Original Article

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Evaluation of an Epidemiological Surveillance System for Preterm Birth and Low Birth Weight in Southern Thailand

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Abstract:

Objective: To assess the prevalence and management of preterm birth and low birth weight (LBW) infants, including the exploration of known risk factors for preterm birth and LBW, recorded in field testing of a web-based surveillance system of maternal-newborn health in southern Thailand.

Material and Methods: The data of 2,459 women who delivered in six community hospitals and two referral hospitals in Songkhla province, southern Thailand were extracted from the field testing records of an experimental surveillance system. The incidences of preterm and LBW and their management with attributed factors to the specific problems and associated factors were analyzed by univariate analysis and multiple logistic regression.

Results: The incidences of preterm birth and LBW were 5.6% and 9.8%, respectively. Maternal age, parity, preeclampsia, antenatal care visits, birth attendant and type of hospital were significantly associated with the incidence of preterm birth or LBW. Of women with preterm birth, 8.4% received a tocolytic and 25.3% received corticosteroids. Half of the women with preterm birth were investigated for infection. More than half of the LBW births were related to a preterm condition and most of the LBW infants were appropriately resuscitated, given appropriate hypothermia prevention and

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early feeding, and infection prevention measures applied. Approximately 25.0% of the preterm and LBW infants had adverse fetal outcomes. Well-known limited factors were found in few cases of preterm and LBW infants.

Conclusion: The incidence of preterm and LBW births and their management can be monitored in a timely way from a web-based surveillance system.

Keywords: evidence-based management, low birth weight, preterm birth, surveillance system

Introduction

Preterm birth and low birth weight (LBW), with global incidences of 9.6% and 14.0%, respectively, are the primary contributors to neonatal morbidity and mortality. Preterm birth is defined as a birth occurring at less than 37 weeks of gestation and LBW is defined as fetal birth weight less than 2,500 grams, which is frequently comorbid with preterm birth, growth restriction, or a combination of the two, leading to both higher rates of health problems and economic burdens.[1-5] Rates of preterm birth have been reported at 7.4-14.3% across Asia[6] with an average global rate of 9.6%.[2] Globally, the rate of LBW was reported to be 15.0% in 2014, with 6.0% in East Asia; this apparently low rate in East Asia may be due to underreporting, considering a recent World Health Organization (WHO) report which found that 22.0% and 66.0% of neonates in East Asia and South Asia, respectively, were not properly weighed at birth.[7]

Since preterm birth and LBW are known to be the causes of significant adverse health outcomes, maternal risk factors, including both non-modifiable and modifiable factors, associated with preterm birth and LBW have been extensively studied.[3,7-9] Currently, various screening methods to identify women who are at high-risk for preterm birth are recommended in order to provide timely prophylactic treatment;[10] however, even following the implementation of such screening programs, neither the prevalence of preterm birth nor LBW have decreased as expected.[11] When a preterm or LBW neonate is detected, prompt appropriate management with evidence-based guidelines for care of preterm and LBW neonates is recommended.[12] Successful systems for monitoring and evaluating the magnitude of problems and identifying risk factors for preterm birth and LBW are essential to reduce their adverse outcomes.[13]

In 2013, the "epidemiological surveillance system for improving maternal and newborn health and survival: field testing in Songkhla, Thailand" was developed with the support of the WHO. The aim of this surveillance system was to provide real-time, online electronic health information and enable efficient physician review of patient histories to screen for preterm birth and LBW risk factors in limited resource settings.[14] Before implementing this system more widely, it first must be evaluated for its efficacy in addressing the management of these birth outcomes. Therefore, this study aimed to assess the prevalence and management of preterm birth and LBW, including the exploration of known risk factors for preterm birth and LBW recorded in field testing of this surveillance system in Thailand.

Material and Methods

Study setting and sample

A field test of this epidemiological surveillance system was implemented in Songkhla province, southern Thailand. This location was selected because there are various types of health centers providing maternity services including district or community hospitals, and general, regional, and university hospitals, categorized as referral

hospitals. Six community hospitals, with at least 600 deliveries per year on average, and two referral hospitals, with at least 2,500 deliveries per year on average, were selected to participate in the testing of this system. There were ten common maternal and newborn complications recorded in the surveillance system, but only preterm birth and LBW were analyzed in this study. Details of the development and testing of this system were previously published.[14] Data were collected from 2,459 women who delivered at the selected hospitals during July to September 2013 for analysis.

Variables

The variables recorded in this system were divided into two groups, one which included variables specific to the women giving birth which were recorded by the nurses in the delivery room and one which included variables specific to preterm and LBW conditions which were recorded by the responsible nurse or doctor working as the actor in the surveillance system in each hospital. Demographic and obstetric characteristics commonly related to preterm birth and LBW were selected from the system for analysis. Demographic characteristics included maternal age, religion, and education. Obstetric characteristics included parity, preeclampsia diagnosis, parity, previous abortion, antenatal care (ANC), gestational age at first antenatal visit, number of antenatal visits, stage of labor at admission, mode of delivery, birth attendant and type of hospital.

The main outcomes of interest were the detection of preterm birth and LBW and their managements. Preterm birth was defined as a birth occurring at a gestational age of less than 37 weeks which was verified using the medical history, gestational age at delivery, and fetal birth weight. LBW was defined as birth weight below 2,500 grams. For preterm birth, details such as anemia during pregnancy, previous admission due to preterm labor, and status of preterm labor were additionally recorded. The actor was responsible for reviewing the cause and management of preterm birth including use of tocolytics or corticosteroids, infection investigation, fetal outcomes, review of risk factors, and action done. Similarly, for LBW, warming of the delivery room, immediate drying and wrapping after birth, delayed bathing, and skin-to-skin contact were additionally recorded. The actor reviewed the management of LBW cases, including provision of appropriate resuscitation/respiratory care, prevention of hypothermia, early feeding within 2 or 3 hours, prevention of infection, and fetal outcomes.

In addition, the actor reviewed all of the information for each woman to determine whether each case of preterm birth or LBW was associated with any of the following limited factors: shortage of human resources, lack of supplies or equipment, lack of medicines, or limited skills of health personnel. The actor was also asked to comment on whether or not any of the following actions were taken when the limited factors were found: discussions on the availability of human resources, improving case management, mobilization of necessary supplies/equipment, reviewing available medicines for treatment, or training in specific skills of case detection or case management.

Statistical analysis

Data analysis was performed with R software version 3.3.1 (The R Foundation for Statistical Computing 2016). Descriptive statistics were used for demographic and obstetric characteristics and the management of the cases. The agreement of diagnosis of preterm birth and LBW from medical records and actors was assessed by kappa statistic. Factors which were associated with preterm birth and LBW in univariate analysis with a p-value of less than 0.2 were selected to be included in the first multiple logistic regression model. A backward stepwise method was used and the factors with a p-value less than 0.05 were kept for the final model.

Results

The demographic characteristics of all study participants are shown in Table 1. The ages ranged from 14 to 45 years (mean±standard deviation (S.D.)=27.0±6.7), 58.9% of the women were Buddhist, and two-thirds of them had graduated from primary or secondary school. Grand multiparity was found in 4.1% of the women and 3.3% of the women had at least two previous abortions. Almost all (95.6%) had received ANC, of which 56.1% had had the 1st ANC visit within the first trimester and 6.2% had fewer than 4 ANC visits. Table 2 presents the labor and delivery information of the study participants. Approximately half of them were in the latent phase of labor at their first admission. Of all deliveries, 68.5% were delivered by normal vaginal delivery, 58.7% with the assistance of a nurse/midwife, and 75.6% in a community hospital.

Table 1 Characteristics of the study participants (n=2,459)

Characteristic	Number (%)
Maternal age	
<20	373 (15.2)
20-34	1,694 (68.8)
≥35	390 (15.8)
Missing data	2 (0.2)
Religion	
Buddhist	1,448 (58.9)
Non-Buddhist	951 (38.7)
Missing data	60 (2.4)
Education	
Illiterate	42 (1.7)
Primary or secondary school	1,581 (64.3)
Technical or higher	598 (24.3)
Missing data	238 (9.7)
Parity	
0	990 (40.3)
1-4	1,368 (55.6)
≥5	101 (4.1)
Previous abortion	
0	2,015 (81.9)
1	363 (14.8)
≥2	81 (3.3)
Received ANC	
No	108 (4.4)
Yes	2,351 (95.6)
Gestational age at 1st ANC	
1st trimester	1,380 (56.1)
2nd trimester	786 (32.0)
3rd trimester	157 (6.4)
Missing data	136 (5.5)
Number of ANC visits	
<4	153 (6.2)
4-10	1,498 (60.9)
≥11	670 (27.3)
Missing data	138 (5.6)

ANC=antenatal care

Table 2 Labor and delivery information of the study participants (n=2,459)

Information	Number (%)
Stage of labor at admission	
No labor	358 (14.6)
Latent phase	1,288 (52.4)
Active phase	689 (28.0)
Second stage or after	124 (5.0)
Mode of delivery	
Normal vaginal delivery	1,684 (68.5)
Operative delivery	680 (27.6)
Birth attendant	
Nurse/midwife	1,444 (58.7)
Doctor/obstetrician	971 (39.5)
Type of hospital	
Referral	600 (24.4)
Community	1,859 (75.6)

Of all 2,459 women, 138 women had delivered before 37 weeks, with a gestational age ranging from 23 to 36 weeks (mean±S.D.=33.7±3.1 weeks), giving a percentage of 5.6% preterm births. The percentage of LBW was 9.8%, with 240 neonates having fetal birth weight ranging from 504 to 2,497 grams. Factors associated with preterm birth and LBW are shown in Tables 3 and 4, respectively. Preterm births were slightly higher in women aged less than 20 years compared to women aged 20–34 years. Women having preeclampsia or less than 4 ANC visits had significantly higher odds of preterm birth. Women with preterm birth were more likely to be delivered by a doctor/obstetrician or at a referral hospital (Table 3). The rate of LBW was lower in multiparous women compared to nulliparous women. Women having preeclampsia or having less than 4 ANC visits had significantly higher odds of LBW. Women with LBW were more likely to have delivered at a referral hospital (Table 4). Preterm birth infants were more likely to be LBW (kappa coefficient=0.71).

Of 138 women with preterm birth, 128 women were recorded as preterm birth in the system (92.8%), of which 83 of them (64.8%) were reviewed by the responsible actor. Of 83 preterm births acted upon, preterm birth was confirmed with perfect agreement (kappa coefficient=0.90). Of the 128 women with preterm birth, anemia at any trimester was found in 21.9%, 11.7% had been previously admitted due to preterm labor, and 8.6% had induced preterm delivery. Almost half of the women had an unidentified cause of preterm birth (Table 5). Table 6 shows the management of preterm birth by the doctors. Of 83 acted upon cases, gestational age ranged from 23 to 36 weeks, of which 29 (35.0%) had gestational age less than 34 weeks. Approximately one-tenth of the women had received a tocolytic and one-fourth had received a corticosteroid. Almost three-fourths of the women with gestational age less than 34 weeks had received a corticosteroid. Half of the women with preterm birth were investigated for infection. Of preterm infants, 16.9% were intubated. Shortage of human resources and supplies were found in 10 cases and action was taken in 7 cases.

Table 3 Factors associated with preterm birth by multiple logistic regression

Variable	Crude OR (95% CI)	Adjusted OR (95% CI)	P-value (Wald's test)	P-value (LR test)
Maternal age (years), ref=20–34				0.15
<20	1.55 (0.97–2.47)	1.66 (1.02–2.70)	0.04	
≥35	1.26 (0.77–2.05)	1.06 (0.63–1.77)	0.83	
Preeclampsia, ref=no				<0.001
Yes	6.92 (2.85–16.79)	7.83 (2.91–21.07)	<0.001	
Number of ANC visits, ref=4–10 times				<0.001
<4	2.32 (1.40–3.85)	2.83 (1.67–4.80)	<0.001	
>10	0.11 (0.04, 0.27)	0.09 (0.03, 0.22)	<0.001	
Birth attendant, ref=nurse/midwife				0.028
Doctor/obstetrician	2.08 (1.44–3.01)	1.64 (1.05–2.56)	0.03	
Type of hospital, ref=community				0.003
Referral	3.10 (1.95–4.92)	2.89 (1.68–4.96)	<0.001	

OR=odds ratio, ANC=antenatal care, LR=Likelihood ratio, CI=confidence interval, Ref=reference

Table 4 Factors associated with low birth weight by multiple logistic regression

Variable	Crude OR (95% CI)	Adjusted OR (95% CI)	P-value (Wald's test)	P-value (LR test)
Parity, ref=nulliparous				0.004
Multiparous	0.64 (0.48–0.85)	0.61 (0.45–0.81)	<0.001	
Grand multiparous	0.73 (0.22–2.44)	0.60 (0.16–2.31)	0.46	
Preeclampsia, ref=no				<0.001
Yes	8.71 (3.98–19.08)	9.68 (4.28–21.89)	<0.001	
Number of ANC visits, ref=4–10 times				<0.001
<4	1.75 (1.11–2.75)	1.93 (1.21–3.08)	0.006	
>10	0.44 (0.30, 0.65)	0.37 (0.25, 0.55)	<0.001	
Type of hospital, ref=community				<0.001
Referral	1.79 (1.32–2.43)	1.83 (1.33–2.52)	<0.001	

OR=odds ratio, ANC=antenatal care, LR=Likelihood ratio, CI=confidence interval, Ref=reference

Table 5 Characteristics of women with preterm birth (n=128)

Characteristic		Number (%)
Anemia at any trimester*		28 (21.9)
1st trimester	5 (17.8)	
2nd trimester	14 (50.0)	
3rd trimester	15 (53.6)	
Previous admission due to preterm labor		
No		111 (86.7)
Yes		15 (11.7)
No data		2 (1.6)
Status of preterm labor		
Spontaneous		104 (81.2)
Induced		11 (8.6)
No data		13 (10.2)
Cause of preterm birth (n=83)		
Unidentified		37 (44.6)
Premature rupture of membranes		17 (20.5)
Multiple pregnancies		12 (14.4)
Inadequate fetal growth		5 (6.0)
Placenta previa		5 (6.0)
Severe maternal disease		4 (4.8)
Fetal congenital malformations		1 (1.2)

*Some women had anemia over more than one trimester

Table 6 Management review of preterm birth by the attending doctor/nurse as the actor (n=83)

Management		Number (%)
Use of tocolytic		7 (8.4)
Betamimetics	4 (57.1)	
Calcium channel blocker	3 (42.9)	
Use of corticosteroids		21 (25.3)
Dose (mg)		
6		16 (76.2)
8		1 (4.8)
10		4 (19.0)
Route		
Intramuscular		16 (76.2)
Intravenous		5 (23.8)
Interval (hours)		
6		2 (9.5)
8		13 (61.9)
12		4 (19.0)
24		2 (9.5)
Completed doses		
Yes		5 (23.8)

Table 6 (continued)

Management	Number (%)
Infection management	
Full blood count	47 (53.0)
Urinalysis	35 (42.2)
Vaginal swab	4 (4.8)
Antibiotics given	28 (33.7)
Fetal outcomes	
Intubation	14 (16.9)
Respiratory distress	14 (16.9)
Necrotizing enterocolitis	1 (1.2)
Sepsis	2 (2.4)
Neonatal death	4 (4.8)
Review of limited factors	
Shortage of human resources	10 (12.0)
Lack of supplies or equipment	10 (12.0)
Lack of medicines	4 (4.8)
Limited skills of health personnel	5 (6.0)
Action done	
Discussion about availability of human resources	4 (4.8)
Discussion of improving case management	7 (8.4)
Mobilization of supplies and equipment	6 (4.8)
Review available medicine for treatment	1 (1.2)
Discuss training for case detection	6 (7.2)
Training of case management	7 (8.4)

Of the 240 women with a LBW infant, 180 women were recorded as LBW in the system (75.0%), of whom 105 (58.3%) were reviewed by the responsible actor. Of the 180 women, the delivery room was warmed before delivery in 86.7%, most infants (79.4%) were immediately dried and wrapped, and one-third received skin-to-skin contact with the mother and had delayed bathing. The management and review of LBW cases is shown in Table 7. More than half of the LBW infants had a preterm condition which was detected before birth. Most infants were appropriately resuscitated, had hypothermia prevention, were fed early, and had actions taken to prevent infection. Shortage of human resources and lack of supplies were found in 10 cases, and action was taken in 8 cases.

Table 7 Management of low birth weight infants (n=180)

Characteristic	Number (%)
Warming of delivery room	
No	24 (12.8)
Yes	156 (86.7)
No data	1 (0.6)
Immediate drying and wrapping after birth	
No	36 (20.0)
Yes	143 (79.4)
No data	1 (0.6)
Delayed bathing	
No	105 (58.3)
Yes	61 (33.9)
No data	14 (7.8)
Skin to skin contact	
No	113 (62.8)
Yes	66 (36.7)
No data	1 (0.6)
Management review by doctor/nurse (n=105)	
Appropriate resuscitation/respiratory care	96 (91.4)
Prevention of hypothermia	95 (90.5)
Early feeding within 2-3 hours	74 (70.5)
Prevention of infection	74 (70.5)
Fetal outcome (n=105)	
Intubation	14 (13.3)
Respiratory distress	10 (9.5)
Necrotizing enterocolitis	1 (1.0)
Sepsis	1 (1.0)
Neonatal death	4 (3.8)
Review of limited factors (n=105)	
Shortage of human resources	10 (9.5)
Lack of supplies or equipment	8 (7.6)
Lack of medicines	4 (3.8)
Limited skills of health personnel	4 (3.8)
Action done (n=105)	
Discussion about availability of human resources	6 (5.7)
Discussion of improving case management	7 (6.7)
Mobilization of supplies and equipment	7 (6.7)
Review available medicine for treatment	3 (2.9)
Discuss training for case detection	8 (7.6)
Training of case management	8 (7.6)

Discussion

Of the women studied, 5.6% and 9.8% faced the problems of preterm birth and LBW, respectively. Preterm birth was found more frequently in women aged less than 20 years and LBW was more common in nulliparous women. Women having preeclampsia or those having less than 4 ANC visits had higher odds of preterm birth and LBW. Women with preterm birth and LBW were more likely to deliver at a referral hospital. Almost half of preterm births had unidentified causes. The management of both preterm and LBW ranged from fair to good. Approximately one quarter of the patients had adverse fetal outcomes. Low rates of risk factors and actions taken were noted.

Rates of preterm birth and LBW in our study were lower than the reported rates for preterm birth and LBW in Southeast Asia,[2,7,15] but the rate of preterm births from this surveillance system was similar to the analysis of a national Thailand database focusing on adolescent pregnancy.[16] The rate of LBW in our study was close to the reported rate in the northern part of Thailand.[17] Various rates of preterm birth and LBW reported previously may be related to the different natures of the study populations, gestational age estimation error, or high ANC coverage.[7,9,16]

None of the factors associated with preterm birth and LBW found in this analysis were surprising, as all have been reported in previous studies. Preterm birth is more common in younger women in Thailand and other countries.[2,9,16,18] Having less than four ANC visits has been associated with increased odds of preterm birth, which may be related to inadequate quality of ANC.[19] Our finding that nulliparous women had a higher risk for LBW than multiparous women was consistent with previous findings, and fetal birth weight increased with increasing parity.[20]

Preeclampsia was significantly associated with both preterm birth and LBW in our study, a finding which is consistent with current research as prompt delivery is justified due to concerns about maternal and fetal safety.[4] An earlier study from India found that the rates of preterm birth and LBW varied from one-fourth to two-thirds among women with preeclampsia depending on the severity of the preeclampsia/eclampsia.[21] We assumed that higher odds of preterm birth and LBW among deliveries performed by a doctor/obstetrician and in referral hospitals could be explained by noting that women at high-risk of preterm birth or LBW were referred to proper facilities with skilled personnel but some preterm births at gestational age more than 34 weeks with low morbidity or unexpected LBW still occurred in the community hospitals or were delivered by a nurse/midwife.

One-fourth of the women with preterm birth received a corticosteroid in our study, which could be because more than half of them had a gestational age greater than 34 weeks and corticosteroids are recommended from 24-34 weeks of gestation.[12] Among the women with preterm birth with gestational age less than 34 weeks, almost three-fourths received a corticosteroid, which was higher than the finding of a Brazilian Multicenter Study on Preterm Birth.[22] Three-fourths of the women in our study received a corticosteroid with the same dose and route as recommended by the American College of Obstetricians and Gynecologists.[23] A low proportion of women received a tocolytic in our study because most of the preterm women had gestational age >34 weeks or other indications for inducing preterm birth. Half of the women who had preterm deliveries were investigated for infection, as maternal infection is a common cause of preterm birth.[24,25]

There were high rates of proper administration of immediate care for LBW neonates, such as warming of the delivery room, drying and wrapping of the infant, early feeding, respiratory care, and prevention of hypothermia and infection. These responses are consistent with the recommendations from the WHO.[12] The rates of delayed bathing and skin-to-skin contact as recommended for LBW infants[26] were low in our study because the incubators

are available in all community and referral hospitals thus these things are not common practice in Thailand. A systematic review reported that the influence of health care providers and facility levels within a health system were important for making decision of their practices.[27]

It is well-known that the respiratory functions of preterm infants are immature, and adverse consequences are related to this immaturity. The rate of intubation among preterm neonates in our study was higher than reported in a literature review in 2008 which examined the intubation rate in very low birth weight infants.[28] This could be explained by the fact that other methods of respiratory support were not used in the delivery rooms of the study hospitals for immediate resuscitation. Shortage of human resources and lack of supplies/equipment were observed in some cases of preterm birth and LBW indicating that better resources must be available when needed. If this information could be provided to the authorities of the hospitals or policy makers immediately or continuously, the translation of evidence into action may be sped up, because the accumulative evidence on problems in a timely basis would be available on a current and very up-to-date basis for decision making, rather than the administrator having to wait a year for statistics to be generated. Preterm birth and LBW are well-known problems contributing to neonatal morbidity and mortality, requiring interventions for prevention and treatment; however, the interventions cannot be fully effective if surveillance of cases and monitoring of management have not been established.[12]

This is the first study to integrate the concepts of reviewing case management and risk factors coupled with potential actions using an online surveillance system. Although an electronic hospital information system is available in all hospitals in Thailand, the incidences and management of preterm birth or LBW are not immediately collected or reported to responsible health personnel in the hospital or Ministry of Health.

There were some notable limitations of this study. First, the field tests were done over a short period of time, from one to three months. Second, this was a secondary analysis of existing data, thus the sample size was not calculated. However, the number of records analyzed was sufficient for the objectives of the study. Finally, only 60.0% of the cases were acted upon by the actor because we planned to observe the feasibility of the actual responses.

Conclusion

The study strongly indicates that data generated from a web-based surveillance system of maternal and newborn health can be useful for assessing and monitoring the rates of preterm birth and LBW and their management in Thailand. Detection of cases at risk with potential notification of limited resources and skills in every hospital can be immediately reviewed by the policy makers at the national level and relevant solutions can be undertaken.

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Declaration of conflicting interests

The authors declare no potential conflicts of interest with respect to the research, authorship and/or publication of this article.

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