MAPPING THE CAUSES OF NEONATAL DEATHS IN INDONESIA: INSIGHTS FROM AMPSR NEONATAL ASSESSMENTS

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ABSTRACT

Neonatal mortality remains a significant public health concern in Indonesia, with preventable causes persisting despite ongoing health interventions. This study aimed to map the causes and contributing factors of neonatal deaths in Indonesia using Maternal and Perinatal Audit and Surveillance Response (AMPSR) assesment. A scoping review method was employed, systematically searching three major databases for relevant articles published between 2021 and 2025. Twenty articles met the inclusion criteria and were analyzed narratively. The findings reveal that the leading direct causes of neonatal deaths include prematurity and its complications, birth asphyxia, neonatal infections, congenital anomalies, and neonatal tetanus. Indirect factors, such as maternal health conditions, inadequate antenatal care, health system limitations, and sociodemographic disparities, further exacerbate neonatal mortality risks. The results underscore the importance of integrated strategies that strengthen maternal and neonatal health services, improve care quality and access, and address broader social determinants. This study provides comprehensive evidence to inform policy and intervention priorities aimed at reducing neonatal deaths in Indonesia.

Keywords: Neonatal Mortality, AMPSR, Indonesia, Causes of Death, Maternal Health.

INTRODUCTION

Neonatal mortality continues to pose a critical public health challenge in low- and middle-income countries like Indonesia. Current evidence indicates that Indonesia's neonatal mortality rate is approximately 19 per 1,000 live births (Herlyssa et al., 2022). The main contributors to neonatal death namely low birth weight, prematurity, asphyxia, and sepsis have persisted over decades [2],[3]. Despite significant gains in reducing overall child mortality, neonatal deaths in Indonesia have stagnated, now constituting a large share of under-five mortality [4],[5]. The neonatal period is highly vulnerable due to preventable and treatable conditions, particularly prematurity, birth asphyxia, and infections. Studies in Indonesia reveal that early-onset neonatal sepsis, closely linked with prematurity and low birth weight, significantly contributes to these deaths [6],[7]. Birth asphyxia, often indicated by low Apgar scores and complications during delivery, remains a leading

cause of mortality (Davidz et al., 2022; Puspita & Diana Indri, 2024).

Indonesia's implementation of the Maternal and Perinatal Audit and Surveillance Response (AMPSR) system represents a strategic advancement in systematically documenting, assessing, and analyzing every maternal and neonatal death at both facility and community levels (Ambarwati et al., 2023).

The AMPSR provides a unique, context-specific, and data-driven insight into the underlying medical causes, delays in care, and social determinants contributing to neonatal deaths (Ambarwati et al., 2023). However, comprehensive mapping and synthesis of the causes and factors identified through AMPSR assessments have been limited. Most previous studies have focused on hospital-based case series or regional reports without integrating findings from the nationwide AMPSR database. As a result, there is a gap in understanding the broader patterns and root causes of neonatal deaths across Indonesia.

The novelty of this study lies in its comprehensive scoping review approach to map and synthesize the causes and contributing factors of neonatal mortality in Indonesia, drawing exclusively from AMPSR neonatal assessments. Unlike earlier studies that relied mainly on clinical records or regional surveillance data, this review leverages the systematic and standardized insights provided by AMPSR, enabling a more holistic and representative understanding of neonatal mortality patterns at the national level. This approach not only fills the knowledge gap in the literature but also provides actionable evidence to inform national policies and targeted interventions for neonatal survival in Indonesia.

This scoping review employed a systematic literature search and data extraction process to identify, chart, and analyze findings from published AMPSR neonatal assessments in Indonesia. The primary aim of this study is to map the causes and contributing factors of neonatal deaths in Indonesia as reported in AMPSR, and to highlight key areas for policy and programmatic action to accelerate progress towards reducing neonatal mortality.

LITERATURE REVIEW

This comprehensive approach enables healthcare providers to identify preventable causes, such as gaps in emergency obstetric and neonatal care, and to subsequently develop targeted, evidence-based interventions. The utilization of standardized audit tools, as highlighted by the development of neonatal death clinical audit instruments (Wandita et al., 2022), facilitates the timely identification of risk factors and care deficiencies. Furthermore, district-level innovations have emerged, translating AMPSR findings into concrete quality improvement strategies that address regional disparities and improve overall maternal and neonatal outcomes (Halimah et al., 2022). This structured surveillance system is therefore essential for enhancing care delivery, informing policy reforms, and ultimately reducing preventable deaths in Indonesia.

RESEARCH METHODS

This study employed a scoping review method to explore the causes of neonatal deaths in Indonesia from AMPSR neonatal assessments. The review followed the Preferred Reporting Items for Systematic

Reviews and Meta-Analyses extension for Scoping Reviews (PRISMA-ScR) guidelines to ensure transparency, rigor, and reproducibility in the study selection and synthesis process (Arksey H, 2005). The literature search was conducted in July 2025 across three academic databases: Google Scholar, Pubmed, and Scopus. The search strategy included a combination of keywords such as “mortality”, “death”, “neonatal”, and “Indonesia” using Boolean operators (AND, OR) to optimize the search results across different platforms. The screening process consisted of several stages, including title and abstract screening, followed by full-text review of potentially relevant articles. The selection of eligible studies was guided by the predefined inclusion and exclusion criteria, as outlined in Table 1. Only peer-reviewed, full-text, open-access original research articles published in English between 2021 and 2025 were included.

The extracted data focused on author(s), publication year, objectives, samples, methodology, and result related to the causes of neonatal deaths in Indonesia from AMPSR neonatal assessments. A narrative synthesis approach was used to summarize key themes and categorize findings based on the causes of neonatal deaths in Indonesia from AMPSR neonatal assessments.

Table 1. Inclusion and Exclusion Criteria

Inclusion Criteria	Exclusion Criteria
Articles discussing the causes of neonatal deaths in Indonesia from AMPSR neonatal assessments	Articles not related to the causes of neonatal deaths in Indonesia from AMPSR neonatal assessments
Original research articles	Non-research articles (e.g., editorials, commentaries)
Published between 2021–2025	Published outside 2021–2025
English and Indonesian language publications	Non-English and non-Indonesian language publications
Full-text available	Abstract-only or inaccessible full-text
Open access publications	Non-open access articles
Studies conducted in Indonesia	-
Quantitative, qualitative, or mixed-method research designs	Review articles (systematic, scoping, narrative), meta-analyses, or protocol papers

RESEARCH RESULTS

A total of 1,641 articles were initially identified through three electronic databases: Scopus (n = 195), PubMed (n = 102), and Google Scholar (n = 1,344). After the title screening process, 1,369 articles were considered to have relevant titles. Subsequently, 1,094 articles were excluded for the following reasons: duplication (n = 345), publication outside the 2021–2025 period (n = 605), non-open access status (n = 48), and non-original research (n = 96). Abstract screening was then conducted on the remaining 275 articles, with 255 being excluded due to abstracts not matching the research topic. This left 20 articles for full-text eligibility assessment. Following the eligibility

review, all 20 articles met the inclusion criteria and were included in the final analysis.

These selected articles collectively provide empirical insights into the causes and contributing factors of neonatal deaths in Indonesia, as identified through AMPSR neonatal assessments. The findings highlight both clinical and systemic determinants, underscoring the need for integrated strategies to reduce neonatal mortality.

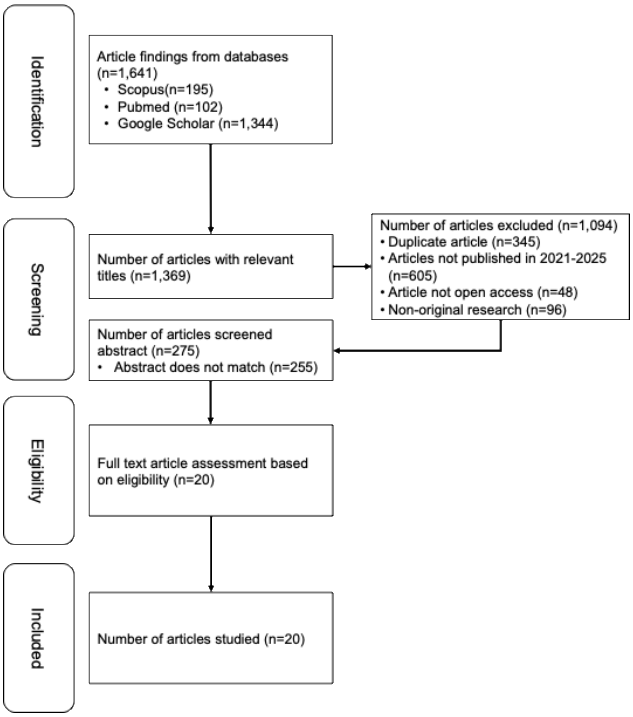

Figure 1. Article extraction process flowchart

Table 2. Article Extraction Data

Title, Authors, Year	Objective	Sample	Method	Result
"Distributions and Determinants of Neonatal Mortality in Rembang Regency, Central Java Province, Indonesia" (Soleman & Odelia, 2023)	to observe and analyze the distribution and determinants of neonatal mortality in Rembang Regency, Central Java Province, Indonesia	100 samples: 50 cases and 50 controls	Case-control design using secondary data from medical records, analyzing 50 cases and 50 controls with chi-square and logistic regression	High-risk birth weight and gestational age significantly predicted neonatal mortality with ORs of 5.4 and 5.8 respectively; other factors were not significant
"Qualitative Study on Maternal and Perinatal	to determine the effect of clinical governance in	117 Primary Health Cares	Observational analytic cross-sectional study using a	117 PHCs participated; "Outstanding" clinical governance

Title, Authors, Year	Objective	Sample	Method	Result
Health Services in Primary Health Care Facility in Banten Province" (Madjid et al., 2023)	PHCs on maternal and perinatal health services in Banten Province, Indonesia		validated self-filled questionnaire completed by PHC representatives in Banten Province.	varied by aspect; 92.3% had good antenatal care, 51.3% good pathology, 90.6% good emergency services; better governance linked to better services
"Development of Pregnancy Class with Husband's Assistance on the Outcome of Teenage Pregnancy" (Riyanti et al., 2023)	to identify the effect of pregnancy classes with husband's assistance on the outcome of teenage pregnancy in the Dayak community, Central Kalimantan	60 samples, with 30 in the treatment group and 30 in the control group	The study used a quasi-experimental posttest-only non-equivalent control group design with simple random sampling of 60 adolescent pregnant women	Pregnancy class with husband's assistance increased positive pregnancy outcomes 2.4 times; family support increased outcomes 2.5 times; high motivation for antenatal care increased outcomes 5.4 times; ANC history, frequency, and health worker support had no effect
"Continuity of Maternal Healthcare Services Utilisation in Indonesia: Analysis of Determinants from the Indonesia Demographic and Health Survey" (Andriani et al., 2021)	to examine determinants of continuity in maternal healthcare service utilization from antenatal care (ANC4+) to skilled birth attendance (SBA) during childbirth in Indonesia	15,288 women respondents	The study used descriptive statistics, chi-squared tests, and multiple binary logistic regression analyses on 2017 Indonesia Demographic and Health Survey data.	Women aged 25–34, higher education, urban residence, favorable distance to health facilities, higher income, healthcare decision autonomy, and mass media exposure were more likely to utilize ANC4+ and skilled birth attendants.
"Faktor-Faktor Yang Berhubungan Dengan Kematian Neonatus Di RSUD Sanjiwani Gianyar"	to identify factors associated with neonatal mortality at Sanjiwani Hospital, Gianyar	104 neonatus	analytic cross-sectional design with consecutive sampling and secondary data analysis using chi-square test	Significant factors related to neonatal mortality were asphyxia, preterm gestational age, low birth weight, and neonatal sepsis; parity was not significant

Title, Authors, Year	Objective	Sample	Method	Result
(Astria & Windasari, 2021)				
"Determinants of Neonatal Deaths in Indonesia: A National Survey Data Analysis of 10,838 Newborns" (Sampurna et al., 2023)	to identify determinants of neonatal mortality in Indonesia to develop better strategies for reducing newborn deaths and achieving sustainable development goals	10,838 newborns from singleton pregnancies	Secondary data analysis of the 2017 Indonesia Demographic Health Survey using multivariate logistic regression with hierarchical approach	Low participation in postnatal care, delivery complications (other than prolonged labor), and low birth weight significantly increased neonatal mortality risk
"Pengaruh Perawatan Kehamilan Dan Persalinan Dengan Kejadian Kematian Neonatal" (Paunno & Siahaya, 2022)	to determine the risk of neonatal death associated with pregnancy care and delivery care, along with other factors such as maternal age and recognition of danger signs	86 samples (43 cases and 43 controls)	Observational case-control study with quantitative approach, using non-probability quota sampling and retrospective data collection	Late recognition of danger signs increases neonatal death risk 3.15 times (P=0.011), age <25 or >35 years increases risk 3.496 times (P=0.006); inadequate prenatal care significantly related to neonatal mortality (P=0.009)
"Effect of Parity on Neonatal Mortality in Indonesia" (Siahaan & Ariawan, 2021)	to determine the effect of parity on neonatal mortality in Indonesia using 2017 IDHS data	14,827 samples	Quantitative study using secondary data from the 2017 Indonesian Health Demographic Survey with cross-sectional design and multivariable multiple logistic regression analysis	Parity ≥4 significantly increased neonatal mortality risk (OR=1.90) after controlling confounders; primipara showed no significant effect. Most neonatal deaths occurred on the first day (61.5%).
"Determinants of Early Neonatal Mortality: Secondary Analysis of the	to investigate the determinants of early neonatal deaths in	58,902 mothers of children	The study used secondary analysis of the 2012 and 2017 Indonesia Demographic	Early neonatal mortality was higher among infants of mothers with low education, working outside the

Title, Authors, Year	Objective	Sample	Method	Result
2012 and 2017 Indonesia Demographic and Health Survey" (Titaley et al., 2024)	Indonesia using nationally representative data from the 2012 and 2017 Indonesia Demographic and Health Surveys		and Health Survey data, applying univariate and multivariate logistic regression with complex sample weighting to assess factors associated with early neonatal death.	home, joint healthcare decision-making, low-quality antenatal care combined with small infant size, delivery complications, cesarean delivery, and male sex
"Risk Factors of Early Neonatal Death in East Nusa Tenggara, Indonesia: a Case-Control Study" (Davidz et al., 2022)	to analyze the risk factors of early neonatal death in East Nusa Tenggara, Indonesia	774 samples: 129 cases and 645 controls	A case-control study using maternal and neonatal medical records and interviews; data analyzed with bivariate and multivariate logistic regression	Early neonatal death was linked to maternal age (<20 or >35), history of stillbirth, tuberculosis, hyperthyroid, premature labor risk, prolonged labor, delivery outside health facilities, low birth weight, and asphyxia
"Potential Impact of Midwives in Preventing and Reducing Maternal and Neonatal Mortality and Stillbirths: A Lives Saved Tool Modelling Study" (Nove et al., 2021)	to estimate the potential impact of midwives on reducing maternal and neonatal mortality and stillbirths in low- and middle-income countries by modeling different scenarios of scaling up coverage of midwife-delivered interventions	88 countries accountin g for most maternal and neonatal deaths and stillbirths	The study used the Lives Saved Tool (LiST) to model the impact of scaling up midwife-delivered interventions under four coverage scenarios in 88 countries.	Scaling up midwife-delivered interventions in 88 countries could substantially reduce maternal, neonatal deaths, and stillbirths, with universal coverage yielding the greatest impact.
"Towards Zero Maternal	to analyze the role of policy	15 informant	qualitative design with	The study identified four factors

Title, Authors, Year	Objective	Sample	Method	Result
Mortality: The Role of Policy Makers in Maternal Perinatal Audit Surveillance and Response" (Ambarwati et al., 2023)	actors in implementing Maternal Perinatal Surveillance and Response Audit using the policy triangle framework of actors, content, context, and process	s in total: 6 main informants and 9 triangulation informants	case studies, data collection through in-depth interviews, document review, and observation, analyzed thematically	influencing AMP-SR implementation: actors, content, context, and process, highlighting political commitment, resource limitations, and roles of health offices
"Impact of the WHO Safe Childbirth Checklist on Safety Culture Among Health Workers: A Randomized Controlled Trial in Aceh, Indonesia" (Kaplan et al., 2023)	to evaluate the impact of the WHO Safe Childbirth Checklist on health workers' safety culture, specifically assessing self-perceived information access, information transmission, frequency of errors, workload, and resource access in Aceh, Indonesia	32 facilities (16 treatment and 16 control) and surveyed 376 midwives out of 623	a cluster randomized controlled trial with matched facilities, implemented the adapted checklist with coaching, and analyzed data using Intention to Treat and Complier Average Causal Effect estimations via OLS regressions	The checklist improved ease of speaking up and reduced perceived errors under high workload but did not affect general workload, paperwork, or information access and transmission significantly
"Pregnancy Examination With Postpartum Hemorrhage: SDKI Data Analysis 2017" (Turnip & Kamso, 2024)	to analyze the relationship between pregnancy examination (antenatal care) frequency and quality with the incidence of postpartum bleeding based on Indonesian Demographic and Health Survey (SDKI) 2017 data	15,345 pregnant women who made more than 6 visits to Primary Health Care	analytical observational quantitative method with a cross-sectional design analyzing secondary data from SDKI 2017	The study found a significant relationship between pregnancy examination frequency and postpartum bleeding (p=0.05), but no significant relationship with quality of examination (p=0.548)

Title, Authors, Year	Objective	Sample	Method	Result
"Determinants of Neonatal Mortality Based on the 2017 Indonesian Demographic and Health Survey (IDHS)" (Rumiati & Adisasmita, 2021)	to determine the most influential determinants of neonatal mortality in Indonesia based on the 2017 IDHS data	15,102 babies	The study used a cross-sectional analytic observational design based on the 2017 IDHS data, with univariate, bivariate (Chi-Square), and multivariate (Logistic Regression) analyses considering complex sampling design and weighting	Key determinants of neonatal mortality include male sex, low birth weight (<2.5 kg), high maternal parity (≥4), and place of delivery; most neonatal deaths occur in the early neonatal period
"A Population-Based Study of Neonatal Deaths in Indonesia Based on the Indonesian Demographic Health Survey: What Determinants Play an Essential Role?" (Sampurna et al., 2021)	to identify key socioeconomic and proximate factors influencing neonatal mortality in Indonesia	11,965 newborns from singleton pregnancies	The study used a cross-sectional design with multistage stratified random sampling of the 2017 Indonesia Demographic Health Survey data, analyzing socioeconomic and proximate determinants via weighted frequency tabulation, contingency tables, and multilevel logistic regression	Neonatal death was significantly associated with insufficient antenatal care, lack of postnatal care, assistance by traditional birth attendants, delivery in public hospitals, male gender, and low birth weight. Maternal education and neonatal factors also influenced mortality risk
"Spatial Distribution of Low-Birth Weight Infants (LBW) on Neonatal Mortality in East Java	to analyze the spatial distribution of LBW cases and neonatal deaths in East Java Province	38 districts/ cities in East Java Province	Descriptive spatial analytic method using secondary data, Geographic Information System (QGIS	An increase in LBW cases is significantly associated with increased neonatal mortality in East Java from 2020 to 2022 (p-values: 0.013, 0.017, 0.000)

Title, Authors, Year	Objective	Sample	Method	Result
Province in 2020-2022"(Melindah , 2024) (Melindah, 2024).	from 2020 to 2022		3.32.3) for mapping, and bivariate analysis with Pearson or Spearman correlation tests	
"Pemetaan Spasial Keterkaitan Faktor Risiko Kematian Neonatal Dengan Mixed Geographically Weighted Regression" (Oktarina et al., 2024)	o map spatial links between risk factors and neonatal death using MGWR in West Java	27 districts/ cities	Descriptive analysis, multiple linear regression, spatial heterogeneity test, Geographically Weighted Regression (GWR), and Mixed Geographically Weighted Regression (MGWR) with adaptive bisquare kernel	Spatial heterogeneity exists in neonatal mortality data; MGWR model fits better than classical regression, identifying both global and local risk factors influencing neonatal death in West Java
"Modified Pathway to Survival Highlights Importance of Rapid Access to Quality Institutional Delivery Care to Decrease Neonatal Mortality in Serang and Jember Districts, Java, Indonesia" (Kalter et al., 2023)	To investigate neonatal causes of death and examine maternal and neonatal care-seeking along the Pathway to Survival in Serang and Jember districts, Indonesia	259 neonatal deaths	Retrospective cross-sectional verbal and social autopsy study of neonatal deaths using the NODE-IN/NODE-FOR listing method and interviews with caregivers	Most neonatal deaths occurred on birth day at delivery facilities; many mothers had complications and faced delays reaching appropriate care
"Quality improvement on reducing neonatal mortality through	to assess the impact of an intensive Clinical Mentorship Intervention	A total death toll of 229 neonates during	Methods involved a 10-year observational study divided into	Neonatal mortality decreased from 6.86% preintervention to 2.07% postintervention,

Title, Authors, Year	Objective	Sample	Method	Result
intensive Clinical Mentorship Intervention: a case study in Biak Regional Hospital, Papua-Indonesia" (Kresnawati et al., 2025).	Programme on reducing neonatal mortality at Biak District Hospital, Papua, Indonesia by comparing preintervention, intervention, and postintervention periods	2017–2020.	preintervention, intervention, and postintervention phases, using clinical mentorship with intensive, hands-on training for neonatal care staff, combined with data collection from medical records and death reviews	with significant reductions in deaths before 24 hours, deaths due to asphyxia, and referral case fatalities; survival rates for low-birth weight neonates also improved markedly

DISCUSSION

Direct and Indirect Causes of Neonatal Deaths in Indonesia Based on AMP-SR

The available evidence suggests that Indonesia experiences approximately 60,000 neonatal deaths each year, with the direct causes by prematurity and its complications, birth asphyxia, neonatal infections, congenital anomalies, and neonatal tetanus accounting for distinct proportions of these losses (Astria & Windasari, 2021; Sampurna et al., 2021). Prematurity and its complications are the predominant direct cause, reportedly accounting for roughly 40–45% of neonatal deaths, which translates to approximately 24,000 to 27,000 cases annually based on a total of 60,000 neonatal deaths. This high burden aligns with global observations that preterm birth is a leading contributor to neonatal mortality.

Birth asphyxia is the second most common direct cause, contributing to about 20–25% of neonatal deaths, the equivalent of approximately 12,000 to 15,000 cases each year (Astria & Windasari, 2021; Sampurna et al., 2021). Various Indonesian studies have highlighted ongoing challenges in preventing asphyxia, despite advancements in monitoring and resuscitative practices. Neonatal infections, including sepsis, are attributed to approximately 20–30% of total neonatal deaths, implying around 12,000 to 18,000 cases annually (Astria & Windasari, 2021; Sampurna et al., 2021). The clinical variability of neonatal infections from early-onset sepsis in preterm infants to nosocomial infections exacerbates management challenges in resource-limited settings.

Congenital anomalies account for a smaller, though significant, fraction typically around 6–9% of neonatal deaths; using the 60,000death benchmark, this category would encompass roughly 3,600 to 5,400 cases (Astria & Windasari, 2021; Sampurna et al., 2021). Factors such as limited access to prenatal screening and delays in necessary interventions contribute to the relatively high mortality

associated with these conditions in Indonesia.

Neonatal tetanus, once a prevalent contributor to neonatal mortality, is now rarely observed due to successful maternal immunization programs. It is estimated to account for less than 2% of neonatal deaths, amounting to fewer than 600 cases annually (Astria & Windasari, 2021; Sampurna et al., 2021), (Kamath et al., 2022). Ongoing public health initiatives and improved cord care practices continue to sustain these low figures relative to other causes.

These estimates, although indicative rather than definitive, underscore that nearly all neonatal mortality in Indonesia is attributable to a set of overlapping, preventable, or manageable conditions. The predominance of deaths due to prematurity, asphyxia, and infections emphasizes the need for comprehensive strategies, including enhanced antenatal care, timely detection, improved obstetric support, and neonatal resuscitation. While neonatal tetanus now constitutes a minimal fraction of neonatal deaths, the sustaining vigilance in vaccination and hygienic delivery practices remains crucial (Astria & Windasari, 2021; Sampurna et al., 2021), (Kamath et al., 2022).

Indirect maternal factors contribute significantly to the overall burden of neonatal mortality in Indonesia. Indirect causes encompass maternal conditions during pregnancy (including hypertension, diabetes, infections, or anemia), inadequate antenatal care, delays or inadequacies in managing obstetric complications (such as prolonged labor, premature rupture of membranes, or hemorrhage), as well as maternal undernutrition and resulting low birth weight among neonates.

For instance, a case-control study conducted in East Nusa Tenggara found that mothers who delivered at home experienced a 4.4-fold increased risk of neonatal death compared to those who delivered in well-equipped settings, thereby highlighting the indirect impact of suboptimal maternal health services and delayed interventions (Davidz et al., 2022). In addition, research focusing on low birth weight, a common sequela of maternal anemia and poor nutritional status, has demonstrated that such infants bear a markedly higher risk of early death, sometimes up to 20 times that of normal-weight babies, establishing a strong link between maternal health and neonatal outcomes (Melindah, 2024). Regional analyses, such as the study in Rembang Regency, have further underscored that factors like long travel distances to community health services, low socioeconomic status, and inadequate antenatal care significantly contribute to neonatal mortality, suggesting that the indirect burden is not uniformly distributed across the country (Odelia & Soleman, 2023).

Large-scale analyses based on national demographic health surveys confirm that maternal complications, poor antenatal care quality, and delayed obstetric interventions are among the key determinants of early neonatal death (Rumiati & Adisasmita, 2021). Moreover, evidence from interventional studies has shown that robust maternal care measures. For example, comprehensive antenatal checkups and timely emergency obstetric services, have the potential to reduce perinatal mortality by as much as 75% (Paunno & Siahaya, 2022). These observations are complemented by recent secondary analyses which demonstrate that an integrated

continuum of maternal and newborn care correlates with lower neonatal mortality rates, thereby implying that deficits in these areas likely contribute to around 15,000 to 20,000 deaths annually (Titaley et al., 2024).

Health System and Sociodemographic Factors Contributing to Neonatal Mortality

Neonatal mortality in Indonesia is driven by a complex interplay between health system limitations and sociodemographic disparities. On the health system side, research has consistently shown that the accessibility and quality of maternal and neonatal care services profoundly affect newborn survival. For example, study demonstrated that factors such as long distances to health facilities, prolonged travel time, and inadequate community health infrastructure are strongly correlated with higher neonatal mortality rates (Odelia & Soleman, 2023). Other study noted that delays in accessing quality institutional delivery care, a core element of a well-functioning health system, are associated with preventable neonatal deaths (Kalter et al., 2023). Moreover, Titaley et al. (2024) identified that deficiencies in antenatal and intrapartum care, including delayed interventions and poor facility preparedness, elevate the risk of early neonatal deaths (Titaley et al., 2024). Marthias et al. "Neonatal Death Incidence in Healthcare Facility in Indonesia: Does Antenatal Care Matter?" (2021) emphasized that inequitable access to national health insurance and suboptimal coverage of maternal health services compound these challenges by perpetuating disparities in care quality (Marthias et al., 2022).

Sociodemographic factors, on the other hand, largely determine which populations are most vulnerable to these health system shortcomings. National survey analyses by Sampurna et al. (2023) confirm that low maternal education levels, poverty, and rural residence significantly reduce the likelihood of timely care-seeking and adherence to recommended health practices (Sampurna et al., 2023). Inadequate maternal knowledge about neonatal danger signs, as highlighted in qualitative studies by Madjid et al., further delays the recognition of complications and timely healthcare utilization (Madjid et al., 2023). Spatial analyses performed by Oktarina et al. (2024) show that regions with lower socioeconomic indices exhibit higher neonatal mortality rates, underscoring how poverty and regional inequality directly translate into adverse health outcomes (Oktarina et al., 2024). In addition, studies such as that by Kaplan et al. illustrate that while interventions like the WHO Safe Childbirth Checklist can improve quality of care, their effectiveness is often moderated by underlying socioeconomic conditions, if households lack the financial or educational resources to access or demand quality services, the potential benefits of such quality improvement initiatives are not fully realized (Kaplan et al., 2023).

Recommendations and Implications from AMP-SR for Neonatal Mortality Reduction

Reducing neonatal mortality in Indonesia requires a comprehensive, multifaceted strategy that addresses both clinical care and broader social determinants. Based on current evidence, several recommendations emerge regarding improvements in maternal and neonatal health

services, workforce capacity, community engagement, and policy reform.

One key recommendation is to strengthen the continuum of care starting with high-quality, timely antenatal care (ANC). Effective ANC facilitates early screening for complications including anemia, preeclampsia, and infections and enables appropriate risk stratification that can prevent adverse neonatal outcomes (Purba et al., 2024; Turnip & Kamso, 2024). Expanding educational initiatives such as pregnancy classes with family involvement can further promote healthy behaviors and early care-seeking among pregnant women (Riyanti et al., 2023). Integrating such programs with digital health innovations, for example: smartphone applications that enhance mothers' knowledge, offers an opportunity to overcome barriers related to literacy and access to health information (Yugistyowati et al., 2022).

Improving the quality and accessibility of intrapartum and delivery services is also critical. Ensuring that mothers deliver in well-equipped and hygienic facilities with skilled birth attendants is a priority. Research underscores that institutional delivery care, with an emphasis on emergency obstetric and neonatal care, is essential for the early recognition and management of life-threatening complications (Kalter et al., 2023; Rumiati & Adisasmita, 2021). In this regard, the establishment of maternity waiting homes has received positive stakeholder support, as these centers can provide safe and proximate accommodations for expectant mothers particularly those in rural regions (Braam et al., 2023). Moreover, reinforcing the continuity of maternal healthcare services from ANC through skilled birth attendance (SBA) can bridge existing gaps between rural and urban healthcare utilization (Andriani et al., 2021; Rammohan et al., 2024).

Equally important is the investment in healthcare worker capacity. Short-duration focused training and intensive clinical mentorship programs have been shown to significantly enhance providers' skills in emergency maternity care and newborn resuscitation, ultimately reducing neonatal mortality (Kresnawati et al., 2025). The effective implementation of these training initiatives is best secured when they are embedded within broader health system strengthening and supported by robust monitoring and evaluation frameworks (Sampurna et al., 2021).

From a policy perspective, scaling up universal health coverage is fundamental. Ensuring that all pregnant women have access to quality maternal services without financial hardship is an essential element of reducing neonatal deaths. Evidence suggests that national health insurance endeavors contribute to improved maternal service utilization and, consequently, lower neonatal mortality (Marthias et al., 2022). Furthermore, long-term sustainability of maternal and child health programs depends not only on government commitment but also on active stakeholder involvement at district levels. Studies indicate that collaborative models that engage community leaders, health cadres, and donors can create resilient and adaptive health systems capable of addressing regional disparities (Aji et al., 2022; Nove et al., 2021).

Finally, preventive strategies that target key risk factors, such as low birth weight and preterm birth, must be integrated within these broader interventions. Efforts to

improve maternal nutrition, facilitate optimal birth spacing through family planning, and promote best practices like early initiation of breastfeeding and kangaroo mother care are imperative. These measures, when combined with improvements in clinical care and systemic reforms, can collectively contribute to a significant reduction in neonatal mortality (Purba et al., 2024; Turnip & Kamso, 2024), (Siahaan & Ariawan, 2021; Sukma & Tiwari, 2021).

CONCLUSION

This review demonstrates that the majority of neonatal deaths in Indonesia are attributed to a cluster of direct causes: primarily prematurity, birth asphyxia, neonatal infections, congenital anomalies, and neonatal tetanus, as well as a wide range of indirect maternal, health system, and sociodemographic factors. The AMP-SR findings underscore the critical role of timely and high-quality antenatal, intrapartum, and neonatal care in shaping newborn survival. Indirect factors such as maternal health complications, inadequate antenatal visits, delayed obstetric interventions, limited access to health services, and disparities driven by socioeconomic status and geographic barriers further intensify the risk of neonatal mortality. Collectively, these findings reinforce the importance of integrated maternal and neonatal health services, supported by robust health systems and community engagement, as the central strategy to reduce preventable neonatal deaths in Indonesia.

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