

# RISK FACTORS FOR NEONATAL RESPIRATORY DISTRESS SYNDROME IN NORTHEAST THAILAND: A HOSPITAL-BASED CASE-CONTROL STUDY

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## Abstract

Neonatal respiratory distress syndrome (RDS) is a dangerous complication. If it is not primarily evaluated and timely cared for, neonatal death can occur. Knowing the risk factors for RDS can reduce perinatal mortality. This study aimed to investigate the risk factors for RDS in 6,209 newborns born from 1 January to 31 December 2015 at the Sunpasitthiprasong Hospital, a tertiary hospital located in Ubon Ratchathani, northeast Thailand. This hospital-based case-control study was conducted. Two hundred eighty-five newborns with RDS were matched with a non-RDS control from the same delivery registry cohort on the birth time and birth month. Researchers collected the data of mothers and infants from the inpatient registry. The odds ratio (OR) with 95% confidence intervals (CIs) were estimated using a conditional logistic regression to assess the associations between potential risk factors and risk of RDS. Risk factors for RDS were mothers did not receive antenatal care covering five times (Adjusted OR=1.61; 95% CI: 1.01-2.29), gestational age was less than 37 weeks (Adjusted OR=1.88; 95% CI: 1.14-3.06), mode of delivery was a cesarean section (Adjusted OR=24.50; 95% CI: 14.83-40.47), delivery was operated after office hours (Adjusted OR=1.60; 95% CI: 1.01-2.52), male newborns (Adjusted OR=2.43; 95% CI: 1.53-3.87), and average birth weight was more than 3,500 grams (Adjusted OR=3.66; 95% CI: 1.42-9.40). Both maternal and infant factors were the risk factors for RDS. Therefore, it is necessary to use knowledge to develop surveillance, disease prediction, and care plans for both mothers and infants.

**Keywords:** Risk factors, Neonatal, Respiratory distress syndrome, Case-control study

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## Introduction

Birth complications and infant mortality are the indicators of the quality of care of each public health facility and the educational level, social conditions, and health systems in the country, such as nutritional status and medical standards. These also reflect the standards of care, mother and child services, social and public health, and the country's economic and social development. The birth statistics reported that there were 800,000 births per year (Thai Neonatal Society, 2009). The newborns weighing less than 2,500 grams were 0.8% of preterm infants, which causes the risk of neonatal respiratory distress syndrome (RDS). Infants have 1% RDS, which is the leading cause of death of preterm infants (Thai Neonatal Society, 2009). The infant with more gestational age is less likely to develop this condition. Around 60-80% of infants born at the gestational age less than 28 weeks are more likely to suffer from RDS, while those born at the gestational age at 32-36 weeks are associated with a 15-30% chance of developing this condition (Wongsang, 2007). It is because the lungs and nervous system controlling the respiratory of premature infants are not completed. The muscles between the ribs are also poorly developed, so the respiratory system is not practical, and the body cannot get rid of fluid from the lungs. There are also other risk factors such as baby gender, mode of delivery, hypoxemia in the uterus, and delivery. Neonatal RDS is a dangerous complication. If it is not primarily evaluated and timely cared for, neonatal death can occur. Therefore, the reduction of neonatal RDS is essential in reducing perinatal mortality.

According to the services in 2012-2014, the number of births at Sunpasit-thiprasong Hospital was 7,392 cases, 6,736 cases, and 6,685 cases, respectively. However, the number of newborns with RDS increased by 85, 306, and 887 cases, respectively. Also, neonatal deaths were 31, 57, and 42 cases, respectively. The most common cause of death was RDS. The numbers of newborns with RDS and the neonatal death rate from this cause are likely to increase. Also, there are other causes, namely maternal and child risk factors and other health problems and complications that are advanced and more severe. Therefore, the hospital is required to develop quality care by increasing the potential of personnel, budget, and tools. The prevention and treatment of respiratory complications in newborns are delicate. Personnel must have knowledge and expertise since the fetus is in the uterus. Maternal complications often affect the fetus. A collaboration of obstetricians,

pediatricians, and nurses in evaluating and screening newborns with postpartum abnormalities to prevent respiratory complications, the development of knowledge and skills in maternal and neonatal care in the prenatal period, waiting for the delivery and postnatal period, and primary assessment of the health of the newborn are essential to maintain proper medical care and prevent complications as well as reduce the death rate and cost and shorten hospital stay.

The previous studies in Thailand and abroad (Panthumapol, 2010; Kaladee and Kositamongkol, 2012; Wang *et al.*, 2012; Liu *et al.*, 2014) revealed that the factors that caused neonatal RDS were preterm labor, male infants, infants with asphyxia, cesarean section, premature rupture of membrane, and maternal or neonatal infections. However, the risk factors for RDS at Sunpasitthiprasong Hospital have never been studied. Therefore, this study aimed to identify the risk factors for neonatal RDS and use it to develop surveillance, disease prediction, and maternal and child care plans.

## Materials and Methods

### Study design

This hospital-based case-control study was conducted to investigate the risk factors for neonatal RDS from January to December 2015. The samples were the newborns born during the study period at Sunpasitthiprasong Hospital. The case group and the control group were selected by a simple random sampling method from the Labor Room delivery registry. Both groups were calculated using the software program, and the odds ratio=2.36. (This was obtained from the 2×2 table in 13 newborns who were at risk for RDS less than 37 weeks, 54 newborns with gestational age more than 37 weeks; 48 newborns who did not have RDS with gestational age less than 37 weeks and 472 newborns with gestational age more than 37 weeks). Exposed controls=10.16%, Alpha risk=5%, Power=95% Controls/Case ratio=1, Total exposed=15.61%. The statistics set the significance level at 0.05. The inclusion criteria were as follows: the respiratory rate was more than sixty times per minute with one of following symptoms: (1) intercostal retraction, (2) nasal flaring, (3) grunting, and (4) cyanosis. The exclusion criteria were newborns who did not have RDS during the study. Finally, 285 newborns with RDS were each matched with a non-RDS control from the same cohort of delivery registry on the birth time and birth month (Reed *et al.*, 1978). Both groups were homogenous to minimize the selection bias (Kherkheulidze *et al.*, 2018).

### Ethics consideration

This study was approved by the Ethics Committee for Human Research at Sunpasitthiprasong Hospital, Ubon Ratchathani, based on the Declaration of Helsinki and the ICH Good Clinical Practice Guidelines (EC Code 049/2559).

### Data collection

1. The simple random sampling method was employed to select the case group and the control group from the Labor Room's delivery registry at Sunpasitthiprasong Hospital. There were 285 samples in each group, and they were born in the same month.

2. Trained nurses retrieved the data of all samples from the inpatient registry. The data were verified for completeness and accuracy.

3. Researchers checked the data for completeness and accuracy, and it was recorded in the computer program.

4. Researchers analyzed the data by using the program.

### Research tool

The tool used in this study was the record of newborns with RDS from the inpatient registry and the delivery registry of the Labor Room at Sunpasitthiprasong Hospital, Ubon Ratchathani. The record was divided into three parts: Part 1: General information, Part 2: maternal risk factors, and Part 3: infant risk factors.

### Data analysis

All statistical analyses were performed with a statistical package, SPSS version 26.0 (IBM Company, Chicago, USA). Descriptive analysis was employed to analyze the maternal and infant factors. The data were presented by frequency and percentage distribution. The odds ratio (OR), 95% confidence intervals (Cis), and p-value were estimated using a conditional logistic regression to assess the associations between potential risk factors and risk of RDS. We controlled covariate factors in two steps: (1) matching some variables from the start of the study and (2) analyzing the data by adjusting the variables in the final model.

## Results and Discussion

The mothers of the samples' data showed that most of the mothers of both groups were 20-34 years old. They were employees. The body mass index was standard. It was their first pregnancy, and the gestational age was 38-40 weeks. They had obstetrics complications. They did not treat by sedative or oxytocin before delivery. The

graph of the progress of labor was typical. The mode of delivery was a vaginal delivery. They delivered during office h. The amniotic fluid was normal. They were not referred from other community hospitals. The most common cause of referring was having complications of the mothers in both groups. The different factors between the two groups were inadequate antenatal care in the

**Table 1. Maternal factors of case and control.**

| Maternal factors                   | Case group |      | Control group |      |
|------------------------------------|------------|------|---------------|------|
|                                    | No.        | %    | No.           | %    |
| Age (years)                        |            |      |               |      |
| 13-19                              | 41         | 14.4 | 41            | 14.4 |
| 20-34                              | 202        | 70.9 | 203           | 71.2 |
| ≥35                                | 42         | 14.7 | 41            | 14.4 |
| Occupation                         |            |      |               |      |
| Farmer/gardener                    | 49         | 17.2 | 57            | 20.0 |
| Employees                          | 199        | 69.8 | 204           | 71.6 |
| Civil servants                     | 18         | 6.3  | 22            | 7.7  |
| Students                           | 19         | 7.0  | 2             | 0.7  |
| BMI                                |            |      |               |      |
| <18.5                              | 3          | 1.1  | 0             | 0    |
| 18.5-24.99                         | 118        | 41.4 | 116           | 40.7 |
| 25-29.99                           | 103        | 36.1 | 123           | 43.2 |
| ≥30                                | 61         | 21.4 | 46            | 16.1 |
| Number of pregnancy                |            |      |               |      |
| 1 <sup>st</sup> time               | 147        | 51.6 | 143           | 50.2 |
| 2 <sup>nd</sup> time               | 99         | 34.7 | 117           | 41.1 |
| 3 <sup>rd</sup> time and more      | 39         | 13.7 | 25            | 8.8  |
| Antenatal care                     |            |      |               |      |
| No                                 | 6          | 2.1  | 1             | 0.4  |
| Inadequate                         | 146        | 51.2 | 110           | 38.6 |
| Adequate                           | 133        | 46.7 | 174           | 61.1 |
| Gestational age (weeks)            |            |      |               |      |
| <34                                | 40         | 14.0 | 2             | 0.7  |
| 34-37                              | 80         | 28.1 | 72            | 25.3 |
| 38-40                              | 157        | 55.1 | 205           | 71.9 |
| ≥41                                | 8          | 2.8  | 6             | 2.1  |
| Complications                      |            |      |               |      |
| No                                 | 59         | 20.7 | 88            | 30.9 |
| Obstetrics                         | 215        | 75.4 | 184           | 64.6 |
| Medical                            | 5          | 1.8  | 3             | 1.1  |
| Others                             | 6          | 2.1  | 10            | 3.5  |
| Receiving sedative before delivery |            |      |               |      |
| No                                 | 265        | 93.6 | 273           | 95.8 |
| Yes                                | 18         | 6.4  | 12            | 4.2  |
| Receiving oxytocin before delivery |            |      |               |      |
| No                                 | 226        | 79.3 | 216           | 75.8 |
| Yes                                | 59         | 20.7 | 69            | 24.2 |
| Progress of labor                  |            |      |               |      |
| Abnormal                           | 10         | 3.5  | 18            | 6.3  |
| Normal                             | 275        | 96.5 | 267           | 93.7 |
| Amniotic fluid                     |            |      |               |      |
| Abnormal                           | 42         | 14.7 | 26            | 9.1  |
| Normal                             | 243        | 85.3 | 259           | 90.9 |
| Mode of birth                      |            |      |               |      |
| Cesarean section                   | 100        | 35.1 | 140           | 49.1 |
| Vaginal delivery                   | 185        | 64.9 | 145           | 50.9 |
| Delivery time                      |            |      |               |      |
| 8 a.m. - 4 p.m.                    | 114        | 40.0 | 159           | 55.8 |
| 4 p.m. - 12 p.m.                   | 80         | 28.1 | 51            | 17.9 |
| 12 p.m. - 8 a.m.                   | 91         | 31.9 | 75            | 26.3 |
| Transfer from community hospitals  |            |      |               |      |
| No                                 | 191        | 67.0 | 228           | 80.0 |
| Yes                                | 94         | 33.0 | 57            | 20.0 |
| Causes of transfer                 |            |      |               |      |
| No                                 | 63         | 22.1 | 92            | 32.3 |
| Maternal                           | 128        | 44.9 | 145           | 50.9 |
| Neonatal                           | 94         | 33.0 | 48            | 16.8 |

case group and adequate antenatal care in the control group. Moreover, having gestational age less than 34 weeks, amniotic fluid abnormalities, transfer from community hospitals, infant complications while being referred from community hospitals were mainly found in the case group, as shown in Table 1.

Most infants in both the case and control groups weighed 2,500-3,500 grams for the infants' data. The assessment of infant health was in the range of 8-10 points. In the case group, most of them had a respiration rate of 61-70 times per minute. The most common symptoms occurring together with RDS were retraction, followed by flaring alar nasi, grunting, and cyanosis, respectively. Blood sugar level was more than 60 mg%. Hematocrit was 44-

70%. Oxygen saturation was above 95%. Most hospital stays of the case group and the control group were 1-3 days, as shown in Table 2.

According to the results of this study, the maternal risk factors in terms of inadequate antenatal care 5 times resulted in neonatal RDS higher than that of mothers with adequate antenatal care of 1.61 times. Gestational age less than 37 weeks caused neonatal RDS 1.88 times higher than gestational age more than 37 weeks. Cesarean section caused neonatal RDS 24.50 times than vaginal delivery. For the infant factors, male infants were more likely to develop RDS than females 2.43 times. Besides, infants with a birth weight of more than 3,500 grams were more likely to develop RDS 3.66 times than those with birth weight 2,500-3,500 as shown in Table 3.

**Table 2. Infant factors of case and control.**

| Infant factors                   | Case group |      | Control group |       |
|----------------------------------|------------|------|---------------|-------|
|                                  | No.        | %    | No.           | %     |
| Gender                           |            |      |               |       |
| Male                             | 176        | 61.8 | 128           | 44.9  |
| Female                           | 109        | 38.2 | 157           | 55.1  |
| Birth weight (grams)             |            |      |               |       |
| <2,500                           | 70         | 24.6 | 19            | 6.7   |
| 2,500-3,500                      | 168        | 58.9 | 236           | 82.8  |
| >3,500                           | 47         | 16.5 | 30            | 10.5  |
| Apgar score at 1 minute (points) |            |      |               |       |
| 0-3                              | 1          | 0.4  | 0             | 0.0   |
| 4-7                              | 11         | 3.9  | 10            | 0.0   |
| 8-10                             | 273        | 95.8 | 285           | 100.0 |
| Respiratory rate (times/minute)  |            |      |               |       |
| 30-60                            | 0          | 0.0  | 285           | 100.0 |
| 61-70                            | 218        | 76.5 | 0             | 0.0   |
| >71                              | 67         | 23.5 | 0             | 0.0   |
| Retraction                       |            |      |               |       |
| No                               | 101        | 35.4 | 285           | 100.0 |
| Yes                              | 184        | 64.6 | 0             | 0.0   |
| Grunting                         |            |      |               |       |
| No                               | 236        | 82.8 | 285           | 100.0 |
| Yes                              | 49         | 17.2 | 0             | 0.0   |
| Flaring alar nasi                |            |      |               |       |
| No                               | 202        | 70.9 | 285           | 100.0 |
| Yes                              | 83         | 29.1 | 0             | 0.0   |
| Cyanosis                         |            |      |               |       |
| No                               | 258        | 90.5 | 285           | 100.0 |
| Yes                              | 27         | 9.5  | 0             | 0.0   |
| Blood sugar level (mg%)          |            |      |               |       |
| <30                              | 5          | 1.8  | 0             | 0.0   |
| 30-60                            | 62         | 21.7 | 0             | 0.0   |
| >60                              | 218        | 76.5 | 0             | 0.0   |
| Hematocrit (%)                   |            |      |               |       |
| <44                              | 39         | 13.6 | 29            | 10.2  |
| 44-70                            | 245        | 86.0 | 256           | 89.8  |
| >70                              | 1          | 0.4  | 0             | 0.0   |
| Oxygen saturation (%)            |            |      |               |       |
| <88                              | 4          | 1.4  | 0             | 0.0   |
| 88-95                            | 36         | 12.6 | 0             | 0.0   |
| >95                              | 245        | 86.0 | 0             | 0.0   |
| Hospital stay (days)             |            |      |               |       |
| 1-3                              | 159        | 55.8 | 224           | 78.6  |
| 4-7                              | 104        | 36.5 | 59            | 20.7  |
| >7                               | 22         | 7.7  | 2             | 0.7   |

**Table 3. Risk factors for RDS.**

| Risk factors            | Crude OR | Adjusted OR | 95% CI*     | p-value** |
|-------------------------|----------|-------------|-------------|-----------|
| Antenatal care          |          |             |             |           |
| Adequate                | 1        | 1           |             |           |
| Inadequate              | 1.74     | 1.61        | 1.01-2.57   | 0.048     |
| Gestational age (weeks) |          |             |             |           |
| ≥37                     | 1        | 1           |             |           |
| <37                     | 2.07     | 1.88        | 1.14-3.06   | 0.014     |
| Delivery approaches     |          |             |             |           |
| Cesarean                | 1        | 1           |             |           |
| Vaginal                 | 21.36    | 24.50       | 14.83-40.47 | <0.001    |
| Delivery time           |          |             |             |           |
| Office hrs              | 1        | 1           |             |           |
| After office            | 1.89     | 1.60        | 1.01-2.52   | 0.045     |
| Amniotic fluid          |          |             |             |           |
| Normal                  | 1        | 1           |             |           |
| Abnormal                | 1.72     | 1.28        | 0.63-2.59   | 0.498     |
| Gender                  |          |             |             |           |
| Female                  | 1        | 1           |             |           |
| Male                    | 1.98     | 2.43        | 1.53-3.87   | <0.001    |
| Birth weight (grams)    |          |             |             |           |
| 2,500-3,500             | 1        | 1           |             |           |
| >3,500                  | 2.23     | 3.66        | 1.42-9.40   | 0.007     |

\*95% CI for adjusted OR, \*\*p-value for adjusted OR

This study showed that the infant factors associated with RDS included that male infants were more likely to develop RDS than females 2.43 times. The newborns delivered by cesarean section were likely to develop RDS 24.50 times than those delivered by vaginal delivery. These were consistent with the study of high-risk factors of RDS in term neonates at Bayi Children's Hospital in China, which found that the most crucial risk causing RDS

was a cesarean section. 5 The causes of this condition were hypoxia and maternal and neonatal infections. These caused higher infant mortality and more extended hospital stay. Male infants were more likely to have RDS than female infants since androgen caused the delayed development of alveolar type 2. It was followed by Catlin *et al.* (1990), who found that males had androgen and Mullerian Inhibiting Substance (MIS) higher than females. Both hormones inhibited the development of lung maturity. The study in female mice by injecting rMIS and analyzing lung tissues showed decreased disaturated phosphatidylcholine (DSPC) after 48-72 h of injection. It has also corresponded to the study in mice aged 18-22 weeks, and it showed that female mice at 19-20 weeks had a higher DSPC level than male mice and at 20-21 weeks. Female mice had cuboidal epithelial cells, lamellar bodies, air sac, and lipid material higher than male mice (Adamson and King, 1984). It can conclude that sex was correlated with the development of lung maturity. Maternal and neonatal infections directly affected the destruction of lungs and alveolar type 2, resulting in decreased gas exchange. It can conclude that premature rupture of membrane, severe hypoxia, and maternal and neonatal infections were associated with RDS in infants. Hitchings *et al.* 2015 studied 55,811 newborns, and 5,875 (10.5%) were diagnosed with RDS. It was found that male infants with white skin and delivered by cesarean section (22.5%) were associated with a higher risk of RDS statistically significant.

Inadequate antenatal care can cause neonatal RDS more than those with adequate antenatal care at 1.61 times. Gestational age less than 37 weeks caused neonatal RDS 1.88 times higher than gestational age more than 37 weeks. Infants with a birth weight of more than 3,500 grams were more likely to develop RDS 3.66 times than those with a 2,500-3,500 grams' birth weight. These results were consistent with the study of Wongsang (2007) studying the causes and mortality rates of newborns in Samutprakarn Hospital in central Thailand. It was found that the infants referred from other health facilities had a mortality rate of nearly three times higher than the infants born at the hospital. The incidence of RDS varied with gestational age. The incidence was 60-80% in the infants delivered with less than 28 weeks of gestational age or birth weight less than 1,000 grams. The incidence was 15-30% in the infants born with 32-36 weeks of gestational age. The infants will have more severe RDS and die if the treatment is inaccurate and not timely. Reducing mortality from RDS is essential in reducing the mortality rate in newborns. Therefore, the prevention of premature birth,

pregnancy care, quality antenatal care, and regular follow-up are needed.

Moreover, RDS is associated with the cesarean section of 3.60% and with medical induction of labor as of 1.60%. The study results on late-preterm infants in Thammasat University Hospital in central Thailand<sup>4</sup> suggested that preterm infants born before the end of gestation had high complications. In particular, it increased the respiratory complications at the gestational age of fewer than 35 weeks. RDS prevalence found in the infants with Apgar scores less than or equal to 7 points was 4.3%, which was rarely found because RDS is only part of the assessment of respiration in the Apgar score from 5 aspects. The total Apgar score is 10 points. If the Apgar score is less than or equal to 7, it indicates that the newborn needs help according to their problems or needs. So, the changes in Apgar score influence neonatal respiratory distress syndrome. Moreover, this was consistent with the study of the relationship between the five minute Apgar score, mode of birth, and neonatal outcomes, which found that low Apgar score (Apgar score 0-3) and intermediate Apgar score (Apgar score 4-6) were associated with complications such as RDS, eating problems, low body temperature and seizures statistically significant. Cesarean section caused infants to have low Apgar scores and intermediate Apgar score statistically significant (Thavarajah *et al.*, 2018).

The limitation of this research was from the study design. It is a retrospective study using a record form created by the researcher in conjunction with the experience and opinions of experts. It is used to decide on a record form for collecting information from the birth registry and inpatient medical records. There was a limit to the use of information that must be present in the medical record only. We cannot see the actual state of the case and control groups.

## Conclusions

This study showed that the factors associated with neonatal RDS at Sunpasitthiprasong Hospital, Ubon Ratchathani Province included inadequate antenatal care, gestational age less than 37 weeks, and cesarean section, male infants, and birth weight more than 3,500 grams. In the future, it will develop additional indicators further to evaluate the outcomes of maternal and infant health. The availability of care depends on the context in which mothers and infants are born, the evaluation and screening of pregnant women at risk for delivery to higher potential health facilities, technology readiness and skills of neonatal care, and abnormal

symptoms assessment. Technology advances can help keep infants safe and free from complications.

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## References

- Adamson, I.Y. and King, G.M. (1984). Sex-related differences in cellular composition and surfactant synthesis of developing fetal rat lungs. *Am Rev. Respir Dis.*, 129:130-134.
- Catlin, E.A., Powell, S.M., Manganaro, T.F., Hudson, P.L., Ragin, R.C., Epstein, J., and Donahoe, P.K. (1990). Sex-specific fetal lung development and müllerian inhibiting substance. *Am Rev. Respir Dis.*, 141:466-470.
- Hitchings, L., Kearney, M., Kattan, G., and Thorp, J. (2015). The association of race and gender with respiratory distress syndrome at caesarian deliveries. *Am J. Obstet Gynecol.*, 212:328.
- Kaladee, P. and Kositamongkol, S. (2012). Outcomes of late-preterm infants in Thammasat University Hospital, Faculty of Medicine, Thammasat University. *Thai J. Pediatrics.*, 51:42-49.
- Kherkheulidze, M., Chkhaidze, I., Kavlashvili, N., Kandelaki, E., Adamia, N., Abelashvili, D., and Tabatadze, T. (2018). Evaluation of developmental outcomes with Bayley III test in preterm infants with respiratory distress syndrome. *Georgian medical news.*, 279:67-73.
- Liu, J., Yang, N., and Liu, Y. (2014). High-risk factors of respiratory distress syndrome in term neonates: A retrospective case-control study. *Balkan Med J.*, 31:64-68.
- Panthumapol, U. (2010). Outcomes of late-preterm infants for three years at Queen Sirikit National Institute of Child Health. Bangkok: Neonatal-Perinatal Medicine of Medical Council of Thailand, Queen Sirikit National Institute of Child Health. [in Thai].
- Reed, D.M., Bakketeig, L.S., and Nugent, R.P. (1978). The epidemiology of respiratory distress syndrome in Norway. *Am. J. Epidemiol.*, 107:299-310.
- Thai Neonatal Society. (2009). Manual of Infant care 1. Bangkok: Faculty of Medicine, Ramathibodi Hospital. [in Thai].
- Thavarajah, H., Flatley, C., and Kumar, S. (2018). The relationship between the five-minute Apgar score, mode of birth, and neonatal outcomes. *J. Matern Fetal Neonatal Med.*, 31:1,335-1,341.
- Wang, A., Holston, A.M., Yu, K.F., Zhang, J., Toporsian, M., Karumanchi, S.A., and Levine, R.J. (2012). Circulating anti-angiogenic factors during hypertensive pregnancy and increased risk of respiratory distress syndrome in preterm neonates. *J. Matern Fetal Neonatal Med.*, 25:1,447-1,452.
- Wongsang, S. (2007). Causes and mortality rates of newborns in Samutprakarn Hospital 2005-2007. *Buddhachinaraj Med. J.*, 25:871-877.