth	0-11 Months	0,045	56.71	<0,0001	1
	12-23 Months	0,040			1.44 (1.28 - 1.62)
	24-35 Months	0,032			1.27 (1.13 - 1.42)
	36+ Months	0,032			1.02 (0.87 - 1.19)
Tetanus Toxoid Injection	No	0,035			1
	Yes	0,042	20.59	<0.0001	1.20 (1.11 - 1.30)

**COR: Crude odds ratio*

However, the results of the multilevel multivariate logistic regression analysis in Table 4 reveal that only a few factors are significantly associated with infant mortality. These factors include the mother's age at first childbirth, the presence of health insurance, the mother's employment status, marital status, the mother's education level, the age of the head of the household, and the birth order.

This study indicates that mothers who had their first birth in the age groups of 10-14 years, 15-19 years, 20-24 years, 25-29 years, and 30-34 years, respectively, had an infant mortality odds ratio that was 1.262 times higher (AOR = 1.262; 95%CI 1.180 – 1.350), 1.253 times higher (AOR = 1.253; 95%CI 1.177 – 1.334), and 1.236 times higher (AOR = 1.236; 95%CI 1.164 – 1.312) compared to mothers who gave birth in the age group of more than 35 years.

In the context of marital status, parents who have never been in a marital relationship have 31.2% lower odds of infant mortality (AOR = 0.688; 95%CI 0.549 – 0.862) compared to parents who are no longer living with a partner. Meanwhile, parents who are married have 14.8% higher odds of infant mortality (AOR = 1.148; 95%CI 1.027 – 1.283). Similar findings were seen in parents who are widowed or divorced, with 15.2% higher odds of infant mortality (AOR = 1.152; 95% CI 1.032 – 1.286). The same finding also applies to separated parents, with 13.2% higher odds (AOR = 1.132; 95%CI 1.008 – 1.272) compared to those who are not living together. Furthermore, the results of this study reveal that individuals without health insurance have lower odds of infant mortality of about 1.8% (AOR = 0.982; 95%CI 0.972 – 0.991) compared to individuals with health insurance. Additionally, unemployed mothers also have lower odds of infant mortality of about 1.8% (AOR = 0.982; 95%CI 0.973 – 0.992) compared to employed mothers.

In the context of maternal education, the study results indicate that various levels of maternal education have an impact on the risk of infant mortality. Mothers with no formal education have 14.7% higher odds of infant mortality (AOR = 1.147; 95%CI 1.103 – 1.192) compared to mothers who have a university/DIV level of education. Likewise, mothers with an elementary school education have 9.2% higher odds of infant mortality (AOR = 1.092; 95% CI 1.063 – 1.122) for infant deaths under one year of age, compared to mothers who have a university/DIV level of education. Meanwhile, mothers with a junior high school education have 5% higher odds of infant mortality (AOR = 1.050; 95% CI 1.022 – 1.080) compared to mothers who have a university/DIV level of education. Similarly, mothers with a high school education show 2.5% higher odds of infant mortality (AOR = 1.025; 95% CI 1.003-1.047) compared to mothers who have a university/DIV level of education. This confirms the important role of maternal education in maintaining the well-being of newborns.

When referring to the age of the head of the household, among 15-24 years old, the head of the household has 28.7% lower odds of infant mortality (AOR=0.713; 95% CI 0.654 – 0.777) compared to household heads aged 65 years and over. Conversely, household heads in the 25-44 years old age group have 7.5% higher odds of infant mortality (AOR = 1.075; 95% CI 1.055 – 1.096) compared to household heads aged over 65 years. Likewise, the group of household heads in the 45-64 years age range show 2% higher odds of infant mortality (AOR = 1.020; 95% CI 1.005 – 1.035) compared to the group of household heads aged 65 years and over.

Regarding the infant's birth order, the findings show that infants born as the first child have an infant mortality odds ratio of 1.171 (AOR = 1.171; 95% CI 1.117 – 1.227) times higher compared to infants born as the seventh or later child in the birth order. Likewise, infants who are in the second or third birth order have 1.056 times higher odds of infant mortality (AOR = 1.056; 95% CI 1.009 – 1.105), compared to infants who are the seventh or later child in the birth order.

Table 4. Multilevel Logistic Regression Results for Determinants of Infant Mortality in Indonesia

Variable	Category	AOR* (95% CI)	
		Model I	Model II
Mother's Age at First Birth	10-14	11.246 (5.729 – 22.078) *	1.262 (1.180 – 1.350) *
	15-19	8.275 (4.582 – 14.944) *	1.253 (1.177 – 1.334) *
	20-24	6.613 (3.791 – 11.537) *	1.236 (1.164 – 1.312) *
	25-29	4.165 (2.302 – 7.538) *	1.178 (1.102 – 1.260) *
	30-34	3.536 (1.960 – 6.380) *	1.142 (1.068 – 1.222) *
	35+ years	ref.	ref.
Health Insurance	No	0.857 (0.768 – 0.957) *	0.982 (0.972 – 0.991) *
	Yes	ref.	ref.
Marital Status	Never Married	0.225 (0.070 – 0.723) *	0.688 (0.549 – 0.862) *
	Married	4.054 (1.509 – 10.890) *	1.148 (1.027 – 1.283) *
	Living with Partner	2.192 (0.807 – 5.955)	1.020 (0.880 – 1.184)
	Divorced/Widowed	6.792 (2.426 – 19.016) *	1.152 (1.032 – 1.286) *
	Separated	3.357 (1.012 – 11.136) *	1.132 (1.008 – 1.272) *
	Not Living Together	ref.	ref.
Mother's Employment Status	Not Working	0.761 (0.684 – 0.845)*	0.982 (0.973 – 0.992) *
	Working	ref.	ref.
Mother's Education Level	No Education	4.263 (2.856 – 6.363) *	1.147 (1.103 – 1.192) *
	Elementary School	2.109 (1.727 – 2.575) *	1.092 (1.063 – 1.122) *
	Junior High School	1.394 (1.109 – 1.753) *	1.050 (1.022 – 1.080) *
	Senior High School	1.105 (0.927 – 1.318)	1.025 (1.003 – 1.047) *
	Academy/DI/DII/DIII	0.879 (0.682 – 1.132)	0.980 (0.943 – 1.020)
	DIV/ University	ref.	ref.
Household Head's Age	15-24	0.248 (0.128 – 0.339)	0.713 (0.654 – 0.777) *
	25-44	1.740 (1.470 – 2.060) *	1.075 (1.055 – 1.096) *
	45-64	0.939 (0.806 – 1.095)	1.020 (1.005 – 1.035) *
	65+	ref.	ref.
Birth Order	1	5.303 (3.265 – 8.613) *	1.171 (1.117 – 1.227) *
	2-3	1.838 (1.111 – 3.043) *	1.056 (1.009 – 1.105) *
	4-6	1.007 (0.577 – 1.756)	1.004 (0.951 – 1.061)
	7+	ref.	ref.
Interval Between Marriage and First Birth	0-11 Months	0.961 (0.819 – 1.127)	0.993 (0.981 – 1.007)
	12-23 Months	1.035 (0.889 – 1.127)	1.000 (0.989 – 1.011)
	24-35 Months	1.084 (0.884 – 1.329)	1.000 (0.987 – 1.013)
	36+ Months	ref.	ref.
Tetanus Toxoid Injection	No	1.099 (0.958 – 1.261)	1.005 (0.993 – 1.016)
	Yes	ref.	ref.

**AOR: Adjusted Odds Ratio; Model I: Individual level factors; Model II: Individual and Province level*

The results of the random-effects variances, as shown in Table 5, indicate that in model I (which represents individual factors), the variation in infant mortality was 0.043. When taking into account the community factors in, the province-level random-effects variance was 0.282, indicating remaining heterogeneity in infant mortality across provinces. ICC (Intraclass Correlation Coefficient) describes the extent to which the variation in infant mortality can be attributed to individual and community factors. In this case, the ICC was 1.2% in Model I and increased to 7.9% in Model II, indicating that province-level clustering accounted for a larger proportion of the total variation after considering community-level factors.

Table 5. Random Effects and Model Fit

	Model I	Model II
Measurement of Random Effects Variation		
Variance	0.043	0.282
ICC (%)	1.2%	7.9%
MOR	1.217	1.656
Model fit statistics		
Deviance	1640652.0	312135.2
AIC	1640654.0	312137.2
BIC	1640663.3	312146.6

Model I: Individual level factors; Model II: Individual and Province level

MOR (Median Odds Ratio) is a measure that describes the magnitude of the variation in the risk of infant mortality among individual and community groups. In this context, an MOR value of 1.217 indicates that the median odds ratio between two individuals who have different characteristics at the individual level is about 1.217. This means that individuals in a group with characteristics that are more likely to experience a certain outcome tend to have odds (probability ratio) that are about 1.217 times higher than individuals in another group. Finally, an MOR value of 1.656 indicates that the median odds ratio between individuals in two different groups, considering both individual and group-level factors, is about 1.656. This illustrates the combined influence of individual and group factors on the odds of an individual being more likely to experience a certain outcome compared to individuals in another group.

Discussion

This study aims to evaluate the factors associated with infant mortality under one year and provides an important contribution to the understanding of infant mortality determinants. Interesting findings show that mothers who experienced their first birth in various age ranges, such as 10-14 years, 15-19 years, 20-24 years, 25-29 years, and 30-34 years, had higher odds of infant mortality than mothers who gave birth in the age group of over 35 years. This is consistent with previous studies, which indicates that maternal age at birth plays an important role in the risk of infant mortality (Mulugeta et al., 2022; Fenta et al., 2022; Gebreegziabher et al., 2023). This finding is in line with literature that has highlighted higher health risks in mothers who are pregnant at too young or too old an age. Previous studies have shown that mothers who are pregnant at too young an age have a higher risk of pregnancy complications, such as anemia, malnutrition, and premature birth (de la Calle et al., 2021). These factors can contribute to a higher infant mortality rate because infants born prematurely or with low birth weight have a greater risk of serious health problems. On the other hand, mothers who are pregnant at an older age may also face higher health risks, such as chronic diseases or medical complications that are more common at an older age (Das et al., 2025). Pregnancy at an older age can also be associated with an increased risk of premature birth and low birth weight infants, which can ultimately increase the risk of infant mortality.

For mothers who did not experience childbirth within one year, there was a significant increase in the risk of infant mortality under one year of age (Mulugeta et al., 2022; Zaly et al., 2024). One of the reasons for this is the effect of previous experience. Mothers who have experienced previous births may have better knowledge and experience in caring for infants, recognizing danger signs, and dealing with infant health problems. This experience can enable mothers to respond to infant health needs more quickly and effectively, which can ultimately reduce the risk of infant mortality. In this context, it may be important to note that mothers who have not experienced childbirth within a year may face certain challenges or conditions that affect their ability to care for and maintain their infants well.

In the context of marital relationships, the study results show a significant link between parents' marital status and the risk of infant mortality under one year of age (Suryaningrum et al., 2023). Parents who have never been married have a lower risk of infant mortality than parents who are no longer living with their partner. However, interestingly, parents who are married have a higher risk of infant mortality compared to parents who have never been married. These findings may reflect the complexity of marital relationships, where factors such as economic pressure, interaction between partners, or psychosocial factors may affect the well-being and care of infants.

The study also found that similar findings apply to parents who are widowed or divorced. Parents in this status have a higher risk of infant mortality compared to parents who have never been married. This may be explained by the challenges faced by single parents, both in terms of social support, economics, and infant care. Similarly, similar findings were also found in divorced parents. Divorced parents have a higher risk of infant mortality compared to parents who have never been married. Factors related to the divorce process, such as psychosocial stress or changes in family dynamics, may play a role in influencing the risk of infant mortality in this group. Overall, these findings highlight the complexity of the relationship between marital status and the risk of infant mortality. Social, economic, and psychosocial factors in the context of marital status may have diverse impacts on infant well-being and care, which need to be considered in efforts to reduce the risk of infant mortality in this population. These findings provide an overview that social support and stable relationships can have a positive impact on maternal and infant well-being (Stein Elger et al., 2025).

The findings of this study indicate an interesting relationship between health insurance and the risk of infant mortality under one year of age (Johnson et al., 2023). The results show that individuals who use health insurance actually have higher odds of infant mortality compared to individuals who do not have health insurance. Although seemingly counterintuitive, this finding can be explained by several possible factors. One possible explanation is that individuals who use health insurance may have limited access to quality health services. Factors such as low quality of health services, delays in medical services, or lack of access to adequate medical facilities can affect the health and well-being of infants. In addition, this counterintuitive result may also reflect broader socioeconomic problems. For example, groups with health insurance may face higher economic pressure or have lower education levels, which in turn can affect their healthcare behaviour and lifestyle. This may lead to the use of health insurance as a complex and deeper indicator than just access to medical care.

In addition to health insurance, mother's employment status has also been shown to be a factor influencing infant mortality (Amir-ud-Din et al., 2022). This may reflect the greater role of non-working mothers in providing intensive care to their infants, as they have more time to allocate to caring for and maintaining their infants' health. They can give more intensive attention to infant care, presenting an important factor in monitoring and handling any changes in infant health conditions more effectively. On the other hand, working mothers may face additional challenges. They have to manage time and commitments between work and infant care, which can be a complicated task. In some cases, time constraints or accessibility to healthcare may affect their ability to respond to infant health needs optimally. In this situation, effective coordination and support from the work environment and family can play an important role in helping working mothers provide good care for their children, and this is an area that can be a focus for improvement in efforts to reduce the risk of infant mortality.

Mother's education level also plays an important role in determining the risk of infant mortality (Sutlović & Graovac, 2023; Atkins et al., 2024; Madichie, et al., 2026). The results show that the higher the mother's education level, the lower the risk of infant mortality. Mothers with higher education tend to have better knowledge and awareness about infant health, as well as the ability to follow appropriate health practices (Kumalasari, 2024). Maternal education also has a positive impact on the application of healthy lifestyles in the family and the possibility of gaining better access to health information. In addition, educated mothers tend to be more aware of nutrition, the use of contraception to regulate birth spacing, and awareness of childhood diseases and care (Fenta et al., 2022).

The study results show an interesting pattern related to the age of the household head and its impact on the risk of infant mortality. In the 15-24 years age group, household heads have lower odds of infant mortality, indicating protection for infant well-being. This may be associated with factors such as relatively good health at a young age, greater access to health information, and perhaps stronger social support in this age group. However, when the household head is in the 25-44 years age group, findings show an increased risk of infant mortality. This can be caused by various factors such as greater responsibility for family and work, and possible exposure to higher pressure and stress. These factors may affect the household head's ability to provide adequate attention and care for the infant, which in turn can negatively impact infant health. Meanwhile, in the 45-64 years age group, there is still an increased risk of infant mortality, although not as large as in the 25-44 years age group. This may reflect health challenges that older age groups may

face, such as decreased physical function, chronic conditions, and increased risk of medical complications. Overall, these findings indicate that the age of the household head has a complex relationship with the risk of infant mortality. Factors such as health, responsibility, and pressure in various age groups can affect the household head's ability to provide optimal care for infants. Therefore, special attention needs to be paid to the support and health services provided to certain age groups to reduce the risk of infant mortality in Indonesia.

The last finding shows that birth order is also a factor related to the risk of infant mortality (Mulugeta et al., 2022). This indicates that first-born children have a higher risk level because they are born to parents who are not yet economically stable and are less experienced in child care. In addition, many first-born children are born prematurely and have lower birth weights, making them very vulnerable to health risks and mortality (Mosli, 2021). Therefore, this shows that it is important for policymakers and health workers to pay special attention to mothers who are giving birth for the first time. Given that these children are born to young women, it is necessary to develop better antenatal and prenatal facilities, which can help first-time mothers who may not be fully prepared to face the role of a mother. In addition, these mothers may lack adequate knowledge about postpartum care and have difficulty accessing institutional medical services (Adams et al., 2023). Previous studies have also linked the risk of infant mortality to birth order, with some studies showing that infants born in lower birth orders tend to have a higher risk of mortality

CONCLUSION

The results of this study provide valuable insights into the factors associated with infant mortality in Indonesia using data from the 2017 IDHS. Ke determinant or infant mortality risk includes health insurance, mother's employment status, mother's education level, household head's age, and birth order. The multilevel approach used in this study accounts for the hierarchical structure of the data, with individual nested within provinces. The relatively high ICC value shows that province-level differences explain a considerable share of the variation in infant mortality. This approach improves interpretability and validity of results and highlights the importance of addressing regional disparities in policy design. The findings provide actionable evidence for designing policies and intervention programs to improve infant health and reduce mortality, while emphasizing the need for equitable access to health services, investments in education, and integrated family- and community-based health initiatives for long-term impact.

AUTHOR CONTRIBUTION STATEMENT

YA conducted data collection, performed the analysis, and drafted the manuscript. MYW conceived the study, provided major guidance on the research design and analysis, reviewed the manuscript, and served as the corresponding author. SI contributed to supervision and provided input on methodology and interpretation of the results. MLW contributed through general support and constructive feedback on the manuscript. All authors reviewed and approved the final version of the manuscript.

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