THE PROPORTION AND ASSOCIATED FACTORS OF PREMATURITY AMONG NEONATAL DEATH IN KELANTAN

2020-2023

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by

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LIST OF SYMBOLS

%	Percent
n	Sample size
p	Probability value
<	Less than
>	More than
≤	Less than or equal to
≥	More than or equal to
±	Plus or minus
=	Equal to
-	Hyphen or range
a	Alpha (significant level)

LIST OF ABBREVIATION

AGA	Appropriate for Gestational Age
AMA	Advance Maternal Age
aOR	Adjusted Odds Ratio
APH	Antepartum Haemorrhage
ANC	Antenatal Care
AUC	Area Under the Curve
B40	Bottom 40% Income Group
CHD	Congenital Heart Disease
CI	Confidence Interval
DM	Diabetes Mellitus
DOSM	Department of Statistics Malaysia
ELBW	Extremely Low Birth Weight (<1000g)
GDM	Gestational Diabetes Mellitus
HCW	Healthcare Worker
HPT	Hypertension

IQR	Interquartile Range
JEPeM	Jawatankuasa Etika Penyelidikan Manusia
LBW	Low Birth Weight (<2500g)
LMIC	Low- and Middle-Income Countries
M40	Middle 40% Income Group
MCH	Maternal and Child Health
MOH	Ministry of Health
MREC	Medical Research and Ethics Committee
MS	Microsoft
NMR	Neonatal Mortality Rate
OGTT	Oral Glucose Tolerance Test
OR	Odds Ratio
PIH	Pregnancy-Induced Hypertension
PROM	Prolonged Rupture of Membranes
ROC	Receiver Operating Characteristic
SD	Standard Deviation
SDG	Sustainable Development Goal
SGA	Small for Gestational Age

SPSS	Statistical Package for the Social Sciences
SU5MR	Stillbirth and Under-5 Mortality Reporting
T20	Top 20% Income Group
USM	Universiti Sains Malaysia
UNICEF	United Nations International Children's Emergency Fund
VLBW	Very Low Birth Weight (1000g–1499g)
WHO	World Health Organization

ABSTRAK

KADAR KELAHIRAN PRAMATANG DAN FAKTOR-FAKTOR YANG BERKAITAN

DALAM KALANGAN KEMATIAN NEONATAL DI KELANTAN, 2020–2023

Latar Belakang: Kematian neonatal menyumbang hampir 47% daripada keseluruhan kematian kanak-kanak bawah lima tahun di peringkat global pada tahun 2022, dengan kelahiran pramatang menjadi penyumbang utama. Walaupun kadar kematian neonatal di Kelantan kekal di bawah sasaran Matlamat Pembangunan Mampan (SDG), trend semasa di Kelantan menunjukkan peningkatan berterusan sejak tahun 2020 yang memerlukan perhatian. Kadar kematian neonatal di Kelantan meningkat daripada 2.79 kepada 4.88 bagi setiap 1,000 kelahiran hidup antara tahun 2020 hingga 2023. Oleh itu, kajian ini bertujuan untuk menentukan peratusan kelahiran pramatang serta faktor-faktor yang berkaitan dalam kalangan kes kematian neonatal di Kelantan bagi tempoh tahun 2020 hingga 2023.

Metodologi: Kajian keratan rentas ini dijalankan dari Disember 2024 hingga Mei 2025 berdasarkan semakan retrospektif terhadap data kematian neonatal yang dilaporkan kepada Jabatan Kesihatan Negeri Kelantan bagi tahun 2020 hingga 2023. Data sekunder diperoleh daripada Sistem Notifikasi Kematian Bawah 5 Tahun dan Borang Siasatan Kematian Neonatal. Sebanyak 475 kes kematian neonatal dipilih menggunakan persampelan rawak mudah dengan bantuan perisian SPSS. Faktor sosiodemografi, ibu, fetal dan intrapartum telah diekstrak

daripada rekod dan dianalisis menggunakan analisis deskriptif, regresi logistik mudah, dan regresi logistik berganda bagi mengenal pasti faktor yang berkaitan dengan kelahiran pramatang

Keputusan: Daripada 475 kes kematian neonatal yang dikaji, peratusan kelahiran pramatang ialah 32.0%. Kelahiran pramatang didapati mempunyai hubungan signifikan dengan beberapa faktor risiko ibu dan janin, termasuk hipertensi kronik (aOR = 4.72, 95% CI: 1.08, 20.53), ketuban pecah awal berpanjangan (aOR = 3.89, 95% CI: 1.86, 8.11), dan anomali kongenital janin (aOR = 2.66, 95% CI: 1.58, 4.47). Risiko kelahiran pramatang meningkat dengan ketara mengikut penurunan berat lahir, dimana bayi dengan berat lahir amat rendah (<1000g) menunjukkan hubungan yang paling tinggi (aOR = 20.54, 95% CI: 10.08, 41.83).

Kesimpulan: Kelahiran pramatang menyumbang kepada peratusan yang signifikan dalam kematian neonatal di Kelantan. Faktor ibu dan bayi seperti hipertensi kronik, ketuban pecah awal berpanjangan, berat lahir dan anomali kongenital janin mempunyai hubungan yang signifikan dengan kelahiran pramatang dalam kalangan kematian neonatal. Pengenalpastian faktor-faktor penyumbang ini dapat menyokong penambahbaikan strategi dan intervensi masa hadapan, termasuk memperkukuh penjagaan antenatal, mengoptimumkan pengurusan intrapartum, serta mempertingkatkan kapasiti perkhidmatan kesihatan neonatal dan materniti. Ini boleh meningkatkan kualiti

perkhidmatan dan menyumbang kepada pengurangan kematian neonatal

akibat kelahiran pramatang di Kelantan

Kata kunci: Kematian neonatal, pramatang, faktor perkaitan, berat lahir rendah,

Kelantan, Malaysia

ABSTRACT

THE PROPORTION AND ASSOCIATED FACTORS OF PREMATURITY AMONG NEONATAL DEATH IN KELANTAN 2020-2023

Background: Neonatal deaths accounted for nearly 47% of all under-five child deaths globally in 2022, with prematurity being a major contributor. Although the neonatal mortality rate in Kelantan has remained below the Sustainable Development Goal (SDG) target, the trend in Kelantan has shown a progressive increase since years 2020 that warrants attention. The neonatal mortality rate in Kelantan increased from 2.79 to 4.88 per 1,000 live births between 2020 and 2023. This study aims to determine the proportion of prematurity and its associated factors among neonatal death cases in Kelantan, from 2020 to 2023.

Methodology: This cross-sectional study was conducted from December 2024 to May 2025 based on a retrospective review of neonatal death data reported to the Kelantan State Health Department from 2020 to 2023. Secondary data for this study were obtained from Under-5 Mortality Notification System and the Neonatal Death Investigation Form. A total of 475 neonatal death cases were selected using simple random sampling with SPSS. Sociodemographic, maternal, fetal and intrapartum factors were extracted from the records and analysed using descriptive analysis, simple logistic regression, and multiple logistic regression to identify factors associated with prematurity.

Results: among 475 neonatal deaths reviewed, the proportion of prematurity was 32.0%. Prematurity was significantly associated with several maternal and fetal risk factors, including hypertension (aOR = 4.72, 95% CI: 1.08, 20.53), prolonged rupture of membranes (aOR = 3.89, 95% CI: 1.86, 8.11), and fetal congenital anomaly (aOR = 2.66, 95% CI: 1.58, 4.47). The odds of premature birth increased markedly with decreasing birth weight, with extremely low birth weight (<1000g) showing the highest association (aOR = 20.54, 95% CI: 10.08, 41.83).

Conclusion: Prematurity accounted for a significant proportion of neonatal deaths in Kelantan. Maternal and neonatal factors such as hypertension, prolonged rupture of membranes, birth weight and fetal congenital anomaly were significantly associated with prematurity among neonatal death. Identification of these contributing factors may support the improvement of future strategies and interventions, including enhancing antenatal care, optimising intrapartum management, and strengthening the capacity of neonatal and maternal healthcare services. This could improve the quality of services and contribute to the reduction of neonatal deaths due to prematurity birth in the Kelantan

Keywords: Neonatal mortality, prematurity, preterm, associated factors, low birth weight, Kelantan, Malaysia

CHAPTER 1
INTRODUCTION

1.1   Study background and significance

1.1.1   Neonatal Death: Global and National Perspective

Neonatal death is referred to infants who die within the first 28 days of life (Wotango et al., 2025). Although global efforts since 1990 have led to significant reductions in under five mortalities, the rate of decline in neonatal deaths has been slower compared to the reduction in post neonatal death. An estimated 6,400 neonates die each day, accounting for nearly 48% of all under-five deaths worldwide. Projections indicate that approximately 26 million newborns could die between 2019 and 2030 if current trends continue, despite most of these deaths being preventable (Wilson Fell et al., 2024). The leading causes of neonatal death globally include prematurity, birth asphyxia and sepsis (WHO, 2023b).

Neonatal death remains a critical global public health concern, especially in low- and middle-income countries where disparities in access to quality maternal and newborn care persist. This indicator reflects the quality of health systems, including antenatal monitoring, skilled delivery care, and immediate postnatal interventions. Among the causes of neonatal deaths, prematurity has been consistently identified as the main contributing factor, often resulting in complications such as respiratory distress syndrome, sepsis,

and poor thermoregulation during the early neonatal period (Wilson Fell et al., 2024).

In Malaysia, the neonatal mortality rate has consistently remained below the Sustainable Development Goal (SDG) target of 12 per 1,000 live births, recorded at 6.06 per 1,000 in 2023, reflecting the nation's strong commitment to child survival. Nonetheless, neonatal deaths continue to occur, and upward trends have been observed in certain states. According to the Stillbirth and Under-5 Mortality Reporting System (SU5MR) of the Family Health Development Division, Ministry of Health Malaysia, the neonatal mortality rate in Kelantan increased from 2.79 per 1,000 live births in 2020 to 4.88 in 2023. This rise is steeper compared to the national rate, which grew more gradually from 5.00 to 6.06 per 1,000 live births over the same period (Family Health Development Division, 2024). Although these values remain below the SDG threshold, the increasing trend need a closer examination, particularly in relation to contributing clinical and social factors.

Understanding the magnitude and distribution of neonatal deaths and the underlying conditions such as prematurity that contribute to them is essential for guiding public health strategies. It serves not only as an indicator of newborn survival but also reflects the effectiveness and equity of maternal and neonatal health services throughout the pregnancy to postpartum continuum (MOH, 2020a).

1.1.2   Prematurity: An overview

Prematurity is defined a birth before completed 37 weeks of gestation (WHO, 2012). Prematurity is physiologically underdeveloped and highly vulnerable to develop complications such as respiratory distress syndrome, sepsis, intraventricular haemorrhage, and feeding difficulties, all of which can rapidly lead to mortality in the early days of life (Ibraheem and Issa, 2024). These complications not only account for a large proportion of early neonatal deaths but also pose significant challenges for long-term child health outcomes, especially in settings lacking specialized neonatal intensive care.

According to the World Health Organization (WHO), prematurity is responsible for approximately 35% of all neonatal deaths worldwide, and an estimated 15 million babies are born premature each year, with nearly 1 million dying from associated complications (WHO, 2012). The burden is disproportionately high in low- and middle-income countries, particularly in South Asia and sub-Saharan Africa, where delays in accessing skilled obstetric and neonatal care are common (WHO, 2012). In Malaysia, as reported by Department of Statistics Malaysia (DOSM) the highest medical certified principal cause of neonatal death was related to prematurity (Ova, 2023). Despite strong national efforts in maternal and child health programs, challenges such as delayed antenatal booking, inadequate risk stratification, and uneven access to neonatal intensive care units continue to impact neonatal survival, particularly among premature babies (Carlo, 2024; Imam et al., 2024).

A recent hospital-based study conducted at Universiti Malaya Medical Centre (UMMC) in Kuala Lumpur reported that babies born prematurely, especially those born before 28 weeks of gestation, faced a significantly higher risk of death, with 40% of neonatal deaths occurring among extremely premature infants (Mohamed Rasheed et al., 2024). In Kelantan, although neonatal mortality trends have shown a rising pattern in recent years, the proportion attributable to prematurity is not fully detailed in public reports. However, national data suggest that prematurity is a primary and preventable factor contributing to the state's neonatal mortality burden. These findings emphasize the critical need for targeted efforts to improve antenatal surveillance, strengthen early referral systems, and enhance neonatal care capacity especially in regions with rising neonatal death trends linked to prematurity.

1.2   Problem Statement and Study Rationale

Malaysia has made notable progress in maternal and child health, with the national neonatal mortality rate (NMR) currently below the Sustainable Development Goal (SDG) target of 12 deaths per 1,000 live births (WHO, 2023b). However, this national achievement masks significant inter-state disparities. In Kelantan, the NMR has increased from 2.79 per 1,000 live births in 2020 to 4.88 in 2023, raising concerns about the effectiveness of current neonatal health interventions in the state. While still below the SDG threshold, this rising trend highlights the need for further investigation and targeted strategies, particularly

because prematurity remains the leading cause of neonatal death, both Malaysia and in globally (Ova, 2023; WHO, 2022).

Globally, an estimated 15 million babies are born prematurely each year, and complications of prematurity account for approximately 35% of neonatal deaths, making it the most common direct cause of neonatal mortality. Low- and middle-income countries (LMICs), including Malaysia, are disproportionately affected due to resource limitations in neonatal care (WHO, 2012).

Understanding the proportion of prematurity among neonatal deaths provides essential evidence for guiding healthcare planning and resource allocation. By quantifying the extent of prematurity as a contributor to neonatal mortality, health authorities can prioritize it as a critical public health issue and allocate appropriate funding and services. This includes improving antenatal care coverage, enhancing neonatal intensive care facilities, and supporting maternal health programs. Clear data on the burden of prematurity allows for better decision-making in directing financial, human, and infrastructural resources toward interventions that are likely to yield the greatest impact in reducing neonatal deaths.

In addition to measuring the burden, identifying the factors associated with prematurity among neonatal deaths in Kelantan is crucial for designing effective and locally relevant prevention strategies. These associated risk factors whether clinical, sociodemographic, or health system related must be understood within the local context that may influence maternal behaviour and

healthcare access. Tailoring interventions to address these local risk profiles will help ensure that strategies are not only evidence based but also practical and acceptable to the target population, ultimately contributing to the reduction of preventable neonatal deaths due to prematurity in the state.

1.3   Research Questions

1. What is the proportion of prematurity among neonatal death in Kelantan from 2020 to 2023?

2. What are the factors associated with prematurity among neonatal death in Kelantan from 2020 to 2023?

1.4   Research Hypothesis

Null Hypothesis (Ho) = There are no significant association between maternal, fetal and intrapartum factors with prematurity among neonatal death in Kelantan 2020-2023.

Alternate Hypothesis (Ha) = There are significant association between maternal, fetal and intrapartum factors with prematurity among neonatal death in Kelantan 2020-2023.

1.5   Research Objective

1.5.1   General Objective

To study the proportion of prematurity and its associated factors among neonatal death in Kelantan from 2020 to 2023.

1.5.2   Specific Objectives

1. To determine the proportion of prematurity among neonatal death in Kelantan from 2020 to 2023.

2. To determine the factors associated with prematurity among neonatal death in Kelantan from 2020 to 2023.

CHAPTER 2
LITERATURE REVIEW

2.1   Overview of Neonatal Death

Neonatal mortality remains persistently high despite substantial reductions in overall child mortality. This disproportionate burden reflects the unique biological vulnerability of neonates and highlights systemic gaps in maternal and newborn care delivery, particularly in low- and middle-income country (Li Liu et al., 2016). While many of these conditions are preventable or treatable with timely, high-quality care, challenges such as delayed access to health services, lack of skilled birth attendants, and inadequate neonatal intensive care continue to obstruct the progress, particularly in resource constrained settings (Bhutta et al., 2014).

In Kelantan, despite achieving the SDG target for neonatal mortality, the increasing trend in recent years is concerning. This localised increase calls attention to context specific factors that may be contributing to neonatal deaths, such as delayed antenatal booking, inadequate maternal risk management, and inequities in access to specialised neonatal care.

Many neonatal deaths occur in the early neonatal period, with 75% taking place within the first week of life and approximately 25–45% dying within the first 24 hours after birth (Kananura et al., 2016). Other studies in Malaysia have highlighted similar trends and highlighted that maternal hypertension, inadequate antenatal visits, and birth spacing associated with adverse neonatal outcomes (Family Health Development Division, 2023). These findings reinforce

the notion that neonatal death often reflects failures not only in neonatal care, but throughout the entire maternal child health continuity of care.

At the international level, Every Newborn Action Plan (ENAP) has emphasized the importance of integrating neonatal mortality surveillance with programmatic response (World Health Organization (WHO) and UNICEF, 2014). Malaysia has established structured national level review mechanisms for perinatal and neonatal deaths, ensuring systematic data collection and sharing with key stakeholders.

2.2   Prematurity as a Global Health Challenge

Prematurity is a significant global health issue and the leading cause of neonatal mortality worldwide (WHO, 2012). Each year, approximately 15 million babies are born premature, accounting for about 11% of all deliveries (Harrison and Goldenberg, 2016). Prematurity contributes to major proportion of neonatal death globally. In 2015 more than one-third of neonatal deaths were attributed by prematurity (Girma et al., 2023). Although the rate of premature births is lower in developed countries and higher in developing countries, prematurity still remains the leading cause of neonatal death in both settings (Lehtonen et al., 2017).

Being born too early interrupts critical periods of growth and organ development, particularly of the lungs, brain, and immune system. Therefore, premature infants face difficulties with breathing, feeding, temperature regulation, and fighting infections (Mathur and Inder, 2009; Sozo and Harding,

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2024; Tanrıverdi and Yılmaz, 2025). Premature infants are at higher risk of developing adverse outcomes such as respiratory distress syndrome, perinatal asphyxia, sepsis, and intracranial haemorrhage, all of which are associated with an increased risk of death (Girma et al., 2023). Infants born prematurely have less time to develop in utero, and their organs and body systems are still undergoing physiological development process at the time of birth. This immaturity of body organs combined with low birth weight puts premature infants at risk of developing various short and long-term complications (Girma et al., 2023).

Globally and locally, prematurity is not only a clinical diagnosis, but also a reflection of health system performance, particularly in maternal care. Numerous studies have identified a wide range of modifiable maternal and fetal risk factors associated with prematurity and subsequent neonatal death. These include hypertension, pre-eclampsia, short interpregnancy intervals, low maternal education, and multiple gestation pregnancies (Defilipo et al., 2022; Toro-Huamanchumo et al., 2021). These risk factors are often embedded within broader socioeconomic and healthcare access issues, particularly in rural settings like many parts of Kelantan. For instance, hypertension a condition that is preventable and manageable with proper antenatal care has been associated with a significantly increased risk of neonatal death, largely mediated through prematurity (Grover et al., 2022). This suggests that the quality and continuity of maternal care are central to tackling neonatal death, not just technical neonatal interventions post-delivery.

2.3   Proportion of prematurity

Globally, prematurity accounts for approximately 35% of neonatal

deaths, followed by intrapartum-related complications, sepsis, and birth

defects (El Rafei et al., 2017). In developed countries, the incidence proportion

of neonatal deaths due to prematurity is even higher, ranging from 60% to 80%

(Covarrubias et al., 2009).

In Bangladesh 46.4% of neonatal death occurred among premature born

babies (R. Shah et al., 2014), while in Eastern Ethiopia, prematurity accounted

for 44.6% of neonatal deaths (H. A. Mohamed et al., 2022). These countries

reported higher proportions compared to the global average. Similarly, in

Indonesia, a study conducted in Serang and Jember districts reported that

prematurity accounted for 44% of neonatal death, with 79% occurring within the

first week of life (Deviany et al., 2022).

In contrast, Malaysia reported significantly lower incidence proportions.

According to data from the Department of Statistics Malaysia (DOSM), neonatal

deaths attributed to prematurity related disorders accounted for only 16.3% in

2020 and 16.2% in 2021, which is less than half the global average and markedly

lower than neighbouring or comparable countries. This discrepancy may reflect

differences in classification systems, reporting practices, or healthcare system

performance.

2.4   Factors Associated with Prematurity

2.4.1   Sociodemographic Factors

While the biological triggers of prematurity are well documented ranging from uterine infections to placental insufficiency the sociodemographic landscape in which these biological events occur is equally important in determining whether a premature birth occurs and whether the infant survives. Increasingly, global and regional literature has highlighted that prematurity is not just a clinical outcome, but a social phenomenon that reflects deeper structural inequalities within health systems (Bishop-Royse et al., 2021).

One of the most prominent sociodemographic determinants is maternal age. Both extremes of age adolescents and women aged 35 and above have been shown to carry higher risks of prematurity (Ling et al., 2018; Malabarey et al., 2012). However, these age groups do not exist in isolation from other risk-enhancing conditions. For adolescent mothers, biological immaturity may be compounded by poor health literacy, limited autonomy, and underutilization of antenatal care (Malamitsi-Puchner and Boutsikou, 2006).

Base on systemic review and meta-analysis conducted in UK, adolescent mothers at risk of premature delivery (aOR = 1.23, 95% CI: 1.09-1.38) and neonatal death (aOR =1.3, 95% CI: 1.14-1.15). Findings show that young maternal age is a significant risk factor for adverse neonatal outcomes in developed countries (Marvin-Dowle and Soltani, 2020).

In contrast, older mothers are more likely to suffer from chronic comorbidities such as hypertension and diabetes, which directly contribute to medically indicated premature deliveries (Moghaddam and Aghaali, 2015). Thus, maternal age intersects with biological, behavioural, and social determinants in complex ways that increase the risk of death due to prematurity.

A study conducted in Tehran, find out the advance maternal age was significantly associated with premature birth (OR=1.75, 95% CI: 1.28, 2.39) (Omani-Samani et al., 2022). A study conducted in low- and middle-income countries (LMICs) found that neonates born to mothers of advanced maternal age were associated with higher mortality (OR=1.30, 95% CI: 1.21, 1.39) (Wu et al., 2021).

Maternal education another critical variable. Beyond acting as a proxy for socio-economic status, education influences health seeking behaviour, decision making power, and ability to interpret medical advice. A study conducted in Brazil found that a low level of maternal education increased the chance of neonatal death by 25% (OR=1.25, 95% CI: 1.14, 1.36) (Fonseca et al., 2017). Another study conducted in a public hospital in Ethiopia found that a higher level of maternal education is a protective factor against prematurity (aOR=0.2, 95% CI: 0.1, 0.4) (Bozzola et al., 2023).The mechanisms are multifactorial with poorly educated mothers may delay seeking antenatal care, be less aware of danger signs, or be unable to advocate for timely intervention during complications (Olukade and Uthman, 2022). This suggests that

interventions to reduce neonatal deaths must extend beyond the clinic and engage communities in health literacy and empowerment efforts.

Household income and broader socio-economic status also play pivotal roles. Financial instability affects nearly every aspect of pregnancy care from affording nutritious food and transportation to health facilities, to access specialist services when complications arise. In low resource settings, women from lower income households are associated with higher rate of prematurity and subsequently lead to neonatal death (Victora et al., 2020). In a study conducted in Côte d'Ivoire, the poorest group was associated with a higher risk of fatal fetal outcomes (aOR=1.79, 95% CI: 1.02, 3.14) (Koné et al., 2018).

Marital status and social support further mediate the effect of sociodemographic risk on prematurity outcomes. Unmarried or unsupported women have been found to experience higher levels of psychosocial stress, which is independently associated with premature labour (T. Berhe et al., 2019). A prospective cohort study conducted in Malaysia found that being unmarried was significantly associated with premature birth (OR=1.66, 95% CI: 1.05, 2.61) (Mohd Zain et al., 2015).

In the Malaysian context, particularly in Kelantan, ethnicity and geographic location introduce additional layers of disparity. For example, studies on the Orang Asli and rural Malay populations have revealed disproportionately high rates of premature birth and neonatal mortality, partly due to traditional health beliefs, transportation challenges, and limited access to higher-level care. Such findings highlight the geographic and cultural

determinants of neonatal survival, which are rarely addressed in top-down policy responses. (Erwan et al., 2021)

2.4.2   Maternal Factors

Maternal conditions remain central to the causal pathway of prematurity and subsequent neonatal mortality. These factors not only reflect biological vulnerabilities but also serve as indicators of how effectively maternal health systems identify, monitor, and respond to gestational risk. The literature consistently highlights how maternal factors such as obstetric history, antenatal care adequacy, hypertensive disorders, and glucose metabolism disorders interact in complex ways often compounding the risk of early delivery and poor neonatal survival outcomes (Tanner et al., 2022; Abdullah et al., 2024).

A history of bad obstetric events such as previous stillbirths, miscarriages, or premature deliveries is a powerful predictor of recurrence in subsequent pregnancies. These adverse outcomes often arise from persistent or undiagnosed conditions like cervical insufficiency, placental dysfunction, or maternal systemic disease. A history of bad obstetric outcomes, particularly previous premature birth, is consistently associated with an increased risk of recurrence in subsequent pregnancies. The risk is notably higher when adverse outcomes occur within short interpregnancy intervals, suggesting that recurrent

obstetric complications may reflect underlying biological vulnerability as well as systemic gaps in interpregnancy care (Wen et al., 2025). This highlights the need for continuity of care that extends beyond individual pregnancies.

Inadequate antenatal care consistently emerges as a modifiable determinant of prematurity and neonatal mortality. WHO recommends a minimum of eight antenatal care to enable early risk identification, tailored interventions, and effective birth planning (WHO, 2016). However, many women, particularly in rural or underserved areas, initiate care late or attend fewer visits, missing critical screening windows for conditions such as hypertension, gestational diabetes, and fetal growth abnormalities. In Tanzania, reported that suboptimal antenatal attendance was strongly associated with prematurity and neonatal death (Schmiegelow et al., 2012), while in rural India, Dalal and Bodar (2013) found that over half of premature births occurred in mothers who had not accessed regular antenatal care. A study conducted in Gujarat India, found that inadequate antenatal care significant with premature deliveries (aOR=2.15, 95% CI: 1.94, 2.37) (S. Shah et al., 2021). A study conducted in Malaysia reported an increasing trend of preventable stillbirths and neonatal deaths from 2015 to 2017, with one-fifth of the cases attributed to factors related to insufficient antenatal care services (Ahmad et al., 2023).

Multiple gestation, due to increased uterine stretch and shared placental resources, poses intrinsic risks for premature labour (Arrowsmith, 2023). Over 60% of twin pregnancies culminate in delivery before 37 weeks, and neonatal mortality rises substantially for deliveries before 34 weeks (Meyer et al., 2018). A

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study conducted in Europe found that infants from multiple pregnancies had a nine-fold increased risk of premature birth and an almost twelve-fold increased risk of very premature birth compared to singletons (pooled RR=9.4, 95% CI: 9.1,9.8) (Heino et al., 2016).

Prolonged rupture of membranes (PROM), is defined as rupture of the amniotic sac lasting more than 18 hours before the onset of labour, has been consistently linked to an increased risk of premature birth (H. Boskabadi et al., 2011). The underlying mechanism involves the loss of a protective barrier between the sterile intrauterine environment and the external vaginal flora, which facilitates ascending infection. This microbial invasion triggers an inflammatory cascade within the amniotic cavity, involving cytokines and prostaglandins that stimulate uterine contractions and cervical ripening physiological processes that initiate premature labour (Ignatko et al., 2021).

A 3-year retrospective record-based study in India, showed that prolonged rupture of the membrane is significant associated with premature birth (OR=2.12, 95% CI 1.08, 4.14) (Shanbhag and Alva, 2020) .Evidence from a clinical study conducted at Hospital Modena in Italy found that a substantial proportion (67%) of neonates born to mothers with prolonged rupture of membranes were delivered prematurely. This finding suggests that prolonged rupture of membranes acts as an early clinical event in a chain of complications that often leads to adverse neonatal outcomes (Tramontano et al., 2024).This was supported by a study conducted in Taipei among infants born at 34 weeks of gestation or later with prolonged rupture of membranes showed that a length

of stay in the intensive care unit exceeding 3 days of admission (OR=5.49, 95% CI: 2.39, 12.60) (Su et al., 2024).

Antepartum haemorrhage (APH), including placenta previa and abruptio placentae, is another significant contributor to indicated premature births (OR=9.0, 95% CI: 5.39-15.03) (Kitil et al., 2025). Inadequate placental implantation and vascular fragility increase the risk of sudden haemorrhage, often necessitating early delivery to prevent maternal or fetal death. Antepartum haemorrhage has been observed in a significant proportion of premature deliveries and is strongly associated with poor neonatal outcomes, including high rates of perinatal mortality and increased NICU admissions particularly in cases where emergency surgical intervention is required and timely access to care is limited (Tyagi et al., 2016).

Pregnancy-induced hypertension (PIH) is one of the most frequently cited medical causes of premature birth, with both PIH and prematurity posing direct threats to placental function and fetal well-being (Al-Bahadily et al., 2017). PIH, which lead to gestational hypertension and preeclampsia, emerges after 20 weeks of gestation and is associated with endothelial dysfunction, vasoconstriction, and placental insufficiency. These pathophysiological changes often necessitate early delivery to prevent complications such as eclampsia, abruptio placentae, and intrauterine fetal death. The clinical challenge with PIH lies in its often-asymptomatic presentation and sudden deterioration, which can be missed without regular blood pressure monitoring and proteinuria screening. Moreover, even when detected, management

practices vary widely depending on facility resources, referral readiness, and practitioner skill level (Magee et al., 2014).

A study conducted in Ethiopia found that pregnancy-induced hypertension was significantly associated with low birth weight (aRR=5.10, 95% CI: 2.40, 7.80). This finding highlights a significant fivefold increased risk of LBW in hypertensive pregnancies, even after controlling for potential confounding factors such as maternal age, education, wealth status, gravidity, anaemia, and nutritional status (A. K. Berhe et al., 2019).

Hypertension, defined as elevated blood pressure diagnosed before pregnancy or before 20 weeks' gestation, is particularly concerning due to its cumulative impact on maternal end organs and the placenta (Newman et al., 2024). Hypertension is strongly associated with superimposed preeclampsia, IUGR, and medically indicated early delivery (Lei et al., 2022). A population-based study demonstrated that women with hypertension were significantly more likely to experience neonatal death, particularly when delivery occurred before 34 weeks' gestation (Leonard et al., 2023). Similarly, a study conducted in Shanghai found that hypertension was associated with premature delivery (aOR=1.58, 95% CI: 1.16, 2.15) and small for gestational age (aOR=1.45, 95% CI: 1.20,1.75).

PIH and chronic hypertension contribute to prematurity but through different mechanisms. PIH is driven by abnormal placental development and poor vascular remodelling, leading to reduced blood flow, inflammation, and rapid clinical deterioration (Lei et al., 2022). In contrast, chronic hypertension

stems from pre-existing vascular disease, gradually impairing placental function and increasing the risk of fetal growth restriction and superimposed preeclampsia. While both may require early delivery, PIH is primarily placenta-related, whereas chronic hypertension reflects underlying maternal cardiovascular strain (Newman et al., 2024).

Importantly, both pregnancy-induced hypertension (PIH) and hypertension reflect not only maternal health conditions but also the insufficient capacity of the healthcare system to respond effectively. Effective control of hypertensive disorders during pregnancy requires more than medication; it demands structured follow-up, integration between antenatal and noncommunicable disease clinics, and real-time referral mechanisms. Yet in many health systems, these linkages are inconsistently applied especially at the primary care level, where early detection must begin (Ekawati et al., 2020).

Diabetes mellitus (DM) and gestational diabetes mellitus (GDM) exert significant influence on the risk of premature birth. GDM is associated with increased rates of polyhydramnios, fetal macrosomia, and preeclampsia all conditions that independently contribute to medically indicated premature delivery (H. Boskabadi et al., 2024). A nationwide cohort study in France involving over 716,000 births found a 61% increase in premature delivery among women with GDM (OR=1.30, 95% CI: 1.25, 1.40) (Billionnet et al., 2017).

A study case-control study between pre-existing DM mother with neonatal outcome in Israel, found out diabetic mother associated with premature birth (OR=10.3, 95% CI: 3.4, 31.0) (Capobianco et al., 2020). Pre-

existing DM, particularly when poorly controlled, is associated with even more severe outcomes. Hyperglycaemia during the first trimester increases the risk of congenital anomalies, while third-trimester glucose dysregulation leads to placental dysfunction subsequently led to premature neonatal death (Jarmuzek et al., 2015). Women with pre-existing diabetes are at increased risk of needing early delivery due to signs of fetal distress, often linked to poor placental function and difficulties in blood sugar control during pregnancy (S. Mohamed et al., 2025).

The nutritional status of mothers plays a significant role in the incidence of prematurity. Poor maternal nutrition, particularly deficiencies in key micronutrients such as iron, folic acid, zinc, and vitamin D, has been linked to an increased risk of spontaneous premature birth (Chulkov et al., 2022; Shikh and Makhova, 2020). The study highlights that undernutrition and low pre-pregnancy BMI are associated with impaired placental development and intrauterine growth restriction, both of which heighten the likelihood of premature delivery.

One of the major contributors to anaemia in pregnancy is poor nutrition (Sharma et al., 2022). Anaemia during pregnancy is significantly associated with low birth weight and prematurity (Salunkhe et al., 2021). According to a study, maternal anaemia particularly iron deficiency can reduce oxygen supply to the fetus, increasing the risk of spontaneous premature delivery. The study also found that anaemic mothers were more likely to deliver prematurely, and their

babies faced a higher likelihood of low birth weight and reduced chances of survival (Noronha et al., 2012).

Amniotic fluid disorder, polyhydramnios is recognized as significant contributors to adverse perinatal outcomes, including prematurity and neonatal death (Yimam et al., 2020). These conditions complicate approximately 1-3% of pregnancies. Polyhydramnios, frequently linked to fetal abnormalities, maternal diabetes, or twin pregnancies though idiopathic in up to 60% of cases has been associated with a prematurity rate of up to 22% and perinatal mortality ranging from 10–30% (Volante et al., 2004). The excess amniotic fluid can result in uterine overdistension, premature rupture of membranes, and early onset of delivery, all of which increase the risk of premature death, a leading cause of neonatal mortality.

Oligohydramnios, defined as an amniotic fluid index (AFI) ≤ 5 cm, occurs in 3-5% of pregnancies and is associated with premature birth which further complicated neonatal outcomes (Rabinovich et al., 2019). The study by Rabinovich, conducted in Israel in 2017, highlights that early-onset oligohydramnios particularly when it occurs before 34 weeks of gestation is strongly associated with spontaneous preterm delivery and increased neonatal morbidity and mortality. These adverse outcomes are often due to pulmonary hypoplasia, umbilical cord compression, and reduced amniotic cushioning, which predispose the fetus to distress and asphyxia. Additionally, the presence of oligohydramnios at term increases the likelihood of interventionist deliveries,

including caesarean section, which may be performed pre-emptively in response to signs of fetal compromise.

2.4.3   Fetal Factor

Fetal conditions are one of important part of the overall risk that leads to neonatal death, especially in premature babies. Two key fetal factors, birth weight and congenital birth anomalies are strong predictors of whether a newborn survives (Kareem Dehiol and Mansoor Abood Al-Asadi, 2018; Moghaddam and Aghaali, 2015). These issues are not just caused by biology alone but often result from combined effects of the mother's health, the pregnancy environment, and the healthcare system's ability to provide early diagnosis and appropriate care.

Low birth weight (LBW) is defined as a birth weight between 1501 and less than 2500 grams. Very low birth weight (VLBW) refers to infants weighing between 1000 and 1500 grams, while extremely low birth weight (ELBW) is defined as less than 1000 grams (WHO, 2022). Babies in these lower weight categories face a significantly higher risk of death, particularly in settings where access to intensive neonatal care is limited or inadequate. These small babies are more likely to face serious health problems like difficulty in breathing, infections, poor temperature control, and feeding difficulties. One study showed that ELBW babies may be up to 200 times more likely to die than full-term babies of normal weight (Sujata et al., 2021a). While another study conducted in Northwest Ethiopia found an association between low birth weight and prematurity (aOR=17.6, 95% CI: 5.18, 60.17) (Ekubagewargies et al., 2019).

The reasons for LBW are many, include maternal health problems like poor nutrition, high blood pressure, infections, or problems with the placenta. When LBW happens together with prematurity, the baby faces even more challenges. In Malaysia, as in many low- and middle-income countries, most neonatal deaths occur in babies with VLBW or ELBW, especially within the first few days of life when they are most fragile (Matute et al., 2022a).

Congenital anomalies refer structural or functional abnormalities that develop during pregnancy and can affect the baby's organs, limbs, or body systems (World Health Organization, 2023). These anomalies are one of the leading causes of neonatal deaths globally. When a baby is born prematurely and has a birth anomaly, the risk of dying early in life increases significantly (Swanson and Sinkin, 2013). This combination often presents urgent clinical challenges and puts additional pressure on already stretched healthcare resources.

A study conducted in Iraq found that premature birth is significantly associated with congenital anomalies (OR=8.47, 95% CI: 6.61, 17.37) (Al-Asadi and Dehiol, 2018). The study highlights among the congenital anomalies observed, neural tube defects were the most common (31.9%), followed by congenital heart disease and cleft lip/palate. Importantly, premature neonates accounted for 24.5% of the cases with multiple congenital anomalies, highlighting the vulnerability of this subgroup.

Structural congenital anomalies particularly neural tube defects such as spina bifida and anencephaly can lead to premature birth and significantly

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