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Trends in Neonatal Mortality as an Indicator of Basic Emergency Obstetric and Neonatal Services (PONED) Readiness in Tabanan, 2019–2023

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ABSTRACT

Neonatal mortality is a sensitive indicator of health system readiness in handling emergency obstetric and neonatal cases. Although Tabanan Regency reports high coverage of skilled birth attendance (>95%) and postnatal visits (KN1 and KN3 >99%), preventable neonatal deaths persist annually. This study aimed to analyze neonatal mortality trends in Tabanan Regency from 2019 to 2023 and examine their association with the readiness of Basic Emergency Obstetric and Neonatal Services (PONED). A descriptive quantitative approach using secondary data from district and provincial health profiles (2019–2023) was applied. Key indicators included neonatal mortality rate (NMR), causes of death, and service readiness components. Data were analyzed through trend visualization and determinant mapping. The NMR peaked at 9.0 per 1,000 live births in 2022 and declined to 7.2 in 2023. Leading causes included prematurity/low birth weight (28.2%), asphyxia (18.4%), and infection (14.6%). Despite service coverage being consistently high, findings indicate persistent gaps in readiness particularly in emergency referrals, skilled provider availability, and resuscitation facilities. Neonatal mortality trends in Tabanan reflect underlying limitations in emergency obstetric preparedness. Strengthening PONED readiness through clinical skill development, equipment availability, and efficient referrals is crucial to reducing neonatal deaths. NMR should be considered a proxy indicator of obstetric emergency readiness in decentralized health systems.

Keywords: *Neonatal mortality, PONED, Emergency obstetric care, Service readiness, Tabanan Regency*

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INTRODUCTION

Neonatal mortality is a critical indicator reflecting the responsiveness of maternal and newborn health systems, particularly in emergency scenarios. The effectiveness of Basic Emergency Obstetric and Neonatal Services (PONED) at primary health centers plays a key role in preventing deaths from birth asphyxia, infection, or complications of prematurity. According to (Siyania et al., 2025), despite the availability of 24-hour services in PONED facilities, many still lack trained personnel, emergency drugs, and proper referral mechanisms, which compromises the quality of emergency care.

Neonatal mortality remains a critical public health challenge worldwide, particularly in low- and middle-income countries. The World Health Organization (WHO) reported that in 2022, approximately 2.3 million neonatal deaths occurred globally, accounting for nearly 47% of all under-five deaths, with most occurring in the first 7 days of life (Liu *et al.*, 2023). The leading causes of these deaths prematurity, birth asphyxia, and infections are largely preventable with timely and appropriate emergency care.

While there has been a global decline in the neonatal mortality rate (NMR) from 37 per 1,000 live births in 1990 to 17 per 1,000 in 2023 this decline remains slower than that of post-neonatal and under-five mortality (Unicef, 2021). This disparity highlights the persistent weaknesses in emergency obstetric and neonatal care, especially during the perinatal period. Inadequate recognition of danger signs, late referrals, and insufficient capacity at basic emergency obstetric and neonatal care (BEmONC) facilities remain critical barriers to reducing neonatal mortality (Kalter *et al.*, 2023)

Nabila *et al.*, (2024) highlighted that the leading determinants of neonatal mortality over the past decade include maternal complications, delays in care, and low birth weight. (SDG Indicators, 2021) emphasize the need for countries to reduce neonatal mortality to fewer than 12 per 1,000 live births by 2030 as a global priority. According to the (World Bank, 2022), the uneven allocation of health resources in Indonesia continues to impact the quality and readiness of neonatal emergency services. The (Charity Organization for Children, 2023) advocated for improving postnatal care access and emergency neonatal interventions in underserved communities.

(Supas et al, 2023) emphasized that limited knowledge and inadequate clinical readiness among healthcare workers have significantly hindered the performance of PONED in districts like Jember, leading to delays in early emergency management. In contrast, (UNICEF, 2022) reported that Indonesia had already achieved over 95% skilled birth attendance nationwide and had made improvements in maternal health infrastructure. However, neonatal mortality remained stagnant at approximately 11 per 1,000 live births, suggesting that facility availability alone is not enough service readiness and quality remain key challenges.

In Indonesia, neonatal deaths still contribute significantly to infant and child mortality. Data from various districts show that most neonatal deaths occur in health facilities, raising concerns about the quality rather than mere availability of health services. A study in Java found that 79% of neonatal deaths occurred within the first week of life, primarily due to prematurity (44%) and

asphyxia (39%), with many of these occurring in primary health centers lacking skilled personnel and equipment (Deviany *et al.*, 2022). The (' Healthy Newborn Network', 2025) reports that although Indonesia has achieved over 95% skilled birth attendance, the neonatal mortality rate remains around 10.7 per 1,000 live births, which is still above the SDG target of 12 per 1,000.

In Bali Province, the 2023 Health Profile reported an NMR of 7.0 per 1,000 live births, still above the SDG target of ≤12 by 2030. In Tabanan Regency, neonatal deaths occur annually, even though over 95% of deliveries are attended by health professionals. In 2023, the local NMR was 7.2, with leading causes including low birth weight/prematurity (28.2%), asphyxia (18.4%), and infection (14.6%) (Profil Kesehatan Kabupaten Tabanan, 2023). These data reflect a gap between coverage and quality of care, and raise the question of how well the current health system is prepared to handle emergency obstetric and neonatal conditions.

According to WHO's service readiness framework, neonatal mortality can be viewed as a proxy indicator of a health system's emergency preparedness, especially in maternal and newborn care. Studies in other low-resource settings have shown that provider training and referral readiness are critical in reducing neonatal mortality (Oumma, 2020). Therefore, examining neonatal mortality trends alongside key determinants can provide crucial insight into the responsiveness and quality of health services.

In Indonesia's decentralized health system, district health offices are tasked with implementing maternal and neonatal programs, yet significant disparities remain in the quality and availability of emergency services. The readiness of Basic Emergency Obstetric and Neonatal Care (BEmONC) services at the primary care level often falls short, especially in peripheral regions. Midwives, who are the first-line providers, frequently encounter challenges in detecting danger signs, performing timely neonatal resuscitation, and executing effective referrals. A recent study highlighted that weak referral pathways and limited provider capacity were closely associated with preventable neonatal deaths in Indonesian districts (Kalter *et al.*, 2023). Consequently, neonatal mortality should not only be viewed as an outcome metric but as a sensitive indicator of a district's readiness for obstetric and neonatal emergencies.

In Tabanan Regency, local data show fluctuating neonatal mortality trends between 2019 and 2023, with a visible decline in 2023. This raises the question of whether improved PONED readiness contributed to that reduction. Therefore, this study aims to examine the relationship between PONED service readiness and neonatal mortality trends in Tabanan during this period.

METHODS

This study was designed to assess neonatal mortality trends and key determinants as an indicator of obstetric emergency readiness. The study area was Tabanan Regency, Bali Province, and data sources included official health department reports, government publications, and relevant international institutions such as UNICEF and WHO. The study population comprised all recorded neonatal deaths in Tabanan Regency from 2019 to 2023. A total sampling technique was used due to the use of complete official records. Secondary data included:

a. Tabanan Health Profile Reports (2019–2023)
b. Bali Province Health Profile (2023).
c. Neonatal mortality data from https://data.unicef.org and https://who.int.
d. Additional peer-reviewed journal articles as needed.

Data collection:

a. Downloaded from Bali Health Office's official website (diskes.baliprov.go.id)
b. Reviewed neonatal mortality data from global organizations
c. Organized into annual aggregate tables for analysis

Analysis included:

a. Annual frequency and percentage distribution of neonatal deaths (2019–2023)
b. Analysis of causes based on WHO/UNICEF classification
c. Temporal relationships between mortality trends and emergency system readiness (e.g., BEmONC coverage, healthcare personnel availability, resuscitation facilities)

Results were presented in tables, graphs, and narratives. As aggregate secondary data were used without personal identifiers, ethical approval was not required. All sources were cited per scientific standards.

RESULTS

3.1 Neonatal Mortality Trends in Tabanan Regency 2019–2023

Based on the Tabanan and Bali Health Profiles, neonatal mortality in Tabanan showed fluctuation over the past five years, calculated as deaths of infants aged 0–28 days per 1,000 live births. The data are presented in table 1 below:

Tabel 1. Neonatal Mortality Trends in Tabanan Regency 2019–2023

Year	Live Births	Neonatal Death	NMR (per 1,000)
2019	6.284	48	7,6
2020	6.021	44	7,3
2021	5.833	52	8,9
2022	5.786	52	9,0
2023	6.139	44	7,2

From: (Tabanan District Health Profile, 2023)

As illustrated in Table 1, the NMR peaked in 2022 at 9.0 deaths per 1,000 live births, before declining slightly to 7.2 in 2023. Although this represents an improvement, the rate remains above the SDG target (<12), warranting further investigation into systemic issues.

The annual fluctuations in neonatal deaths do not correlate directly with the overall number of live births, suggesting that factors beyond delivery volume such as quality of emergency response, facility readiness, and health personnel competence may be more influential.

3.2 Visualization of Neonatal Mortality Rate Trends

To better understand the development of neonatal health outcomes in recent years, Table 1 presents the trend of Neonatal Mortality Rate (NMR) in Tabanan Regency between 2019 and 2023.

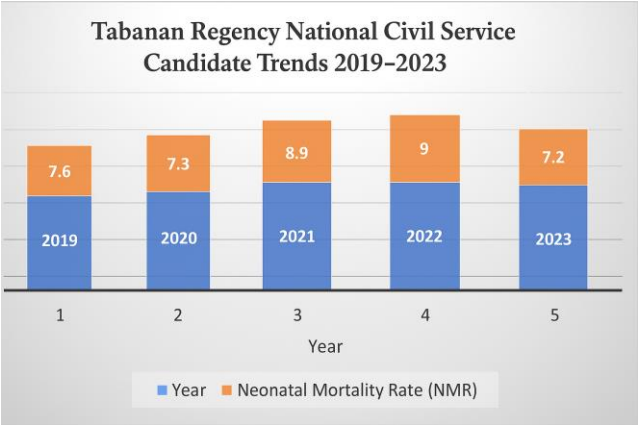

Figure 1. Trend of Neonatal Mortality Rate (NMR) in Tabanan Regency, 2019–2023.
Source: Tabanan District Health Profile

The trend peaked in 2022 and declined again in 2023. The peak in 2022 may be attributed to lingering impacts of the COVID-19 pandemic, which disrupted referral access and reduced health-seeking behaviors. This aligns with global findings by UNICEF (2021) that reported increased neonatal vulnerability during health system disruptions.

3.3 Causes of Neonatal Death and Service Coverage

In 2023, the leading causes of neonatal death in Tabanan were: low birth weight/prematurity (28.2%), birth asphyxia (18.4%), and neonatal infections (14.6%). These causes are consistent with both national and global patterns (Kalter *et al.*, 2023). Despite these preventable causes, key service coverage indicators remain high: KN1 (first neonatal visit within 48 hours): 99.98%. KN3 (visit between 8–28 days): 99.15%. Delivery by skilled health personnel: >95%

This data reflects a paradox: although coverage is high, mortality persists. This underscores that readiness and quality of emergency neonatal care not merely access must be examined.

3.4 Readiness of Emergency Obstetric and Neonatal Services

In 2023, the leading causes of neonatal death in Tabanan were: low birth weight/prematurity (28.2%), birth asphyxia (18.4%), and neonatal infections (14.6%). These causes are consistent with both national and global patterns (Kalter *et al.*, 2023). Despite these preventable causes, key service coverage indicators remain high: KN1 (first neonatal visit within 48 hours): 99.98%. KN3 (visit between 8–28 days): 99.15%. Delivery by skilled health personnel: >95%

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The high NMR despite excellent service coverage suggests potential gaps in: Timely identification of neonatal danger signs, Availability of emergency equipment (e.g., resuscitation tools), Referral system efficiency, and Midwives' clinical decision-making skills in emergencies.

DISCUSSION

The results of this study demonstrate that neonatal mortality in Tabanan Regency fluctuated over a five year period, peaking in 2022 at 9.0 per 1,000 live births and decreasing to 7.2 in 2023. While the 2023 figure meets the national average and aligns with the Sustainable Development Goals (SDGs) threshold (<12 per 1,000), the persistence of preventable deaths calls attention to deeper systemic issues. These fluctuations suggest that neonatal mortality is not solely influenced by birth volume or service coverage but reflects more complex interactions between health system readiness, clinical competence, and referral efficiency.

Wang *et al.*, (2022) found that neonatal and maternal services were disrupted during the pandemic, contributing to excess mortality across multiple countries. (Pasaribu and Novita Br Ginting Munthe, 2025) found that the availability of trained personnel and equipment in PONED services significantly improved maternal health outcomes. Concluded that reducing neonatal mortality requires coordinated interventions across antenatal, intrapartum, and postnatal periods.

A review by (Mulyono and Umaroh, 2023) emphasized the importance of hospital based PONEK programs in reducing neonatal mortality in Indonesia. (Susanti *et al.*, 2024) reported that challenges in BEmONC implementation include inconsistent protocols, limited supervision, and equipment shortages. (Putri *et al.*, 2022) identified prematurity, inadequate antenatal care, and low maternal education as dominant risk factors for neonatal mortality in Pekanbaru.

The leading causes of neonatal mortality—low birth weight/prematurity, birth asphyxia, and neonatal infections are consistent with global and national patterns (UNICEF, 2021); (Liu *et al.*, 2023). These causes are largely preventable through timely detection and appropriate emergency management. Despite high rates of neonatal care coverage (KN1 and KN3 above 99%), mortality rates remain concerning. This points to potential gaps in the quality of emergency obstetric and neonatal care rather than mere availability.

High coverage rates, such as >95% skilled birth attendance, indicate that the health system is achieving broad access. However, access alone does not guarantee outcomes. According to (Kalter *et al.*, 2023), delay in recognizing neonatal danger signs, inadequate initial stabilization, and inefficient referral systems are common contributors to neonatal deaths in Indonesia. In Tabanan, the persistent NMR suggests similar challenges, particularly at the primary care level, where most deliveries and postnatal visits occur.

The decline in neonatal mortality in 2023 may suggest recovery from disruptions caused by the COVID-19 pandemic. During 2020–2022, service access, referral capacity, and health-seeking behavior were impacted, potentially contributing to the elevated mortality in 2022. This is supported by (UNICEF, 2021), which reported increased neonatal vulnerability in many countries due to pandemic-related health system disruptions.

Beyond external shocks, structural readiness is crucial. The availability of trained midwives and doctors, resuscitation equipment, neonatal emergency protocols, and rapid referral mechanisms form the backbone of Basic Emergency Obstetric and Neonatal Care (BEmONC). When any component is weak, outcomes are compromised even with full coverage. The WHO emphasizes that emergency readiness is measured not only by inputs but by consistent, rapid, and skilled response to critical cases.

Furthermore, this study highlights the importance of viewing neonatal mortality as a tracer indicator of emergency obstetric system effectiveness. Mortality data can be used not only to track outcomes but also to evaluate the performance of referral hospitals, puskesmas, and maternal-neonatal units. Such data should inform local health policy and budgeting priorities, especially in areas where neonatal deaths persist despite adequate service reach.

The findings also suggest the need for routine audit and feedback mechanisms, including perinatal death reviews and near-miss assessments. These tools can uncover delays in decision-making, transport, or treatment that are not always evident in administrative data. Strengthening midwives' competencies in neonatal resuscitation, continuous fetal monitoring, and early referral decisions is equally critical.

Lastly, the limitations of this study include reliance on aggregate secondary data, which may lack granularity such as time of death (early vs. late neonatal), maternal risk factors, or treatment histories. Nevertheless, the use of district health profiles provides a valuable starting point for local planning and targeted intervention.

CONCLUSIONS

From 2019–2023, NMR in Tabanan fluctuated, peaking in 2022 at 9.0 and declining in 2023 to 7.2 per 1,000 live births. Despite high neonatal service coverage, deaths from preventable causes persist.

These findings suggest that neonatal mortality is a reliable indicator of obstetric emergency readiness. Emphasis should be placed on quality of care, skilled health personnel, effective referrals, and BEmONC facility preparedness.

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