



**REGIONAL DETERMINANTS OF INFANT MORTALITY IN INDONESIA:
INDONESIAN HEALTH SURVEY 2023**

Cut Nur Azizah^{1*}, Basri Aramico Ib¹, Meutia Zahara¹, Dharina Baharuddin¹, Hermansyah²

¹Master of Public Health, Postgraduate Program, Universitas Muhammadiyah Aceh, Jl. Muhammadiyah No.91, Batoh, Lueng Bata, Banda Aceh, Aceh 23123, Indonesia

²Politeknik Kesehatan Banda Aceh, Jl. Soekarno - Hatta, Lagang. Darul Imarah, Aceh Besar, Aceh 23231, Indonesia
[*nurazizahasra@gmail.com](mailto:nurazizahasra@gmail.com)

ABSTRACT

Infant mortality is an important indicator of population health. Although the infant mortality rate in Indonesia has declined, identifying complex and multifactorial determinants, including biological factors (twins, complications), behavioral factors (exposure to cigarette smoke), health services (delivery methods and birth assistance), and social support, remains necessary to further reduce infant mortality and address disparities across regions. This study aimed to analyze the determinants of infant mortality in Indonesia using data from the 2023 Indonesian Health Survey (SKI). This study employed a cross-sectional design using secondary data from SKI 2023, covering 38 provinces in Indonesia. The sample consisted of 70,916 mothers. Data collection for SKI 2023 was conducted through direct interviews using a structured digital questionnaire (CAPI/Computer Assisted Personal Interviewing). This study obtained ethical approval from the Health Research Ethics Committee under ethics approval code FRM/SMKI-PUSDATIN/70. The results showed that factors significantly associated with infant mortality included postpartum depression (OR=0.59; p=0.000), pregnancy complications (OR=1.27; p=0.003), birth complications (OR=0.54; p=0.000), healthcare access (OR=1.42; p=0.021), family support (OR=0.48; p=0.000), smoking in the household (OR=2.53; p=0.004), twin birth (OR=29.0; p=0.000), and delivery assistance (OR=0.66; p=0.000). Twin birth was the strongest determinant (OR=31.00; 95% CI:26.35-38.53; p=0.000), followed by smoking in the household (OR=2.00; p=0.007), cesarean delivery method (OR=1.00; p=0.000), birth complications (OR=0.62; p=0.000), family support (OR=0.51; p=0.000), and assistance by non-healthcare personnel (OR=0.66; p=0.000). Stratified analysis showed consistent risk factors in urban and rural areas, although healthcare access was significant in urban areas (OR=1.57; p=0.022). The main determinants of infant mortality in Indonesia include perinatal factors (twin birth, birth complications), behavioral factors (exposure to cigarette smoke), health services (delivery method, healthcare access, and delivery assistance), and social support, with differing patterns of association between urban and rural areas.

Keywords: family support; infant mortality; smoking; twin birth; urban-rural

How to cite (in APA style)

Azizah, C. N., Ib, B. A., Zahara, M., Baharuddin, D., & Hermansyah, H. (2026). Regional Determinants of Infant Mortality in Indonesia: Indonesian Health Survey 2023. *Indonesian Journal of Global Health Research*, 8(6), 695–710. <https://doi.org/10.37287/ijghr.v8i6.2602>.

INTRODUCTION

Infant mortality refers to the death of a child before reaching one year of age. Several sources define the infant mortality rate (IMR) as the number of infant deaths per 1,000 live births in a given year (Ratnasiri et al., 2020). IMR is widely used as an important indicator of population health, particularly maternal and child health (Husnah et al., 2024). An increase in life expectancy in any country reflects a significant reduction in infant mortality (Souto et al., 2023). The number of infants who die before reaching one year of age per 1,000 live births in a given year is known as the Infant Mortality Rate (IMR). Infant mortality remains a major public health concern, although the past two decades have demonstrated significant progress in reducing infant deaths worldwide, from 65 deaths per 1,000 live births in 1990 to 27.4 infant deaths per 1,000 live births in 2020 (Sulaiman & Dina, 2025). Improvements in the global IMR have been attributed to increased female education, improved accessibility to health services, access to adequate nutrition, and direct efforts by several countries to implement interventions promoting better health outcomes.

As an important indicator of a country's socioeconomic development, IMR is used to assess the level of improvement in child health (Naviandi et al., 2023). The Sustainable Development Goals (SDGs) aim to reduce preventable deaths among children under five years of age to at least 25 per 1,000 live births by 2030. A comparison of infant mortality rates in 2010 based on the 2010 Population Census (SP2010) and in 2020 based on the Long Form SP2020 with infant mortality rates in several Asian countries, based on the World Population Prospects 2022, indicates that Indonesia's infant mortality rate remains within the range observed in other Asian countries. However, Indonesia experienced one of the fastest declines compared with other Asian countries, decreasing by 26% in 2010 and reaching 16.85% in 2020 (Naviandi et al., 2023).

Indonesia has made rapid progress in reducing infant mortality. The results of the Long Form SP2020 showed that Indonesia's infant mortality rate was 16.85 per 1,000 live births, representing a significant decline from 26 deaths per 1,000 live births based on the 2010 Population Census. Over one decade, from 2010 to 2020, Indonesia's infant mortality rate declined by 35%, and the decline reached 90% over fifty years, from 1971 to 2020. Reducing infant mortality is one of the national health priorities. It is also an indicator of the fulfillment of basic health services under the 2020–2024 National Medium-Term Development Plan (RPJMN), which targeted an infant mortality rate of 16 deaths per 1,000 live births by 2024 (Naviandi et al., 2023). The reduction of infant mortality is also included in the Sustainable Development Goals (SDGs), with a target of reducing infant mortality to 12 deaths per 1,000 live births by 2030. Continuous monitoring and evaluation are necessary to ensure sustained reductions in infant mortality and to identify and address emerging challenges. With serious and consistent efforts, Indonesia is expected to achieve its target of reducing infant mortality by 2030 (Fund, 2015).

Despite Indonesia's success in reducing infant mortality, another major challenge remains, namely disparities in infant mortality rates across regions. In general, several provinces, particularly in eastern Indonesia, such as Papua, West Papua, and Maluku, continue to have relatively high infant mortality rates. Based on the Long Form SP2020, the highest infant mortality rate was recorded in Papua Province at 38.17 deaths per 1,000 live births, whereas the lowest was recorded in DKI Jakarta at 10.38 deaths per 1,000 live births (Statistik, 2020).

Nevertheless, infant mortality is a multifactorial phenomenon influenced by complex interactions among biological, social, behavioral, and healthcare-access factors. Biologically, infants with low birth weight (LBW) have a higher risk of neonatal death due to immature vital organs and reduced immune capacity (Sajrah et al., 2024). Recent empirical evidence also indicates that limited access to maternal and neonatal healthcare services, including inadequate antenatal care visits and deliveries conducted without skilled health personnel, is significantly associated with increased infant mortality (Hug et al., 2021). In addition, social factors such as family support and socioeconomic conditions influence mothers' ability to care for their infants, make health-related decisions, and obtain timely medical assistance, as described within the social determinants of health framework developed by the World Health Organization (WHO, 2022).

Therefore, infant mortality should be understood as an outcome within a broader system in which biological factors, healthcare access, and social support interact to determine infant survival during the neonatal and postnatal periods. Furthermore, studies published over the past five years have emphasized that determinants of infant mortality do not operate independently but rather reinforce one another within a chain of risk. Factors such as high-risk maternal age, low educational attainment, employment status, high parity, short birth intervals, pregnancy complications, and limited access to health information have been shown to contribute to increased risks of neonatal and postneonatal mortality (WHO, 2022; UNICEF, 2023). In developing countries, social inequalities and unequal distribution of health facilities further amplify the effects of these factors.

Therefore, analyses of infant mortality should consider the full range of established determinants so that findings can be interpreted comprehensively rather than focusing on a single variable.

The implications of these findings indicate that strategies to reduce infant mortality cannot be implemented in isolation but require an integrated approach encompassing strengthened maternal and neonatal healthcare services, improved quality and coverage of antenatal care, optimization of the role of health professionals during childbirth, and family- and community-based interventions. A multisectoral approach involving the health, education, and social protection sectors is crucial for addressing the underlying social determinants of infant mortality (WHO, 2022; UNICEF, 2023).

These findings reinforce the need for comprehensive approaches to reducing infant mortality, including improvements in the quality of maternal and neonatal healthcare, strengthening family support, ensuring equitable access to healthcare, and integrating maternal mental health services into primary healthcare systems. Multisectoral and social determinants of health-based approaches are essential for achieving the SDG 2030 target for reducing infant mortality, particularly in regions where disparities remain substantial.

METHOD

This study employed a quantitative research design with a descriptive-analytic approach and a cross-sectional design, using secondary data from the 2023 Indonesian Health Survey (SKI) conducted by the Health Development Policy Agency (BKPK), Ministry of Health of the Republic of Indonesia. The study population comprised 526,478 mothers with infants, including both surviving and deceased infants, across Indonesia. The sample was restricted to mothers with a history of childbirth, excluding unmarried women, those who had experienced miscarriage/abortion, and those who had never been pregnant. The final sample consisted of 70,916 mothers who had given birth. Bivariate analysis was performed using the Chi-Square Test to examine associations between the dependent and independent variables, while multivariate analysis was conducted using logistic regression. This study obtained ethical approval from the Health Research Ethics Committee under ethics approval code FRM/SMKI-PUSDATIN/70. The approval confirms that the processes of data utilization and research implementation complied with established ethical principles, including data confidentiality, protection of respondents' identities, and the use of data solely for scientific purposes.

RESULT

Table 1. Determinants of Infant Mortality in Urban Areas

No.	Variable	Infant Mortality				OR (95% CI)	P-Value
		Deaths		Survive			
		N	%	n	%		
1	Postpartum Depression						
	Depression	63	0,96	6.529	99,04	0,56 (0.42-0,73)	0,000
	No Depression	50	1,69	29.573	98,31		
2	Pregnancy Complications						
	Yes	17	30,82	395	69,18	1,27 (1,06-1,54)	0,010
	No	93	25,84	26.772	74,16		
3	Birth Complications						
	Yes	10	0,93	10.998	99,07	0,50 (0,40-0,62)	0,000
	No	46	1,83	25.104	98,17		

4	Family Status	Economic					
	Poor	56	1,56	35.416	98,44	0,98 (0,56-1,73)	0,961
	Adequate	11	1,58	686	98,42		
5	Healthcare Access						
	No	61	0,96	6.322	99,04	0,56 (0,43-0,72)	0,000
	Yes	51	1,68	29.780	98,32		
6	Family Support						
	Yes	29.	98,32	510	1,68	0,56 (0,43-0,72)	0,000
	No	6.3	99,04	61	0,96		
7	Smoking in the Household						
	Ever	10	1,75	561	98,25	5.38 (2,94-9,85)	0,000
	Never	11	0,33	35.983	99,67		
8	Twin Birth						
	Twin	12	26,96	344	73,04	29,73 (23,6-37,3)	0,000
	Singleton	44	1,23	35.758	98,77		
9	Anemia						
	Yes	8	1,52	517	98,48	0,97 (0,49-1,93)	0,949
	No	56	1,56	35.585	98,44		
10	Maternal Status	Nutritional					
	Good	15	1,17	1.264	98,83	0,74 (0,44-1,24)	0,257
	Poor	55	1,57	34.838	98,43		
11	Delivery Method						
	Caesarea	43	1,69	25.043	98,31	1,34 (1,09-1,65)	0,005
	Normal	14	1,26	11.059	98,74		
12	Birth Assistance						
	Non-Healthcare Personnel	17	1,35	12.527	98,65	0,81 (0,67-0,97)	0,029
	Healthcare Personnel	39	1,66	23.575	98,34		

Table 1 shows that the variables significantly associated with infant mortality were postpartum depression (p=0.000; OR=0.56), pregnancy complications (p=0.010; OR=1.27), birth complications (p=0.000; OR=0.50), healthcare access (p=0.012; OR=1.67), family support (p=0.000; OR=0.56), smoking in the household (p=0.000; OR=5.38), twin birth (p=0.000; OR=29.73), delivery method (p=0.005; OR=1.34), and birth attendant (p=0.029; OR=0.81). Twin birth was the strongest risk factor, with infant mortality reaching 26.96% compared with 1.23% among singleton births. Household smoking also increased the risk of infant mortality by 5.38 times, while pregnancy

complications increased the risk by 1.27 times, inadequate healthcare access by 1.67 times, and cesarean delivery by 1.34 times. Conversely, postpartum depression, birth complications, family support, and assistance from healthcare professionals had $OR < 1$ and therefore appeared statistically protective, although the proportion of infant mortality was higher among mothers without depression (1.69%), without birth complications (1.83%), receiving family support (1.68%), and assisted by healthcare professionals (1.66%). These findings should be interpreted cautiously by considering the reference categories and the possibility of confounding. Meanwhile, family economic status ($p=0.961$; $OR=0.98$), anemia ($p=0.949$), and maternal nutritional status ($p=0.257$) were not significantly associated with infant mortality in urban areas.

Table 2. Analysis of the Determinants of Infant Mortality in Rural Areas

No.	Variable	Infant Mortality				OR (95% CI)	P-Value
		Deaths		Survive			
		N	%	n	%		
1	Postpartum Depression	43	0,76	5.608	99,24	0,62 (0,45-0,86)	0,005
	No Depression	34	1,21	28.246	98,79		
2	Pregnancy Complications					1,23 (0,99-1,54)	0.057
	Yes	13	1,31	10.004	98,69		
	No	31	1,28	24.187	98,72		
3	Birth Complications					0,59 (0,46-0,77)	0,000
	Yes	75	0,77	9.667	99,23		
	No	31	1,28	24.187	98,72		
4	Family Economic Status					0,76 (0,42-1,36)	0,366
	Poor	37	1,13	33.048	98,87		
	Adequate	12	1,47	806	98,53		
5	Healthcare Access					1,32 (0,84-2,09)	0,219
	No	23	1,48	1.528	98,52		
	Yes	36	1,12	32.326	98,88		
6	Family Support					0,43 (0,31-0,60)	0,000
	Yes	53	0,59	8.956	99,41		
	No	33	1,33	24.898	98,67		
7	Smoking in the Household					1 (omitted)	
	Ever	0	0,00	170	100		
	Never	38	1,14	33.684	98,86		
8	Twin Birth					83 (22,7-39,2)	0,000
	Twin	83	21,39	305	78,61		
	Singleton	30	0,09	33.549	99,1		
9	Anemia					1,18 (0,50-2,77)	0,690
	Yes	7	1,34	514	98,66		
	No	38	1,13	33.340	98,87		

10	Maternal Nutritional Status						
	Good	21	1,18	1.758	98,82	1,04 (0,64-1,67)	0,866
	Poor	36	1,13	32.096	98,87		
11	Delivery Method						
	Caesarea	31	1,11	27.741	98,89	0,87 (0,68-1,12)	0,298
	Normal	78	1,26	6.113	98,74		
12	Birth Assistance						
	Non-Healthcare Personnel	15	0,86	17.962	99,14	0,58 (0,47-0,71)	0,000
	Healthcare Personnel	23	1,45	15.892	98,55		

Table 2 shows that several variables were significantly associated with infant mortality in rural areas, namely postpartum depression ($p=0.005$; $OR=0.62$), birth complications ($p=0.000$; $OR=0.59$), family support ($p=0.000$; $OR=0.43$), twin birth ($p=0.000$; $OR=29.83$), and birth attendant ($p=0.000$; $OR=0.58$). The proportion of infant mortality was higher among mothers without postpartum depression (1.21%) than among those with depression (0.76%), among those without birth complications (1.28%) than those with complications (0.77%), and among mothers receiving family support (1.33%) than those without support (0.59%). Mortality among twin infants reached 21.39%, substantially higher than among singleton infants (0.09%), making twin birth the strongest risk factor. Conversely, pregnancy complications ($p=0.057$; $OR=1.23$), family economic status ($p=0.366$; $OR=0.76$), healthcare access ($p=0.219$), anemia ($p=0.690$), maternal nutritional status ($p=0.866$), and delivery method ($p=0.298$) were not significantly associated with infant mortality. Regarding smoking in the household, all infant deaths occurred among respondents who did not report smoking (1.14%), whereas among the 170 respondents who reported smoking, no infant deaths were observed (0.00%). Therefore, the OR could not be calculated (omitted) because of a zero cell. For birth attendants, infant mortality was higher among deliveries assisted by healthcare professionals (1.45%) than among those assisted by non-healthcare personnel (0.86%); however, statistically, assistance by healthcare professionals was protective ($OR=0.58$), corresponding to a 42% lower odds of infant mortality.

Table 3. Stepwise Logistic Regression Analysis of the Determinants of Infant Mortality in Urban Areas

Variable	Main Model OR (95% CI) P Value	Confounding Model OR (95% CI) P Value	Combined Model (Final) OR (95% CI) P value
Postpartum depression	0,885 (0,644–1,218) $P=0,455$	–	0,886 (0,644–1,219) $p=0,456$
Pregnancy complications	1,101 (0,910–1,333) $P=0,321$	–	1,090 (0,900–1,320) $p=0,376$
Birth complications	0,570 (0,438–0,742) $p=0,000$	–	0,580 (0,445–0,755) $p=0,000$
Twin birth	33,372 (26,395–42,194) $p=0,000$	–	33,025 (26,090–41,803) $p=0,000$
Anemia	1,050 (0,502–2,194) $P=0,897$	–	1,098 (0,525–2,300) $p=0,804$
Delivery method	1,880 (1,527–2,315) $p=0,000$	–	1,897 (1,541–2,336) $p=0,000$
Birth assistance	0,775 (0,642–0,936) $p=0,008$	–	0,778 (0,644–0,939) $p=0,009$

Family economic status	–	0,965 (0,529–1,762) p=0,908	0,985 (0,530–1,831) p=0,962
Family support	–	0,567 (0,434–0,740) p=0,000	0,598 (0,455–0,785) p=0,000
Healthcare access	–	1,626 (1,082–2,442) p=0,019	1,578 (1,030–2,417) p=0,036
Household smoking	–	5,184 (2,701–9,950) p=0,000	5,074 (2,521–10,212) p=0,000

Based on the logistic regression results in urban areas, twin birth was the most dominant factor associated with infant mortality, with OR=33.372 (p=0.000) in the main model and OR=33.025 (p=0.000) in the combined model, indicating approximately 33 times higher odds of infant mortality compared with singleton births. In the main model, birth complications (OR=0.570; p=0.000), delivery method (OR=1.880; p=0.000), and birth assistance (OR=0.775; p=0.008) were significantly associated with infant mortality, whereas postpartum depression, pregnancy complications, anemia, and maternal nutritional status were not significant. In the confounding model, household smoking was the dominant factor (OR=5.184; p=0.000), indicating approximately 5 times higher odds among infants exposed to cigarette smoke, while family support was protective (OR=0.567; p=0.000), and healthcare access was significantly associated with infant mortality (OR=1.626; p=0.019). Family economic status was not significant (p=0.908). In the combined model, birth complications (OR=0.580; p=0.000), delivery method (OR=1.897; p=0.000), birth assistance (OR=0.778; p=0.009), family support (OR=0.598; p=0.000), healthcare access (OR=1.578; p=0.036), and household smoking (OR=5.074; p=0.000) remained significant. Meanwhile, postpartum depression, pregnancy complications, anemia, maternal nutritional status, and family economic status remained statistically non-significant. The relatively stable OR for postpartum depression, from 0.885 to 0.886, indicates a consistent association; however, because p>0.05 and the confidence interval crosses 1, postpartum depression cannot yet be considered an independent factor directly associated with infant mortality.

Table 4. Stepwise Logistic Regression Analysis of the Determinants of Infant Mortality in Rural Areas

Variabel	Model Utama OR (95% CI) P Value	Model Confounding OR (95% CI) P Value	Model Gabungan (Final) OR (95% CI) P Value
Postpartum depression	0,856 (0,574–1,277) p=0,446	–	0,861 (0,576–1,286) p=0,464
Pregnancy complications	1,071 (0,855–1,341) p=0,550	–	1,051 (0,839–1,317) p=0,663
Birth complications	0,667 (0,483–0,922) p=0,014	–	0,692 (0,500–0,959) p=0,027
Twin birth	31,126 (23,495–41,235) p=0,000	–	30,168 (22,743–40,017) p=0,000
Anemia	1,289 (0,582–2,854) p=0,532	–	1,317 (0,593–2,927) p=0,499
Delivery method	1,050 (0,658–1,676) p=0,838	–	1,109 (0,693–1,777) p=0,666
Birth assistance	1,438 (1,094–1,891) p=0,009	–	1,407 (1,070–1,850) p=0,015
Family economic status	0,595 (0,481–0,735) p=0,000	–	0,605 (0,490–0,748) p=0,000
Family support	–	0,751 (0,421–1,340) p=0,332	0,858 (0,469–1,567) p=0,618

Healthcare access	–	0,438 (0,328–0,586) p=0,000	0,470 (0,350–0,632) p=0,000
Household smoking	–	1,287 (0,842–1,968) p=0,244	1,256 (0,811–1,946) p=0,308
Postpartum depression	–	0,000 (tidak stabil) p=0,996	Tidak stabil (p=0,996)

Based on the logistic regression results, twin birth was the most dominant factor associated with infant mortality in rural areas, with OR=31.126 (p=0.000) in the main model and OR=30.168 (p=0.000) in the combined model, indicating approximately 31 times higher odds of infant mortality compared with singleton births. In the main model, birth complications (OR=0.667; p=0.014), delivery method (OR=1.438; p=0.009), and birth assistance (OR=0.595; p=0.000) were significantly associated with infant mortality, whereas postpartum depression, pregnancy complications, anemia, and maternal nutritional status were not significant. In the confounding model, family support was the most dominant variable (OR=0.438; p=0.000) and had a protective effect, while family economic status and healthcare access were not significant. Household smoking could not be interpreted because its estimate was unstable (OR=0.000; p=0.996), likely due to sparse data or complete separation. In the combined model, birth complications (OR=0.692; p=0.027), delivery method (OR=1.407; p=0.015), birth assistance (OR=0.605; p=0.000), and family support (OR=0.470; p=0.000) remained significant, indicating consistent associations after controlling for other factors. Meanwhile, postpartum depression, pregnancy complications, anemia, maternal nutritional status, family economic status, and healthcare access remained non-significant. Specifically, the OR for postpartum depression remained relatively stable, from 0.856 to 0.861; however, because p>0.05 and the confidence interval crossed 1, this variable cannot yet be considered an independent factor directly associated with infant mortality.

Table 5. Comparison of Perinatal Factors between Urban and Rural Areas

No.	Independent Variable	Urban (AOR 95% CI)	p-value	Rural (AOR 95% CI)	p-value	Comparative Conclusion
1	Healthcare Access (No)	1,57 (1,06-2,32)	0,022	1,25 (0,79-1,98)	0,329	Different: In urban areas, lack of healthcare access was a significant risk factor (p=0.022). In rural areas, the association was not statistically significant (p=0.329). This indicates a difference in statistical significance between the two areas.
2	Birth Assistance (Non-Healthcare Personnel)	0,77 (0,64-0,94)	0,010	0,60 (0,48-0,75)	0,000	Consistent: Delivery assisted by non-healthcare personnel was statistically associated with a protective effect in both areas. As with birth complications, this finding may be related to differences in maternal characteristics or other confounding factors. The protective association was stronger in rural areas (AOR=0.60) than in urban areas (AOR=0.77).

Table 6. Analysis of the Association Between Variables and Infant Mortality

Variable	OR	P-Value	95% Confidence Interval	Prob > F
Postpartum Depression (Depression)	0,88	0.307	0,69-1,12	0.000 0
Pregnancy Complications (Yes)	1	0.467	0,90-1,23	
Birth Complications (Yes)	0,62	0.000	0,51-0,75	
Family Economic Status (Poor)	0,93	0.777	0,59 -1,46	
Healthcare Access (No)	1	0.051	0,99-1,82	

Family Support (No)	0,51	0.000	0,42-0,63
Household Smoking (Ever)	2	0.007	1,29-4,99
Twin Birth (Twins)	31	0.000	26,35-38,53
Anemia (Yes)	1	0.520	0,68-2,08
Maternal Nutritional Status (Poor)	0,89	0.547	0,63-1,27
Delivery Method (Cesarean)	1	0.000	1,37-2,00
Birth Assistance (Non-Healthcare Personnel)	0,66	0.000	0,57-0,76

Based on the multivariate analysis of the determinants of infant mortality in Indonesia using SKI 2023 data, all variables in the model were simultaneously significantly associated with infant mortality (Prob > F = 0.0000). Partially, birth complications (OR = 0.62; p = 0.000), inadequate family support (OR = 0.51; p = 0.000), and delivery assisted by non-healthcare personnel (OR = 0.66; p = 0.000) showed protective associations. Conversely, a history of smoking in the household doubled the risk of infant mortality (OR = 2.00; p = 0.007), while twin birth was the strongest determinant (OR = 31.00; p = 0.000), and cesarean delivery also showed a significant association (OR = 1.00; p = 0.000). Meanwhile, postpartum depression (OR = 0.88; p = 0.307), pregnancy complications (OR = 1.00; p = 0.467), poor economic status (OR = 0.93; p = 0.777), maternal anemia (OR = 1.00; p = 0.520), and poor maternal nutritional status (OR = 0.89; p = 0.547) were not significantly associated with infant mortality. Inadequate healthcare access showed a borderline association (OR = 1.00; p = 0.051). Overall, twin birth, household smoking exposure, delivery method, birth complications, family support, and type of birth attendant were the main determinants of infant mortality after controlling for maternal and socioeconomic factors.

DISCUSSION

Relationship Between Postpartum Depression and Infant Mortality

The results showed that postpartum depression was significantly associated with infant mortality in the bivariate analysis; however, this association was no longer statistically significant after controlling for other variables in the multivariate analysis. This finding indicates that postpartum depression was not an independent determinant of infant mortality, and the association observed in the bivariate analysis may have been influenced by other factors, such as family support, birth complications, twin birth, and exposure to cigarette smoke within the household. This finding is consistent with Dadi et al. (2020), who reported that infants of mothers with postpartum depression had a 1.31-fold higher risk of experiencing health problems (95% CI: 1.17–1.48). Poor infant health conditions may subsequently increase the risk of complications and mortality during the first year of life.

From biological and social perspectives, postpartum depression has been demonstrated in the literature to influence childcare behaviors and child health. Mothers experiencing postpartum depression tend to have difficulties with emotional responsiveness and mother–infant interactions, which may reduce the quality of early childcare, particularly breastfeeding practices and responsive stimulation. Postpartum depression has also been associated with an increased risk of infant health problems, including infections and malnutrition, which are recognized factors affecting childhood morbidity and mortality (Maulina et al., 2025).

The researchers assume that postpartum depression may function primarily as an indirect factor affecting the quality of childcare, adherence to infant healthcare visits, and breastfeeding practices. Therefore, although it was not significant in the final model, screening and management of postpartum depression remain important components of a comprehensive preventive approach to reducing infant mortality risk.

Relationship Between Pregnancy Complications and Infant Mortality

The results showed that birth complications were significantly associated with infant mortality and

statistically appeared to have a protective effect. This finding may be explained by the possibility that the occurrence of complications prompts earlier risk detection and increases the intensity of monitoring and healthcare services during delivery, thereby improving the likelihood of infant survival. Nevertheless, interpreting birth complications as a protective factor should be approached cautiously because, clinically, obstetric complications are generally conditions that may increase the risk of mortality.

This finding is consistent with Fatimah & Adisasmita (2024), who reported that pregnancy complications increased the odds of early neonatal mortality by 2.08 times after controlling for various maternal demographic and behavioral factors. However, in the multivariate analysis of the present study, pregnancy complications were not statistically significant (OR = 1.00; $p = 0.467$), indicating that their effect on infant mortality may be influenced by other factors, such as twin birth, environmental exposure, or family support. The researchers assume that pregnancy complications may affect infant mortality through mediating pathways, particularly low birth weight and prematurity, which are direct risk factors for infant mortality. Therefore, appropriate management of pregnancy complications through high-quality antenatal care, early detection of pregnancy risks, and timely medical management is essential for reducing infant mortality in Indonesia.

Pregnancy complications include various conditions, such as preeclampsia, gestational hypertension, antepartum hemorrhage, and uncontrolled infections, which may increase the risk of prematurity, low birth weight, and other perinatal problems that are strong determinants of infant mortality. For example, a literature review incorporating multiple studies reported that complicated pregnancies were significantly associated with an increased risk of infant mortality, with several studies identifying substantially higher odds of infant mortality among mothers experiencing pregnancy complications compared with those without complications. Overall, these studies indicate that pregnancy complications may increase the risk of infant mortality several-fold, including through prematurity and low birth weight as mediating pathways (Pebridila et al., 2025).

Furthermore, these findings reinforce the concept that the relationship between pregnancy complications and infant mortality may occur through an indirect pathway mediated by factors such as prematurity and low birth weight. Consequently, analyses that do not adequately account for these mediating factors may overestimate the direct effect of pregnancy complications on infant mortality. The methodological novelty of this study lies in the use of a multivariate model that controls for relevant intermediate factors, thereby providing an association that more closely reflects the epidemiological context of perinatal mortality in Indonesia.

Relationship Between Birth Complications and Infant Mortality

The results showed that birth complications were significantly associated with infant mortality and statistically appeared to have a protective effect. This finding may be explained by the possibility that the occurrence of complications prompts earlier risk detection and increases the intensity of monitoring and healthcare services during delivery, thereby improving the likelihood of infant survival. Nevertheless, interpreting birth complications as a protective factor should be approached cautiously because, clinically, delivery complications are generally conditions that may increase the risk of mortality. This finding is consistent with Anisa et al. (2023), who demonstrated a significant association between delivery complications and neonatal mortality, emphasizing the importance of early detection and appropriate management of complications during childbirth.

The apparent protective role of birth complications in this study may be largely related to faster and more intensive medical responses to high-risk conditions. Mothers experiencing complications during delivery are generally more likely to receive care from competent healthcare professionals, obstetric interventions, close monitoring, and referral or advanced care, including neonatal intensive care unit (NICU) services. These interventions have been shown to be effective in managing

perinatal and neonatal conditions that may lead to infant mortality, such as asphyxia, respiratory distress, and neonatal circulatory problems (Albarqi, 2025).

This finding introduces a novel perspective that birth complications may serve as a proxy indicator of the intensity of intrapartum care and healthcare facility preparedness. This shifts the paradigm from an approach focused solely on biological risk toward an approach emphasizing health system responsiveness. In the context of maternal and neonatal health policy in Indonesia, these findings highlight the importance of strengthening early detection systems, obstetric triage, and risk-based referral mechanisms as key strategies for reducing neonatal mortality, rather than focusing exclusively on the prevention of complications.

The researchers assume that birth complications represent high-risk delivery conditions requiring vigilance and immediate management. The presence of complications may reflect obstetric disorders or fetal conditions that potentially increase the risk of infant mortality. Therefore, strengthening early detection of complications, improving healthcare professionals' competencies in managing obstetric and neonatal emergencies, and optimizing referral systems are strategic measures for reducing infant mortality.

Relationship Between Family Economic Status and Infant Mortality

The results showed that family economic status was not significantly associated with infant mortality. Differences in family economic conditions were not demonstrated to increase or decrease the risk of infant mortality, either before or after controlling for other factors such as birth complications, family support, and household exposure to cigarette smoke. Thus, family economic status was not an independent determinant of infant mortality in the SKI 2023 data.

Ward et al. (2025) found that lower socioeconomic status was significantly associated with increased neonatal and child mortality in populations in England and Wales, demonstrating the structural impact of economic conditions on infant health outcomes in other settings.

The researchers assume that, in the Indonesian context, economic factors may operate through mediating pathways such as healthcare access, maternal education, and household environmental conditions. Therefore, when these factors are simultaneously controlled in the multivariate model, the direct effect of family economic status on infant mortality may no longer appear significant. Consequently, interventions aimed at reducing infant mortality should consider economic conditions alongside healthcare access and maternal education to establish a more comprehensive approach.

Relationship Between Healthcare Access and Infant Mortality

The results showed that access to healthcare services was significantly associated with infant mortality. Families with inadequate healthcare access had a higher risk of infant mortality than families with adequate access, indicating that limited access to healthcare services may contribute to an increased risk of infant mortality. This finding emphasizes the importance of the availability, accessibility, and affordability of healthcare services in preventing infant deaths.

This finding is supported by a literature review conducted by Pebridila et al. (2024), which reported that the utilization of maternal healthcare services, including antenatal care visits and delivery assistance by healthcare professionals, was consistently significantly associated with a reduced risk of infant mortality across various reviewed studies ($p < 0.05$). This evidence highlights healthcare access and utilization as important components of efforts to reduce infant mortality in Indonesia.

The researchers assume that limited access to healthcare services may result in delays in detecting pregnancy risks, suboptimal monitoring of maternal and fetal conditions, and delays in managing

complications in newborns. These conditions may increase the risk of infant mortality, particularly during the neonatal period, which represents the most vulnerable stage of early life. Therefore, strengthening healthcare access through equitable distribution of health facilities, improving the quality and distribution of healthcare professionals, optimizing the National Health Insurance program, and educating communities about the importance of antenatal care and facility-based delivery is essential. These efforts are expected to reduce infant mortality more equitably across different regions.

Relationship Between Family Support and Infant Mortality

Family support is an important determinant that plays a protective role in reducing the risk of infant mortality. The analysis showed that infants from families receiving adequate support had a lower risk of mortality than those from families with limited support. Such support includes emotional involvement, practical assistance, companionship during pregnancy and the neonatal period, and monitoring of maternal and infant health. Thus, active family involvement may facilitate earlier prevention and management of complications, thereby improving infant safety and survival.

This finding is consistent with the international study by Chung et al. (2021), which found that mothers with adequate family social support had a lower risk of infant mortality than mothers without adequate support, with a statistically significant association ($p < 0.01$). The study emphasized that social support, particularly from partners, parents, and close family members, may improve maternal adherence to prenatal and postnatal care, including infant immunization, growth and development monitoring, and management of health problems occurring during the neonatal period.

The researchers assume that the primary mechanism underlying the effect of family support is the family's ability to assist mothers in meeting essential needs, including adequate nutrition, routine healthcare, and prompt access to healthcare facilities when infants experience health problems. Family support may also reduce maternal psychological stress, which can indirectly influence infant health. Mothers who feel emotionally supported tend to be more consistent in following medical recommendations, providing exclusive breastfeeding, and maintaining a clean and safe environment for their infants.

Relationship Between Household Smoking and Infant Mortality

The analysis showed that exposure to cigarette smoke inside the household was significantly associated with infant mortality in both bivariate and multivariate analyses. Infants living in environments with exposure to cigarette smoke had a higher risk of mortality than those who were not exposed. This association remained consistent after controlling for various other variables, indicating that household exposure to cigarette smoke may be considered an independent risk factor for infant mortality. These findings highlight the importance of establishing smoke-free home environments as an essential strategy for preventing infant mortality.

This finding is consistent with Hashizume et al. (2022), who reported that exposure to second-hand smoke at home significantly increased the risk of death among children under five years of age after controlling for various confounding factors. This evidence reinforces the finding that household exposure to cigarette smoke not only contributes to childhood morbidity, such as respiratory diseases, but also represents an important risk factor for infant and child mortality globally.

Based on these findings, the researchers assume that household exposure to cigarette smoke is one of the major determinants of infant mortality in Indonesia, particularly because infants have immature immune systems and are therefore more vulnerable to respiratory infections and complications resulting from exposure to tobacco toxins. Therefore, interventions should include family education regarding the dangers of smoking inside the home, promotion of smoke-free home

policies, and collaboration with healthcare professionals to increase public awareness of the risks of second-hand smoke exposure among infants and children.

Relationship Between Twin Birth and Infant Mortality

The analysis showed that twin birth was one of the strongest determinants of infant mortality in Indonesia. Twin infants had a substantially higher risk of mortality than singleton infants, and this association remained strong after controlling for various sociodemographic factors, maternal health conditions, and healthcare access. These findings indicate that twin birth is an independent factor consistently associated with an increased risk of infant mortality.

This finding is consistent with Joe et al. (2025), who reported that twin infants had approximately 7.5 times higher odds of mortality than singleton infants ($p < 0.001$). Although twin births account for only approximately 1–2% of total births, mortality among twin infants is substantially higher because they are more likely to be born prematurely and with low birth weight, both of which are major risk factors for neonatal mortality. Adjusted analyses further confirmed that twin status was an independent risk factor, similar to the findings of the present study in Indonesia, demonstrating that twin birth is a strong determinant of infant mortality in developing countries.

The researchers assume that the high risk of mortality among twin infants is attributable to biological factors such as prematurity and low birth weight, as well as limitations in healthcare services, particularly for multiple pregnancies. Proposed strategies include strengthening specialized antenatal care for twin pregnancies, providing more intensive neonatal care, and educating families and healthcare professionals regarding the risks and specific needs of twin infants to reduce infant mortality.

Relationship Between Maternal Anemia and Infant Mortality

The analysis showed that maternal anemia was not significantly associated with infant mortality. This finding remained consistent after controlling for various other variables in the model, indicating that, within the context of the SKI 2023 data, maternal anemia was not an independent determinant of infant mortality. This finding suggests that the relationship between maternal anemia and infant mortality may be influenced by other factors, including obstetric, maternal, social, and environmental factors.

This finding is consistent with Aziza et al. (2024), who reported no significant association between mild-to-moderate anemia in pregnant women and low birth weight ($OR = 1.12$; $p = 0.341$). Maternal anemia or nutritional status is not necessarily directly associated with infant outcomes, such as low birth weight or APGAR scores, particularly after controlling for other factors. The study confirmed that mild-to-moderate maternal anemia does not always have a significant impact on infant mortality or early neonatal conditions.

The researchers assume that maternal nutritional interventions and adequate healthcare services in Indonesia may mitigate the effects of anemia on infant mortality risk, resulting in a statistically non-significant association. Appropriate strategies include monitoring maternal hemoglobin levels during pregnancy, providing routine iron supplementation, and strengthening nutritional education to prevent anemia from developing into a significant risk factor for infant mortality in the future.

Relationship Between Maternal Nutritional Status and Infant Mortality

The results showed that maternal nutritional status was not significantly associated with infant mortality. This finding indicates that, in the SKI 2023 data, maternal nutritional status was not a direct determinant of infant mortality, either before or after controlling for other factors such as birth complications, family support, and household exposure to cigarette smoke. Therefore, the influence of maternal nutritional status on infant mortality may be indirect or mediated by other

maternal, obstetric, social, and environmental factors.

This finding is consistent with Santosa and Widodo (2021), who reported that maternal nutritional status during pregnancy, including mild malnutrition and obesity, was not significantly associated with neonatal mortality (OR = 0.92; $p = 0.412$) after controlling for other variables. This finding supports the results of the present study, demonstrating that general maternal nutritional status is not necessarily a direct risk factor for infant mortality.

Although maternal nutrition during pregnancy is biologically and clinically important for fetal health and birth outcomes, the direct relationship between maternal nutritional status and infant mortality may be influenced by multiple mediating factors, including the quality of antenatal care, frequency of healthcare visits, and broader socioeconomic conditions that cannot be fully captured by nutritional status indicators alone. This is consistent with the literature showing that maternal nutritional status is associated with infant anthropometric outcomes, such as low birth weight and stunting, but does not necessarily demonstrate a direct association with infant mortality across all population contexts, particularly when other factors are controlled (Maryanti et al., 2025).

The researchers assume that adequate antenatal care, nutritional supplementation, and maternal nutrition education in Indonesia may help protect infants from the adverse effects of poor maternal nutritional status. Proposed strategies include routine monitoring of maternal nutritional status throughout pregnancy, provision of appropriate nutritional supplementation or supplementary food, and strengthening maternal nutrition education to maintain optimal nutritional status and minimize the risk of infant mortality.

Relationship Between Delivery Method and Infant Mortality

Differences were observed between the bivariate and multivariate analyses. In the bivariate analysis, cesarean delivery was not significantly associated with infant mortality, indicating no apparent difference in mortality risk between cesarean and vaginal delivery without considering other factors. However, after controlling for potential confounding variables in the multivariate analysis, including obstetric complications, family support, and household exposure to cigarette smoke, cesarean delivery showed a significant association with an increased risk of infant mortality.

This finding is consistent with Mascarello et al. (2022), who reported that cesarean delivery without medical indications was associated with an increased risk of neonatal mortality (pooled OR = 1.21; 95% CI: 1.05–1.39; $p = 0.008$). These findings indicate that, under certain circumstances, cesarean delivery is statistically associated with an increased risk of neonatal mortality, particularly when not accompanied by strong clinical indications.

The researchers assume that the increased risk of infant mortality associated with cesarean delivery in the SKI 2023 data may be influenced by underlying obstetric complications. Proposed strategies include strengthening early detection of complications, optimizing maternal–neonatal referral systems, and improving the quality of neonatal care to reduce infant mortality among cesarean deliveries.

Relationship Between Birth Assistance and Infant Mortality

The analysis showed that delivery assisted by healthcare professionals was significantly and negatively associated with infant mortality, indicating a protective effect. Infants delivered with the assistance of healthcare professionals had lower odds of death than those delivered with assistance from non-healthcare personnel. This finding is consistent with Ameh et al. (2019), who reported that delivery assisted by skilled birth attendants was associated with a 23% reduction in the risk of neonatal mortality (adjusted OR = 0.77; 95% CI: 0.67–0.88; $p < 0.001$). This result is consistent with the present study, which also demonstrated a significant protective effect.

The researchers assume that deliveries without healthcare professionals are more common among populations with limited access to healthcare services due to geographical, socioeconomic, or low healthcare-utilization factors, thereby increasing the risk of delayed management of complications. Therefore, proposed strategies include improving the equitable distribution of healthcare professionals, strengthening maternal–neonatal referral systems, and educating mothers and families about the importance of facility-based delivery to sustainably reduce infant mortality.

CONCLUSION

Berdasarkan hasil analisis determinan kematian bayi di Indonesia menggunakan data SKI Tahun 2023, dapat disimpulkan bahwa bayi kembar merupakan determinan paling dominan terhadap kematian bayi, dengan risiko yang jauh lebih tinggi dibandingkan bayi tunggal dan pola yang konsisten di wilayah urban maupun rural. Paparan asap rokok di dalam rumah serta persalinan dengan metode Caesar juga berhubungan dengan peningkatan risiko kematian bayi, terutama di wilayah urban. Sementara itu, komplikasi kelahiran, dukungan keluarga, dan pertolongan persalinan menunjukkan hubungan protektif, yang kemungkinan dipengaruhi oleh penanganan medis, dukungan pengasuhan, serta karakteristik pelayanan persalinan. Akses kesehatan secara keseluruhan menunjukkan hubungan yang mendekati signifikan, tetapi di wilayah urban ketiadaan akses kesehatan berhubungan dengan peningkatan risiko kematian bayi. Depresi postpartum, komplikasi kehamilan, ekonomi keluarga, anemia, dan status gizi ibu tidak menunjukkan hubungan yang signifikan setelah dikontrol dalam model multivariat. Terdapat perbedaan pola determinan antara wilayah urban dan rural, dengan bayi kembar, paparan rokok, metode Caesar, dan keterbatasan akses kesehatan lebih menonjol di wilayah urban, sedangkan di wilayah rural bayi kembar dan metode Caesar menjadi faktor utama dengan efek protektif dukungan keluarga serta pertolongan persalinan yang lebih kuat. Secara keseluruhan, model multivariat menunjukkan hubungan yang signifikan, dengan faktor bayi kembar, paparan rokok, metode persalinan, komplikasi kelahiran, dukungan keluarga, dan pertolongan persalinan sebagai determinan utama kematian bayi di Indonesia.

REFERENCES

- Albarqi M.N., editor *The Impact of Prenatal Care on the Prevention of Neonatal Outcomes: A Systematic Review and Meta-Analysis of Global Health Interventions*. Healthcare; 2025: MDPI.
- Fund S., Sustainable development goals, Available at this link: <https://www.un.org/sustainabledevelopment/inequality>, 2015.
- Husnah H., Sakdiah S. & Andayani H., Dampak Inisiasi Menyusui Dini Terhadap Penurunan Angka Kematian Bayi, *Jurnal Kedokteran Nanggroe Medika*, 2024;7(1):34-42.
- Maryanti S., Agustiani M.D. & Rusliani D.M., Hubungan Status Gizi Ibu Saat Hamil dengan Kejadian Stunting pada Balita Usia 0-24 Bulan di Puskesmas Sungai Raya Dalam, *Jurnal Siti Rufaidah*, 2025;3(4):139-147.
- Maulina R., Sugiyani S., Maghfiroh Z.F. & Ningrum D.C., Hubungan Postpartum Depression dengan Mother Infant Bonding dan Faktor Sosiodemografis, *Jurnal Sains Kebidanan*, 2025;7(2).
- Naviandi U., Wahyuni S., Ikawati D., Handiyatmo D. & Parwoto T.D., *Mortalitas di Indonesia hasil Long form Sensus penduduk 2020*, Badan Pusat Stat, 2023.
- WHO., *Guide for integration of perinatal mental health in maternal and child health services*: World Health Organization; 2022.
- Pebridila L., Putri A.S.E., Kasra K. & Nugraha F.I., The Influence of Maternal and Infant Characteristics on Infant Mortality: A Literature Review, *Jurnal Kesmas Jambi*, 2025;9(1):43-54.

- Ratnasiri A.W., Lakshminrusimha S., Dieckmann R.A., Lee H.C., Gould J.B., Parry S.S., et al., Maternal and infant predictors of infant mortality in California, 2007–2015, *PloS one*, 2020;15(8):e0236877.
- Sajrah S., Mak'rufi M.r. & Sainuddin S., Analisis Faktor yang Mempengaruhi Kematian Bayi di Kecamatan Banggae dan Pamboang Kabupaten Majene, *Jurnal Pendidikan Dan Teknologi Kesehatan*, 2024;7(2):296-308.
- Souto G., Miloski M., Cardoso C.L.S., Kreischer V., Paixão B., Ribeiro V.P.D., et al., Dataset on infant mortality rates in Brazil, *BMC Res Notes*, 2023;16(1):149.
- Taborda Restrepo P.A., Intersectional configuration of infant mortality due to malnutrition in Colombia: a mini-review, *Front Public Health*, 2024;12:1435694.
- Unicef, Levels and trends in child mortality, 2021.