Incidence and Survival Rate of Having Newborn with Low Birth Weight and its Determinants among Thai Women

นิพนธ์ต้นฉบับ

Original Article

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บทคัดย่อ

วัตถุประสงค์: เพื่อวิเคราะห์อัตรารอดชีพและอัตราเสี่ยงที่มารดาคลอดทารกแรกเกิดน้ำหนักน้อย และหาความสัมพันธ์ระหว่างปัจจัยต่างๆ กับระยะปลอดเหตุการณ์การคลอดทารกแรกเกิดน้ำหนักน้อยของมารดาชาวไทย **วิธีการศึกษา:** เป็นการศึกษาแบบย้อนกลับ รวบรวมข้อมูลจากหญิงตั้งครรภ์เดี่ยวจำนวน 1,645 คน ที่ฝากครรภ์และคลอดที่โรงพยาบาลศูนย์การแพทย์สมเด็จพระเทพรัตนราชสุดา สยามบรมราชกุมารี ระหว่างวันที่ 1 มกราคม – 31 ธันวาคม 2560 นำปัจจัยประชากร เศรษฐกิจและสังคมและปัจจัยด้านมารดาจากแบบบันทึกผู้คลอดมาพิจารณา ใช้สถิติการวิเคราะห์อัตรารอดชีพและอัตราเสี่ยง **ผลการศึกษา:** อุบัติการณ์คลอดทารกแรกเกิดน้ำหนักน้อย คือ 47.8 คน-สัปดาห์ ต่อ 100 คน เมื่อควบคุมอิทธิพลของปัจจัยประชากร เศรษฐกิจและสังคม พบว่าปัจจัยด้านมารดาที่สัมพันธ์กับอัตรารอด ได้แก่ จำนวนครั้งของการตั้งครรภ์ (HR = 2.30, *P* = 0.037) จำนวนครั้งของการฝากครรภ์ (HR = 0.78, *P* < 0.001) อายุครรภ์เมื่อคลอด (HR = 0.51, *P* < 0.001) ภาวะแทรกซ้อนทางสูติศาสตร์ (HR = 1.77, *P* = 0.008) และภาวะแทรกซ้อนทางสูติศาสตร์ร่วมกับโรคอายุรกรรม (HR = 3.64, *P* < 0.001) **สรุป:** ทารกแรกเกิดน้ำหนักน้อยสัมพันธ์กับปัจจัยด้านมารดาหลายปัจจัย หญิงตั้งครรภ์ควรได้รับการส่งเสริมการฝากครรภ์อย่างต่อเนื่องจนครรภ์ครบกำหนดคลอด เนื่องจากเพิ่มอัตรารอดจากการคลอดทารกแรกเกิดน้ำหนักน้อยได้

คำสำคัญ: อัตรารอดชีพ, อัตราเสี่ยง, ทารกแรกเกิดน้ำหนักน้อย, ตัวกำหนดด้านมารดา

Abstract

Objective: To determine the incidence and survival rate of having newborn with low birth weight and its associating factors among Thai women. **Method**: In this retrospective study, data were collected from 1,645 women with singleton pregnancy who had antennal care (ANC) and delivered in the HRH Princess Maha Chakri Sirindhorn Medical Center (MSMC) Hospital from January 1 to December 31, 2017. The individual socio-demographic and maternity record were reviewed. Kaplan-Meier survival analysis and Cox proportional hazard regression was conducted. **Results:** The incidence rate of low birth weight was 47.8 per 100 person-weeks. The results revealed that after controlling for individual socio-demographic factors, maternal factors namely gravida (HR = 2.30, *P* = 0.037), number of antenatal visit (HR = 0.78, *P* < 0.001), gestational age at delivery (HR = 0.51, *P* < 0.001), obstetric complication (HR = 1.77, *P* = 0.008), and obstetric complication related with medicine disease (HR = 3.64, *P* < 0.001) were found to be significantly associated with hazard rate. **Conclusion:** Our result suggest that the birth weight and certain maternal factors were correlated. Pregnant women should be encouraged to have antenatal visit continuously until term labor to improve survival rate of low birth weight of the newborn.

Key words: survival probability, hazard rate, low birth weight, maternal determinant

Introduction

Low birth weight is one of the major public health problems both in developing and developed countries since it is one of the risk factors of morbidity and mortality of infants.[1,2] Based on the data of the maternal and child health network of Thailand, the effort to reduce low birth weight in the last two decades (1992 – 2011) had not been in full effect[3], hence the goal of 7% or lower was not achieved.[4] From 2015 to 2016, incidents of infants with low birth weight decreased from 5.80% to 5.78% at the national level.[5] At the regional level, it was found that in Nakhonnayok province under the supervision of the Health Region 4 network, low birth weight cases (< 2,500 grams) in 2015 and 2016 were 8.93% and 9.125% of the newborns, respectively.[1] In Ongkharak district of Nakhonnayok province, such low birth weight cases were as high as 13.04% and 10.13% in 2015 and 2016, respectively.[1] At the hospital level, low birth weight cases (< 2,500 gm) in HRH Princess Maha Chakri Sirindhorn Medical Center (MSMC), a medical teaching hospital, were 9.87%, 10.44% and 11.37% in 2014, 2015, and 2016, respectively (unpublished data), which were higher than the goal of 7% or lower set by the Ministry of Public Health of Thailand.

Most studies found that morbidity and mortality of the infants at the early postpartum period were found more frequently among those with low birth weight compared with those with normal weight. In addition, low birth weight further led to death especially those with pre-term labor[2] For pre-term infants with 1,500 – 2,500 grams birth weight, mortality rate within 28 days after delivery was 5 to 30 times of that in infants

with 10th to 50th percentile of birth weight (2,900 – 2,500 grams). Among infants with full-term labor but a low birth weight of 1,500 grams or lower, mortality rate was as high as 70 to 100 folds of those with normal birth weight.[3] It has been known that pre-term labor and slow fetal growth are the major causes of low birth weight.

In terms of maternal factors influencing the infant's low birth weight, they include maternal inappropriate pregnancy self-care, and non-adherence to the ante-natal care appointments which could result in a disruption of the monitoring of maternal self-care and the assessment of fetal growth. If any abnormalities such as fetus's inactivity (less moving or kicking than usual), and gestational complications, mothers and their fetus could not be helped in a timely fashion and low birth weight could be one of the consequences.[4-8] Pregnancy complications could retard the fetal growth and subsequently pre-term labor. These abnormalities are evident immediately or later on at 7 to 28 days post-delivery. In terms of fetal factors, chromosomal abnormalities, birth defects, and umbilical and amniotic abnormalities could lead to stillbirth.[3]

Studies about survival and risk of low birth weight in Thailand from 2008 to 2017 have been limited.[9-13] The issues most studied include factors influencing low birth weight; while maternal factors have been scarcely studied. In addition, at the MSMC which is our affiliated healthcare institution, the proportion of infants with low birth weight (< 2,500 grams) has been higher than the goal of 7% set by the Ministry of Public Health. The authors were concerned about the need to alleviate such problem. However, to proceed and solve the problem, we firstly needed to understand the risk of having newborn with low birth weight and its associated factors. Specific objectives of this study were to determine the incidence and survival rate of having newborn with low birth weight and its determining factors among Thai women.

Methods

In this retrospective study, we used the data from medical records of the patients receiving maternal care at the Labor Department at the MSMC. The study population was singleton pregnancy women who received antenatal care and delivery service at the MSMC. Study sample was those who delivered the single live birth during 1st January to 31st December, 2017. Those received delivery service but no antenatal care (i.e., zero antenatal care visits) at the MSMC were excluded. Those with twin newborns were also excluded. Based on these criteria, a sample of 1,645 cases of mothers with their live single newborns was included in the study. The medical records at the labor department of the MSMC were used for information. The data collection was conducted from 1st to 10th January, 2018.

In this study, low birth weight was defined as the newborn with a body weight of less than 2,500 gram regardless of the gestational age. Low birth weight is associated with various factors. Based on previous research, demographic and socio-economic factors have been found to influence the newborn weight.[14] These different contexts surrounding mothers were, for instances, maternal age[20], residence area[13], ethnicity[20], and payment scheme.[21,22] For maternal factors, number of previous pregnancy (gravida), number of ANC visit, number of previous live delivery (parity), number of abortion, gestational age at delivery, gestational complications (eg., diabetes, hypertension, and intrauterine growth retardation or IUGR), medical complications and comorbidities (eg., diabetes, hypertension, heart diseases, anemia, thalassemia, and infections), hematological laboratory tests (eg., immunodeficiency disease, sexually transmitted diseases, hepatitis, and Rh-blood group)[7,10,15-17] were associated with low birth weight and could significantly predict survival rate of newborns with low birth weight.[9,13,18-21] These factors were studied in our study.

The study was approved by the Ethics Committee for Human Study, Srinakharinwirot University (approval number: 184/60; approval date: September 12, 2017). The study was also permitted by the director of the MSMC on November 22, 2017.

Statistical analysis

Comparisons between mothers of newborns with and without low birth weight were made. Survival analysis was performed using the Kaplan-Meier survival probability and hazard ratio was estimated by the Cox's proportional hazard regression analysis.[22,23] Time to event was the duration in weeks since the first ANC visit till the delivery of the newborns with low birth weight. For newborns with normal weight, the duration since the first ANC visit till the delivery was taken into account as the censored cases. Differences of survival rates between demographic, socio-economic characteristics as well as maternal factors were tested using log-rank test. All analyses were performed using the software program STATA

version 13.1. For statistical significance, a type I error of 5% was set for all analyses.

Results

We found a total of 133 and 1,512 mothers of newborns with and without low birth weight (< 2,500 grams), respectively. For demographic characteristics of the mother of newborns with and without low birth weight, significant difference was found in payment scheme (*P*-value = 0.014) (Table 1).

Table 1 Demographic and socio-economic characteristics of mothers of newborns with and without low birth weight (< 2,500 and 2,500 - 4,000 grams, respectively) (N = 1,645).

Characteristics	N, % of mothers of newborns				*P*-value*
	With low birth weight (n = 133)		Without low birth weight (n = 1,512)		
1) Demographic, socio-economic characteristics					
Age (years)					
14 - 19	11	8.27	133	8.80	0.092
20 - 34	89	66.92	1,120	74.07	
35 or older	34	24.81	259	17.13	
Residence regions					
Nakhonnayok province and vicinity	114	85.71	1,287	84.89	
Provinces in other regions	19	14.07	229	15.11	
Eastern region	(0)	0.00	(17)	(1.12)	
Northern region	(2)	(1.50)	(18)	(1.19)	0.924
North-eastern region	(10)	(7.52)	(108)	(7.14)	
Central region	(5)	(3.76)	(54)	(3.57)	
Western region	(0)	(0.00)	(7)	(0.46)	
Southern region	(0)	(0.00)	(10)	(0.66)	
Foreigners	(2)	(1.50)	(15)	(0.99)	
Ethnicity					
Thai	123	92.48	1,410	93.25	0.719
Others	10	7.52	102	6.75	
Payment scheme					
Out-of-pocket	107	80.45	1,266	83.73	
Universal coverage scheme	13	9.77	135	8.93	
Civil servant scheme	7	5.26	87	5.75	
Social security scheme	1	0.75	14	0.93	0.014
Welfare benefit	1	0.75	7	0.46	
Benefit for the disabled	4	3.01	3	0.20	

* Pearson's chi-square test or Fisher's exact test, as appropriate.

Regarding maternal factors, significant differences were found in gravida, parity, number of ANC visit, health risk, and gestational age at delivery (*P* -value = 0.023, 0.041, 0.004, < 0.001, and < 0.001, respectively) (Table 2).

Incidence rate of low birth weight

Once the ANC follow-up time of all 1,645 mothers was taken into account, a total of 27,776 person-weeks were found. Incidence rate of low birth weight was 0.47883 per person-weeks, or 47.8 per 100 person-weeks. At the end of the usual 40-week follow-up till delivery, only 133 of 1,645

Table 2 Maternal characteristics of mothers of newborns with and without low birth weight (< 2,500 and 2,500 - 4,000 grams, respectively) (N = 1,645).

Maternal factors	N, % of mothers of newborns				*P*-value*
	With low birth weight (n = 133)		Without low birth weight (n = 1,512)		
Number of previous pregnancy (gravida)					
1					
2	54	40.60	550	36.38	
3	35	25.32	537	35.52	
4	31	23.31	270	17.86	
5	10	7.52	104	6.88	0.023
6	1	0.75	38	2.51	
7	0	0.00	5	0.33	
8	2	1.50	3	0.20	
11	0	0.00	3	0.20	
Mean = 2.07	0	0.00	2	0.13	
Number of previous live delivery (parity)					
0					
1	67	50.38	644	42.59	
2	38	28.57	572	37.83	
3	20	15.04	222	14.68	0.041
4	6	4.51	54	3.57	
5	0	0.00	15	0.99	
6	0	0.00	2	0.13	
8	2	1.50	1	0.07	
	0	0.00	2	0.13	
Gestational trimester at ANC registration					
First trimester	66	49.62	805	53.24	
Second trimester	44	33.08	421	27.84	0.440
Third trimester	23	17.29	286	18.92	
Number of ANC visit					
1 - 5 times	39	29.32	279	18.45	
6 time or more	94	70.68	1233	81.55	0.004
Mean = 8.94 times					
Number of abortion					
Never	105	78.95	1,221	80.75	
1	25	18.80	238	15.74	0.772
2	2	1.50	38	2.51	
3	1	0.75	11	0.73	
4	0	0.00	4	0.27	
Hematology tests					
Normal	129	97.00	1461	96.63	
Abnormal	4	3.00	51	3.37	
HBsAg positive	(2)	(1.50)	(37)	(2.45)	0.352
Anit-HIV reactive	(2)	(1.50)	(5)	(0.33)	
VDRL reactive	(0)	(0.00)	(7)	(0.46)	
Rh negative	(0)	(0.00)	(2)	(0.13)	
Health risk					
Good health	36	27.07	743	49.14	
Having obstetric complications	64	48.12	577	38.16	< 0.001
Having medical illness	6	4.51	85	5.62	
Having obstetric complications and internal medicine diseases	27	20.30	107	7.08	
Gestational age at delivery					
< 38 weeks	16	24.81	271	13.36	< 0.001
38 – 42 weeks	117	75.19	1241	86.64	

* Pearson's chi-square test or Fisher's exact test, as appropriate.

mothers had newborns with low birth weight. Therefore, median survival time could not be obtained in this study. Probabilities of surviving the low birth weight, in other words, probability of being free of having a newborn with low birth weight or probability of having a newborn with normal birth weight, at 4, 8, 12, 16, 20, 24, 28, 32, 36 and 40 weeks after the first ANC visit were 99.88%, 97.91%, 95.28%, 93.86%, 91.75%, 89.85%, 86.52%, 82.20%, 77.87%, and 76.59%, respectively. At the end of the follow-up of December 31,

2017, with a total of 133 mothers having low-birth weight newborn, 1,512 mothers were free of having a newborn with low birth weight (Table 3 and Figure 1).

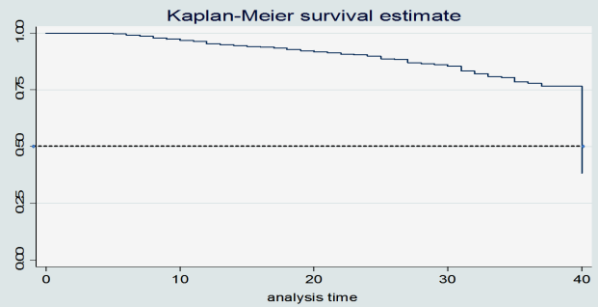

Figure 1 Probability curve of being free of having a newborn with low birth weight (LBW) (N = 1,645).

Table 3 Probability of being free of having a newborn with low birth weight (LBW) (i.e., survival function) (N = 1,645).

Time since the first ANC visit (weeks)(t_i)	Number of mothers free of having a newborn with LBW at time t	Number of mothers delivering a newborn with LBW at time t	Survival function, S(t_i)	Standard deviation of survival function	95% CI of survival function*
4	1,643	2	0.9988	0.0009	0.9951 - 0.9997
8	1,344	29	0.9791	0.0037	0.9704 - 0.9853
12	966	29	0.9528	0.0060	0.9394 - 0.9633
16	723	12	0.9386	0.0072	0.9228 - 0.9513
20	558	14	0.9175	0.0090	0.8755 - 0.9175
24	439	10	0.8985	0.0106	0.8363 - 0.8893
28	335	14	0.8652	0.0135	0.7850 - 0.8533
32	223	13	0.8220	0.0174	0.7309 - 0.8190
36	108	8	0.7787	0.0224	0.7309 - 0.8190
40	2	2	0.7659	0.2711	0.0170 - 0.7976

* Statistical significant at *P*-value < 0.05.

The associations between survival rates of newborn with low birth weight and various factors

Based on preliminary analysis with log-rank test, it was found that survival rate of being free from having newborn with low birth weight was significantly associated with age, payment scheme, number of gravida, number of ANC visit, number of parity, gestational age at delivery, obstetric complications, and obstetric complications with internal medicine-related diseases (Table 4). Significant association of having low birth weight newborns with ethnicity, residence region, or number of abortion was not found.

After adjusting for demographic and socio-economic factors, proportional hazard regression analysis revealed that probability to have the newborn with low birth weight was significantly associated with number of gravida, number of parity, number of abortion, obstetric complications, obstetric complications with internal medicine-related diseases, and gestational age at delivery (*P*-value < 0.001) (Table 5).

Table 4 Associations between various factors and survival of low birth weight newborns (N = 1,645).

Factors#	χ^{2}*	*P*-value
Age	68.53	< 0.001
Payment scheme	28.77	< 0.001
Number of previous pregnancy (gravida)	16.96	0.031
Number of ANC visit	382.54	< 0.001
Number of previous live delivery (parity)	31.65	< 0.001
Gestational age at delivery	155.55	< 0.001
Obstetric complications	7.88	0.005
Obstetric complications and internal medicine-related diseases	26.65	< 0.001
Ethnicity	0.95	0.331
Residence region	2.94	0.890
Number of abortion	3.73	0.444

All factors were categorical variables as shown in Table 1 and 2.

* Log-rank test.

Table 5 The risk of having the newborn with low birth weight by proportional hazard regression analysis (N = 1,645).

Factors	Risk as hazard ratio (HR)		*P*-value
	Hazard ratio	95% CI	
Maternal factors			
Number of previous pregnancy (gravida)	2.301	1.340 - 4.165	0.037
Number of previous live delivery (parity)	1.388	0.514 - 3.440	NS
Number of ANC visit	0.781	0.634 - 0.965	< 0.0001
Gestational age at delivery (≥ 38 vs. < 38 wks)	0.512	0.283 - 0.878	< 0.001
Having abortion (having no abortion as reference)	1.2548	0.658 - 2.273	NS
Hematology tests			
HBsAg–positive	0.932	0.228 - 3.819	NS
Anti-HIV–reactive	1.918	0.963 - 3.148	NS
VDRL–reactive	0.000	0.000 - 3.143	NS
Rh–negative	0.000	0.000 - 3.223	NS
Normal tests (as reference)			
Health risks			
Obstetric complications	1.771	1.163 - 2.695	0.008
Internal medicine diseases	1.027	0.415 - 2.546	NS
Obstetric complications and internal medicine diseases	3.638	2.140 - 6.185	< 0.001
Good health (as reference)			
Demographic and socio-economic factors			
Age	1.034	1.006 - 1.064	0.018
Residence region			
Nakhonnayok and vicinity	1.246	0.755 - 2.056	NS
Others (as reference)			
Payment scheme			
Universal coverage scheme	1.548	0.845 - 2.836	NS
Civil servant scheme	1.372	0.624 - 3.016	NS
Social security scheme	0.929	0.128 - 6.710	NS
Welfare benefit	1.324	0.179 - 9.800	NS
Benefit for the disabled	8.174	2.804 - 23.825	< 0.001
Out-of-pocket (as reference)			
Regression model: Wald $\chi^{2}_{(19)}$ = 231.52, *P*-value < 0.001.			

Note: NS = not significant.

From the hazard ratios in Table 5, as the mother aged one more year, the risk of having the newborn with low birth weight significantly increased by 1.03 folds (HR = 1.034, 95% CI = 1.006 – 1.064, *P*-value = 0.018). Mothers with the payment benefit for the disabled had a risk of as high as 8.17 folds of

those who paid out-of-pocket (HR = 8.174, 95% CI =2.804 - 23.835, *P*-value < 0.001).

The risk of having the newborn with low birth weight among mothers with one more pregnancy (gravida) was increased 2.30 folds (HR = 2.301, 95% CI = 1.340 – 4.165, *P*-value = 0.037). For women with one more ANC visit, the risk of low birth weight newborn was decreased by 0.22 folds (HR = 0.781, 95% CI = 0.634 - 0.965, *P*-value < 0.0001). A greater gestational age, i.e., ≥ 38 vs. < 38 weeks, was associated with a lower risk of having newborn with low birth weight (HR = 0.512, 95% CI = 0.283 - 0.878, *P*-value < 0.001). Women with obstetric complication had a risk of having newborn with low birth weight by 1.77 folds of those with good health (HR = 1.771, 95% CI = 1.163 - 2.695, *P*-value = 0.008). Having obstetric complications and internal medicine diseases was also associated with a higher risk of low birth weight newborn (HR = 3.638, 95% CI = 2.140 - 6.185, *P*-value < 0.001).

Discussions and Conclusion

This study aimed at determining survival rate of having newborn with low birth weight, i.e., less than 2,500 grams among Thai women. At the end of the usual 40-week follow-up till delivery, 133 of 1,645 mothers had low birth weight newborns while the rest 1,512 did not. At 40 weeks after the first ANC visit, probability to survive having a low birth weight newborn was 76.59%, respectively. Various factors significantly explained the possibility of having the newborn with low birth weight (*P*-value = 0.001). These factors included age, number of pregnancy (gravida), payment scheme (benefit for the disabled), number of ANC visit, gestational age at delivery, obstetric complication, and obstetric complications and internal medicine diseases.

Regarding age, the risk of having the newborn with low birth weight significantly increased by 1.03 folds for one more year of the mother age. This could be attributable to the decrease in the production of estrogen and progestogen hormones, the ovulation, and the uterus physiological status suitable for fetal development.[22] It also could be due to the increase in the risk of pregnancy complications including hypertension, diabetes, and pre-term labor.[22] With a U-shaped relationship between maternal age and newborn's low birth weight, younger and older mothers were more likely to deliver low birth weight newborns.[31,32] Women with young and old age have physiological and hormonal status not perfectly suitable for pregnancy. Dennis and Mollborn found that even though associated with low birth weight newborns, maternal age did not directly affect the newborn's weight once socioeconomic and behavioral factors of the mothers were adjusted for.[33]

For payment scheme, those having benefit of disability experienced an 8.17-fold risk of having low birth newborn compared to those paying out-of-pocket. This could be attributable to the discrepancy between healthcare providers and disabled persons such as communications, attitudes, and sexual relationship counseling. Being considered a personal or even an inappropriate topic for the disabled, therefore the trust to seek this sexual relationship consultation is lost. In addition, a more severe level of disability could also limit the ability to nurture the fetus.[34] A study by Redshaw and Malouf found that compared with mothers with no disability, disabled mothers were more likely to have newborn with low birth weight with a statistical significance.[35]

Various maternal factors played a significant role in the newborn's weight. One more previous pregnancy or gravida was associated with a 2.3-fold risk of having newborn with low birth weight. More number of gravida could result in the dilation of endometrium and uterus muscle, and the physiological change of the endometrium specifically where the placenta attaches.[12] These could lead to placenta previa, pre-term labor, and newborn with low birth weight.[36] The risk of low birth weight newborn for one more ANC visit was decreased about 0.22 folds. This could be explained by the fact that mothers attending the ANC clinic more frequently were advised on ANC self-care and examined on fetal health status more regularly. These women were expected to attend the ANC clinic to receive regular care and realize the importance of such visit.[37] Based on the ANC quality standard, pregnant women should have at least 5 ANC visits.[3,38] It has been found that having less than 5 ANC visits was significantly associated with low birth weight newborn.[19,32] However, a study found that number of ANC visit was not a sole predictor or low birth weight newborn since having low birth weight newborn was affected by multiple and complicate factors.

We found that those delivering the newborn at the gestational age of 38 weeks or greater had a lower risk of low birth weight newborn compared to those delivering at 37 weeks or lower (HR = 0.51). This could be due to the fact that gestational age has been known to be associated with the

newborn weight. A longer gestational age is usually associated with more development of the fetus organs and the body weight. It also has been known that delivery at the gestational age of less than 38 weeks is associated with a higher risk of the newborn's morbidities and mortalities.[2,24]

Women with obstetric complication had a risk of having newborn with low birth weight by 1.77 folds of those with good health. Having obstetric complications and internal medicine diseases was also associated with a higher risk of low birth weight newborn (HR = 3.638). These complications could contribute to fetal growth retardation, pre-term labor, and premature rupture of the fetal membrane.[1,2] These associations were shown various studies including Bener and Salameh[40], Bernabe and Soriano[20], and Pupongpunkul and Suphunnakul.[37]

Our study offered a relatively strong observation that maternal factors especially regular ANC follow-up visits were positively associated with the weight of the newborn. It has been known that ANC registration at the first trimester is for screening risks of pregnancy complications while regular ANC follow-up visits mainly aim at monitoring the health of the mother and the development of the fetus, and ultimately the desirable delivery outcomes.[38]

With the use of retrospective design in our study, incomplete data based on the data collection forms used in the actual practice were inevitable. For example, data of body mass index (BMI) and the actual health behavior practice of the mothers were incomplete. BMI[12,41,42] and actual health behavior[19] have been known to be associated with the newborn's weight. This was a limitation in our study. To overcome the drawback of the retrospective design, a prospective study to determine the effects of ANC registration at least 12 weeks before delivery and regular ANC follow-ups should be conducted. In prospective study, data collection on various factors could be planned.

In terms of clinical practice, positive correlations of number of ANC clinic visits and gestational age with a lower risk of low birth weight suggest that registering with ANC clinic at the early gestational age and regular ANC follow-ups should be encouraged. A progressive campaign to recruit women before and at early pregnancy should be initiated. Complications in addition to low birth weight of the newborn could also be dramatically lessened.

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Editorial note
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