A systematic review of the burden of neonatal mortality and morbidity in the ASEAN Region

Hoang T Tran¹, ², Lex W Doyle³, ⁴, Katherine J Lee⁵, ⁶, Stephen M Graham⁷

Neonatal morbidity and mortality are major global public health challenges representing an increasing proportion of overall under-5 child mortality, with the vast majority of neonatal deaths occurring in resource-limited settings. In the Association of Southeast Asian Nations (ASEAN) region, it is estimated that approximately 200 000 neonatal deaths occur annually with reported estimates of the neonatal mortality rate ranging from 1 to over 30 per 1000 live-births, depending on the setting. The aim of this study is to conduct a systematic review of published data on neonatal morbidity and mortality from the ASEAN region over the last 10 years. Very few published studies reporting neonatal morbidity and mortality in this region were found. Importantly, data are available from just a few countries, with an underrepresentation of the most resource-limited settings. The majority of the studies describing mortality and morbidity were retrospective surveys or focussed on a specific cause of neonatal morbidity. Studies included findings from a range of settings, from neonatal intensive care to community settings utilizing verbal autopsy. Therefore, comprehensive and prospective data are needed to inform priorities and potential interventions to improve neonatal care and reduce neonatal mortality in this region.

Key words: Neonatal mortality, neonatal morbidity, neonatal care, Association of Southeast Asian Nations (ASEAN).

Introduction

Neonatal morbidity and mortality are major global public health challenges with approximately 3.1 million babies worldwide dying each year in the first month of life.¹ The vast majority (up to 98.5%) of neonatal deaths occur in developing countries. As overall infant and child mortality fall, neonatal mortality represent an increasing proportion with recent estimates showing that neonatal mortality now accounts for more than 40% of the overall under-5 child mortality, an increase from 37% in 1990.¹,² It is therefore clear that strategies to reduce neonatal mortality are essential in reaching the Millennium Development Goal 4 to reduce child mortality.

The Association of Southeast Asian Nations (ASEAN) is a collaborative group of 11 countries located in South-East Asia. It is a populous region with wide variability in socioeconomic and development indicators. In

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In this region, it is estimated that about 11 million babies are born each year with approximately 200,000 neonatal deaths annually. Reported estimates of the neonatal mortality rate in 2010 range from very low, for example around 1 to 3 per 1000 live-births in Singapore and Malaysia, to over 30 per 1000 live-births in Myanmar (Table 1). In the ASEAN region, it is estimated that preterm birth complications account for 45% and birth asphyxia for 25% of neonatal deaths, while congenital anomalies and neonatal sepsis account for 16% and 14%, respectively. These proportions vary among individual countries.

While such variations are expected due to differing levels of health care across the region, it is difficult to know the accuracy of these estimates as there are differences between official reports and research data. Further, socioeconomic parameters change with time, in some settings quite markedly, and so the timing of data collection is relevant in that more recent data are likely to reflect more accurately the current situation than data from more than a decade ago.

We aimed to review systematically published data of the current burden in neonatal care in the ASEAN region over the last 10 years, including major causes of neonatal death, common morbidities, and associated risk factors of mortality and morbidity, in order to identify priorities for potential interventions to reduce the burden in the future.

Table 1: An overview of ASEAN socioeconomic and health indicators

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</tr>
</thead>
<tbody>
<tr>
<td>Brunei</td>
<td>399</td>
<td>18</td>
<td>8</td>
<td>32 648</td>
<td>4</td>
<td>100%</td>
<td>...</td>
<td>14.2</td>
<td>48.8</td>
<td>2.3</td>
</tr>
<tr>
<td>Cambodia</td>
<td>14 138</td>
<td>22</td>
<td>315</td>
<td>684</td>
<td>22</td>
<td>44%</td>
<td>27</td>
<td>2.3</td>
<td>7.9</td>
<td>5.9</td>
</tr>
<tr>
<td>Indonesia</td>
<td>239 871</td>
<td>17</td>
<td>4 270</td>
<td>2 611</td>
<td>17</td>
<td>73%</td>
<td>82</td>
<td>2.9</td>
<td>20.4</td>
<td>2.2</td>
</tr>
<tr>
<td>Lao PDR</td>
<td>6 201</td>
<td>22</td>
<td>140</td>
<td>1 005</td>
<td>21</td>
<td>20%</td>
<td>&lt;35</td>
<td>2.7</td>
<td>9.7</td>
<td>4</td>
</tr>
<tr>
<td>Malaysia</td>
<td>28 401</td>
<td>20</td>
<td>584</td>
<td>8 083</td>
<td>3</td>
<td>100%</td>
<td>&lt;79</td>
<td>9.4</td>
<td>27.3</td>
<td>4.4</td>
</tr>
<tr>
<td>Myanmar</td>
<td>47 963</td>
<td>17</td>
<td>815</td>
<td>876</td>
<td>32</td>
<td>37%</td>
<td>43</td>
<td>4.6</td>
<td>8</td>
<td>1.9</td>
</tr>
<tr>
<td>Philippines</td>
<td>93 261</td>
<td>25</td>
<td>2 385</td>
<td>2 851</td>
<td>14</td>
<td>62%</td>
<td>78</td>
<td>11.5</td>
<td>60</td>
<td>3.9</td>
</tr>
<tr>
<td>Singapore</td>
<td>5 086</td>
<td>10</td>
<td>50</td>
<td>42 165</td>
<td>1</td>
<td>100%</td>
<td>...</td>
<td>18.3</td>
<td>59</td>
<td>3.1</td>
</tr>
<tr>
<td>Thailand</td>
<td>69 122</td>
<td>11</td>
<td>802</td>
<td>4 414</td>
<td>8</td>
<td>99%</td>
<td>80</td>
<td>3</td>
<td>15.2</td>
<td>3.7</td>
</tr>
<tr>
<td>Viet Nam</td>
<td>87 848</td>
<td>16</td>
<td>1 434</td>
<td>1 041</td>
<td>12</td>
<td>88%</td>
<td>29</td>
<td>12.2</td>
<td>10.1</td>
<td>7.1</td>
</tr>
<tr>
<td>Timor-Leste</td>
<td>1 124</td>
<td>38</td>
<td>46</td>
<td>2 405</td>
<td>24</td>
<td>30%</td>
<td>55</td>
<td>1</td>
<td>21.9</td>
<td>13.6</td>
</tr>
</tbody>
</table>

Sources: World Health Organization, United Nations1,42-44
NMR: neonatal mortality rate, GDP: gross domestic product
"Myanmar", "Philippines", "Singapore", "Thailand", "Vietnam", "Timor", "Borneo", "Mekong", "morbidity", "mortality", "risk factors", "cause of death", "survival analysis", "infant mortality", "perinatal mortality", "neonat* or neonatal", "neonatal intensive care", "newborn infant", "infant newborn diseases", "infant premature diseases", "premature birth", "preterm or pre-term or prematur*", "infection", "sepsis", "asphyxia", "inborn genetic diseases", "congenital abnormalities". Studies that reported morbidity or mortality prevalence or incidence among a defined population were included. Case series and case reports were not included. Both retrospective and prospective studies were included. Unpublished data were not available and therefore not included.

**Results**

The search identified 674 publications, and of these only 19 publications fitted the selection criteria (Figure 1). Information on the location and timing of the included studies along with main study findings are listed in Table 2.

Five studies reported the incidence of neonatal mortality with a known population denominator, only one of which collected data prospectively. Of these five, three studies were from Viet Nam, one from Indonesia and one from Thailand. The neonatal mortality varied across studies; the Thai study reported a neonatal mortality rate of 3.97 per 1000 live-births for early neonatal mortality (deaths within the first week of life) while the neonatal mortality rate in the Indonesian study was 19.2 per 1000 live-births with 75.6% having occurred in the first week of life. Two of the studies reporting neonatal mortality rate were from the same province in Northern Viet Nam at different time-points and demonstrated the improving neonatal mortality rate in eight rural districts from 24/1000 live-births in 2005 to 16/1000 live-births in 2010. Four of these five studies also reported risk factors for poorer perinatal outcomes. Common causes of neonatal deaths in these five studies included prematurity, growth restriction, birth asphyxia, infections and congenital anomalies.

**Figure 1: Flow of study selection**

Identified from the search after elimination of duplicates (n=674) → Excluded on title (n=631)

Abstract reviewed (n=43) → Excluded on abstract (n=16)

Full text articles reviewed (n=27) → Articles excluded (n=8)

Articles included for analysis (n=19)
The remaining 14 publications represented the findings of 13 studies (two papers represented the same study\textsuperscript{12,13}) that reported mortality rates or morbidity data from specific sub-populations of newborns. The major and varied findings from each study are shown in Table 2. There was marked heterogeneity in the focus of the studies as regards conditions and settings, and only four were prospective studies. Ten of the studies were undertaken in large urban-based hospitals. Three studies reported the incidence of birth defects,\textsuperscript{14-16} one study investigated risk factors associated with birth defects,\textsuperscript{17} three studies focused on bacterial sepsis in hospitalized newborns,\textsuperscript{18-20} one study reported the incidence of perinatal asphyxia\textsuperscript{21} and one study described outcomes of normal birth weight infants in a Singapore neonatal intensive care unit.\textsuperscript{22} The remaining four studies were reports from hospital-based neonatal care settings, mainly of VLBW newborns.\textsuperscript{12,13,23-25}

There was also marked variation in sample across the studies, ranging from 154 neonatal admissions to a neonatal intensive care unit\textsuperscript{22} to 17 519 live-births in a community in Viet Nam\textsuperscript{9} to 320 093 in a national database in Singapore\textsuperscript{15}. Four studies\textsuperscript{7-10} were conducted in rural areas and one in both rural and urban areas\textsuperscript{11}, the remaining studies were from urban settings or from national databases. Study designs also varied from review of medical records in health facilities to interview of related participants in community.

**Discussion**

This systematic review has found that there are few published data of neonatal mortality and morbidity in the ASEAN region. Further, it is not possible to combine data from these studies for a meta analysis because of marked heterogeneity in study sites, the scope of data collected and populations studied. Among the population-based studies of overall mortality, four of five were retrospective, using interviews of households, women or healthcare workers to identify the causes of deaths. Two studies in Viet Nam\textsuperscript{8,10} conducted the interviews within 2-3 months after the neonatal deaths while another study in Viet Nam conducted the interviews within one year after the neonatal deaths occurred.\textsuperscript{9} The Indonesian study used information from the previous five years.\textsuperscript{11} It is clear that recall bias could not be avoided in these studies. Furthermore, among four studies concerning birth defects, only one was prospective and this was also population-based,\textsuperscript{16} one was from a Malaysian hospital\textsuperscript{14} and two were from national data in Singapore\textsuperscript{15,17}. Among the other hospital-based studies, only three prospective studies had a sample size of more than 400 neonates describing LBW infants in Malaysia and sepsis in Philippines\textsuperscript{12,13,18,24} while five retrospective studies describing common problems in the neonatal intensive care units reported fewer than 200 cases.

An important finding is that, 13 of the 19 publications identified in this review were from three of the better-resourced countries in the region — Thailand, Singapore and Malaysia. More data are clearly needed from the more resource-limited, higher mortality settings within this region because neonatal mortality is such an important contributor to child mortality, and because data are needed to inform possible interventions to improve outcomes for newborns in the region. Of note, there is marked variation in the available data on morbidity in terms of focus, and so it is difficult to have a clear picture of the relative contributions of the likely main causes.

Common causes of neonatal deaths in resource-limited settings include sepsis, prematurity/LBW (especially VLBW preterm babies), birth asphyxia and congenital anomalies. The incidence of some of these morbidities such as sepsis, asphyxia and low birth weight due to intrauterine growth restriction, as well as mortality among all
## Table 2: Summary of major findings for 18 studies (19 publications)

<table>
<thead>
<tr>
<th>Ref</th>
<th>Study year(s)</th>
<th>Setting</th>
<th>Focus</th>
<th>Pop size</th>
<th>Design</th>
<th>Main findings</th>
</tr>
</thead>
<tbody>
<tr>
<td>(10)</td>
<td>1/1/1999-31/12/2005</td>
<td>Community, Bavi, Viet Nam</td>
<td>Overall mortality</td>
<td>5521 reported births</td>
<td>Retrospective, interviewed heads of households and women</td>
<td>Neonatal mortality 11.6/1000 live-births; early neonatal death (within the first week of life) accounted for 80%; prevalence of preterm births 15.6%; small for gestational age 6.4%</td>
</tr>
<tr>
<td>(11)</td>
<td>1997-2002</td>
<td>26 provinces, Indonesia</td>
<td>Overall mortality</td>
<td>15 952 singleton liveborn infants</td>
<td>Retrospective, interviewed households and eligible women</td>
<td>307 neonatal deaths (19.2 /1000 live-births). NMR among newborns from 2.5 to 3.5kg birth weight was 8.4/1000 live-births, and 72.4/1000 live-births among newborns &lt;2.5kg birth weight. Risk factors for deaths were higher in infants born to employed parents or unemployed fathers, mothers with history of delivery complications; short birth interval, male infants, small for gestational age (SGA)</td>
</tr>
<tr>
<td>(7)</td>
<td>2000-2002</td>
<td>Community, Thailand</td>
<td>Overall mortality</td>
<td>3522 births from 3494 women from 28 to 38 weeks gestation</td>
<td>Prospective, semi-structured verbal autopsy questionnaire and medical records</td>
<td>Early neonatal mortality rate 3.97/1000 live-births. Common causes of deaths were malformations, asphyxia, meconium aspiration and sepsis. 35.7% of early neonatal deaths could have been prevented by appropriate antenatal or intrapartum care.</td>
</tr>
<tr>
<td>(9)</td>
<td>1-12/2005</td>
<td>Community, Quang Ninh, Viet Nam</td>
<td>Overall mortality</td>
<td>17 519 live-births in Quang Ninh province (14 districts)</td>
<td>Retrospective, data from health facilities and interview of health workers</td>
<td>238 neonatal deaths: NMR 16/1000 live-births. Of deaths, 95% were singletons and 58.6% died within 24 hours of delivery – 80.6% within the first week of life, 31% born at home. Leading causes of deaths: prematurity/LBW 37.8%, intrapartum-related 33.2%, infections 13% and congenital malformation 6.7%.</td>
</tr>
<tr>
<td>(8)</td>
<td>2008-2010</td>
<td>Community, Quang Ninh, Viet Nam</td>
<td>Overall mortality</td>
<td>14 453 live-births in 8 districts in Quang Ninh province</td>
<td>Retrospective Verbal autopsy</td>
<td>238 neonatal deaths: NMR 16/1000 live-births. Of deaths, 95% were singletons and 58.6% died within 24 hours of delivery – 80.6% within the first week of life, 31% born at home. Leading causes of deaths: prematurity/LBW 37.8%, intrapartum-related 33.2%, infections 13% and congenital malformation 6.7%.</td>
</tr>
<tr>
<td>(14)</td>
<td>1/1999-6/2000</td>
<td>Hospital Kuala Lumpur, Malaysia</td>
<td>Birth defects</td>
<td>34 109 births</td>
<td>Retrospective, cross-sectional study. Data from medical records</td>
<td>1506 (31/1000) births with defects.</td>
</tr>
<tr>
<td>(16)</td>
<td>2/2003-4/2004</td>
<td>Kinta district, Perak, Malaysia</td>
<td>Birth defects</td>
<td>17 720 births</td>
<td>Prospective, case-controlled study</td>
<td>253 (14.3/1000) births with major birth defects. Mortality rate 25.2%, multiple birth defects 32.5%, isolated birth defects 67.5%.</td>
</tr>
<tr>
<td>(17)</td>
<td>1/1994-31/1998</td>
<td>National data, Singapore</td>
<td>Birth defects</td>
<td>237 755 live-births</td>
<td>Retrospective</td>
<td>3276 birth defect cases. Maternal age ≥40 was a risk factor for all types of birth defects. Parents worked as &quot;cleaners, labourers, and related workers&quot; were likely to have an increased risk of having children with chromosomal single defects (CSDs), non-CSDs and multiple defects.</td>
</tr>
<tr>
<td>(22)</td>
<td>1/1991-12/1992</td>
<td>Level III NICU, Singapore General Hospital</td>
<td>NICU admissions</td>
<td>154 normal birth weight babies admitted to the NICU</td>
<td>Retrospective review from medical records</td>
<td>Complete data for 137 babies. MBW 3243 g, GA 39 weeks. 81.8% required respiratory support. Mortality rate 11.7%. Causes of death: congenital malformation, asphyxia, and meconium aspiration syndrome.</td>
</tr>
<tr>
<td>Ref</td>
<td>Study year(s)</td>
<td>Setting</td>
<td>Focus</td>
<td>Pop size</td>
<td>Design</td>
<td>Main findings</td>
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<tr>
<td>(12, 13)</td>
<td>1996</td>
<td>20 hospitals in Malaysia</td>
<td>Very low birth weight babies</td>
<td>962 VLBW babies</td>
<td>Prospective, Inpatient data</td>
<td>69% survived to discharge; 52.3% required PPV; 5.5% received surfactant; 19.3% (out of 822 cases) had late onset infections (LOS). 30.8% died among the LOS group, higher than the non-infection group. The most common bacteria: <em>K. pneumoniae</em> (38.3%), coagulase-negative <em>staphylococci</em> (17.6%), <em>Staphylococcus aureus</em>. 116 SGA VLBW and 116 AGA controls. There was higher proportion of SGA compared with AGA infants with an Apgar score at one minute of three or less. SGA group had higher mortality rate (52.6% vs 28.4%) and longer mean duration of stay.</td>
</tr>
<tr>
<td>(23)</td>
<td>1/1/2003-31/12/2006</td>
<td>Songklanagarind Hospital-Thailand</td>
<td>Very low birth weight babies</td>
<td>178 VLBW infants</td>
<td>Retrospective, medical records</td>
<td>MBW was 1123 g and 29 weeks. Antenatal corticosteroid 48.9%, required PPV at birth 58.4%, 55.6% had clinical sepsis, 16.3% had blood-culture proven infections. 73% survived until discharge. 29.2% had major morbidities.</td>
</tr>
<tr>
<td>(24)</td>
<td>15/3-14/8/2006</td>
<td>Hospital Tuanku Jaafar, Malaysia</td>
<td>Low birth weight babies</td>
<td>3341 inborn live-births, including 422 LBW infants</td>
<td>Prospective, data from health records and interview of mothers</td>
<td>350 LBW babies were recruited and 350 controls. Risk factors for LBW were low GA, maternal pre-pregnancy weight, nulliparity, previous LBW, and PIH.</td>
</tr>
<tr>
<td>(25)</td>
<td>1/7/2003-30/6-2006</td>
<td>Thammasat University Hospital, Thailand</td>
<td>Very low birth weight babies</td>
<td>16 114 inborn live-births, including 78 VLBW</td>
<td>Retrospective, review of medical records</td>
<td>The incidence of VLBW was 4.9/1000, 27% ELBW. Median birth weight 1200 g, GA 30w, 15% had no antenatal care, 18% had severe pre-eclampsia. Survival rate was 81%, survivals with morbidity was 35%.</td>
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<tr>
<td>(21)</td>
<td>7/1999-12/2000</td>
<td>King Chulalongkorn Memorial Hospital, Thailand</td>
<td>Perinatal asphyxia</td>
<td>17 706 deliveries, including 111 perinatal asphyxia babies, (Apgar&lt;6)</td>
<td>Retrospective, review of medical records</td>
<td>The incidence of perinatal asphyxia was 6.3/1000 live-births, 84 babies were eligible, 22/84 perinatal asphyxia babies had HIE (1.2/1000 live-births). A 5-minute Apgar score was associated with HIE.</td>
</tr>
<tr>
<td>(19)</td>
<td>1/1996-12/2001</td>
<td>Siriraj hospital, Thailand</td>
<td>Group B strep bacteremia</td>
<td>Total live-births during six-year period</td>
<td>Retrospective, review of medical records</td>
<td>There were 19 cases (0.32 cases/1000 live-births in 1996 to 0.1/1000 live-births in 2001). 47% were premature, 53% had LBW, 79% had early onset, 10.5% late onset. 68% survived. All deaths were early onset cases.</td>
</tr>
<tr>
<td>(18)</td>
<td>5/2003-7/2004</td>
<td>Two largest NICUs in Manila, Philippines</td>
<td>Newborn infections</td>
<td>1831 neonates hospitalized during the study period</td>
<td>Prospective, pre- and post-intervention study</td>
<td>19.6% had bacteremia drug-resistant gram negative rods; <em>Klebsiella species</em>, <em>Enterobacter species</em>, <em>Acinetobacter species</em>, <em>Pseudomonas aeruginosa</em> were the most common bacteria. Of these, 20% resistant to imipenem; 52% to amikacin, 67% to cefazidim, 80% to tobramycin.</td>
</tr>
<tr>
<td>(20)</td>
<td>5/2003-6/2005</td>
<td>Women's and Children's Harapan Kita Hospital, Jakarta, Indonesia</td>
<td>Neonatal sepsis</td>
<td>216 NICU babies, including 133 newborns with symptoms of infections</td>
<td>Retrospective, review of medical records</td>
<td>6.7% had proven EOS, 63/133 (47.4%) had proven LOS. Common EOS bacteria: <em>Serratia sp.</em>, <em>staph aureus</em>. Common LOS bacteria were <em>Klebsiella sp.</em>, <em>Enterobacter sp</em>. There was a high incidence of bacteria resistant to ampicillin-sulbactam.</td>
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</tbody>
</table>

NMR: Neonatal mortality rate  
AGA: appropriate for gestational age  
GA: gestational age  
LBW: Low birth weight  
NBW: Normal birth weight  
LOS: Late onset sepsis  
PPV: Positive pressure  
ELBW: Extremely low birth weight  
MBW: Mean birth weight  
EOIS: Early onset sepsis  
SOGA: small for gestational age  
LOS: Late onset sepsis  
PIH: pregnancy-induced hypertension
of these groups are generally higher in the resource-limited compared with the resource-rich settings. In the ASEAN region, it is estimated that birth asphyxia makes up 25% of neonatal deaths, and that 45% of neonatal deaths are due to preterm birth complications, while congenital anomalies and neonatal sepsis account for 16% and 14% of neonatal deaths, respectively.\(^{3}\)

Neonatal sepsis is an important cause of neonatal mortality globally that is treatable and potentially preventable but the studies reviewed do not provide adequate information of its actual incidence and of the common causative pathogens. Risk factors for sepsis have been reported to be mechanical ventilation, prematurity and positive colonization.\(^{18}\) A high prevalence of bacteria resistant to multiple antibiotics was reported with up to 20% of gram-negative rods resistant to the broad spectrum antibiotic, Imipenem.\(^{18,20}\) However, both of these studies were carried out in neonatal intensive care units in large urban hospitals and it is not clear what the indications for sampling for culture were or the timing of the sampling in relation to admission to the neonatal intensive care unit. Nosocomial infections are likely to be common in these settings and are more likely to be caused by antibiotic-resistant pathogens than perinatally acquired sepsis. Blood culture studies also have inherent limitations in comparing the prevalence of different pathogens as there may be a bias to more robust, antibiotic-resistant Gram negatives while more fastidious organisms such as Group B streptococci are underrepresented. Importantly, there appear to be no published studies reporting perinatally acquired neonatal sepsis, which would be more informative for determining first-line empirical treatment. Studies of neonatal sepsis from different regions of the globe have been reviewed recently. There appear to be differences in the pattern between regions, particularly of the relative importance of Group B streptococcus and staphylococci.\(^{26-28}\) The study from urban Thailand\(^{19}\) reported an incidence of Group B streptococcus which was much lower than has been reported from other regions of the world.\(^{29-31}\) It is difficult to know whether this may be an underestimate or not.

There are currently limited published data of the causes of neonatal sepsis in the ASEAN region that could inform empirical therapy for neonatal sepsis,\(^{29}\) and yet it is very likely that the inappropriate use and choice of antibiotics is leading to multidrug resistance among bacterial pathogens that commonly cause neonatal sepsis.

Preterm birth complications are directly responsible for approximately one million neonatal deaths globally each year. From the limited studies published in Thailand, Malaysia and Viet Nam, high mortality and major morbidities were seen among babies that were preterm or LBW, or both. The mortality among VLBW infants varied with places and time; from 19% to 27% in Thailand in 2006\(^{23,25}\) to 31% in Malaysia in 1996.\(^{13}\) LBW and/or prematurity was reported to be associated with 37.8% of neonatal deaths in Quang Ninh province in Viet Nam.\(^{9}\) Deaths from prematurity and/or LBW in other countries such as PDR Lao, Cambodia or Myanmar are likely to be even higher because healthcare is of a lower quality. Risk factors for mortality in LBW infants included low rates of antenatal corticosteroid use, high rates of hypothermia, and low Apgar score at five minutes of less than 5.\(^{25}\) Risk factors for LBW or preterm births from these studies were farming women, low pre-pregnancy weight, pregnancy-induced hypertension and low gestational age.\(^{10,24}\)

Globally, it has been reported that preterm newborns have a 13 times greater risk of death than full-term newborns,\(^{7,32}\) with babies
born prematurely and small for gestational age at even higher risk of death.\textsuperscript{13} In low-resource ASEAN countries where high-technology equipment is not widely available in neonatal care, and thus it is important that prevention of preterm births/LBW and application of effective interventions is increased. Most preterm deliveries occur between 33 to 37 weeks,\textsuperscript{33} and these newborns have a good survival rate if they receive appropriate care for hypothermia, feeding, respiratory problems, jaundice and infections. These problems may not require the same level of intensive care technology as seen in developed countries for VLBW babies. Therefore in addition to good coverage of antenatal care, low cost interventions such as antenatal corticosteroids, breastfeeding and kangaroo mother care\textsuperscript{34-37} should be prioritized in the ASEAN region.

Birth asphyxia has been identified as another leading cause of neonatal deaths, causing more than 700 000 neonatal deaths per year worldwide. Limited data in the ASEAN region did not reveal the real burden of birth asphyxia in this region but these studies did report some data; the incidence was 6.3 per 1000 live-births and a low Apgar score at five minutes was associated with hypoxic-ischemic encephalopathy in a Thai study.\textsuperscript{21} Asphyxia was reported to cause between 14.3\% of the early neonatal deaths in Thailand\textsuperscript{7} to as much as 33.2\% of deaths in Quang Ninh, Viet Nam.\textsuperscript{8} While an Indonesian study showed that the mortality rate was reduced significantly when a high percentage of births had attendants present,\textsuperscript{11} the Quang Ninh study reported high intrapartum-related deaths regardless of whether delivery was in a healthcare facility or not, especially at the district levels. Furthermore, one Thai study stated that 37\% of early neonatal deaths could be prevented with good antenatal care and appropriate mode of delivery.\textsuperscript{7} These studies emphasized that health facilities do not always have staff with sufficient skills for obstetric emergency care, neonatal resuscitation and appropriate basic equipment for care.\textsuperscript{8,38}

Effective interventions for birth asphyxia include improving quality and coverage of intrapartum care, or increasing the coverage of emergency care for mothers and resuscitation for newborns.\textsuperscript{39,40} Research to reduce mortality related to birth asphyxia in the ASEAN region should therefore prioritize improving the coverage of available healthcare, and delivering effective interventions to improve infant outcomes in the targeted population.\textsuperscript{41}

**Conclusions**

This systematic review has demonstrated that there are limited published contemporary data regarding neonatal mortality and morbidity in the ASEAN region. The data that are available are from just a few countries with an underrepresentation of the most resource-limited settings. The majority of the studies describing mortality and morbidity in the ASEAN region were retrospective surveys, with widely variable denominators and outcomes of interest. Additional and contemporary data are needed to inform priorities and potential interventions to improve perinatal and neonatal care targeted to reduce neonatal mortality and morbidity in the region.

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**References**


