The Risk Factors of Low Birth Weight Infants in the Northern Part of Thailand

Chiang Mai Low Birth Weight Study Group*

** Faculty of Medicine, Chiang Mai University, Chiang Mai, Thailand*

Background: *The incidence of low birth weight (LBW) in Chiang Mai University Hospital was high.*
Objective: *Determined the incidence and risk factors of low birth weight infants.*
Material and Method: *The present study included pregnant women between 1989 and 1990 who attended the antenatal clinics (ANC) having a gestational age less than or equal to 24 weeks. During that period, up to delivery, clinical and other potential data namely demographic and biomedical factors, maternal status, socioeconomic factors, and nutritional factors were included. The birth weight at birth less than 2,500 gm was considered LBW.*
Results: *Two thousand one hundred eighty four pregnant subjects who delivered live born and were still eligible, were used for analysis in the present study. The incidence of LBW was 9.2% (201/2,184). Women with body mass index (BMI) at first antenatal clinics (ANC) less than 18.5 Kg/m^2 and weight gain during the second trimester less than 300 grams/week was the strongest independent risk factor for LBW (odds ratio 11.25, 95% confidence interval (CI) 5.77-21.94). The number of antenatal care less than 4, monilial vaginitis, the infestation of hookworm and strongyloides, and pregnancy-induced hypertension were independent risk factors (odds ratio 11.04, 3.14, 4.93 and 4.02 respectively).*
Conclusion: *The present study showed that low initial BMI, low weight gain in the second trimester, and low attendance at ANC are associated to the occurrence of LBW. The development of a scoring system for detecting high-risk of LBW in pregnant women based on a combination of antenatal factors should be pursued.*

Keywords: *Low birth weight, Maternal, Pregnancy, Risk factors, Thais*

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Infants with low birth weight (LBW-birth weight under 2,500 grams), have higher neonatal mortality and morbidity rates than those with normal birth weight[1]. Birth weight is one of the most important determinants of its chances of survival and healthy growth and development. At the time of the present study, Thailand still had a relatively high infant mortality rate and high LBW rate. In 1986, infant mortality rate in the Northern part of Thailand was 48 per 1,000 livebirths, which was quite higher than other regions of Thailand[2]. Being preterm, including LBW was the third leading cause of infant death (8%)[3,4]. The incidence of LBW in the Northern part of Thailand (11.8%) is higher than other parts[5]. These data pointed to the need for further in depth study to investigate the risk factors to determine the high incidence of LBW.

Correspondence to:
Rerkasem K, Department of Surgery, Faculty of Medicine, Chiang Mai University, Chiang Mai50200, Thailand.
Phone: 053-945-532, Fax: 053-946-139
E-mail: krerkase@gmail.com

Several LBW studies have been carried out in the past in Thailand[5-7]. However, most of these largely retrospective studies were unable to definitely demonstrate risk factors in the areas of maternal nutrition and other biomedical parameters. The authors therefore investigated the incidence and risk factors for LBW in a cohort of mothers receiving antenatal care and delivering in the birth facilities of Chiang Mai.

Material and Method

The present design was a prospective cohort study, with women recruited at first attendance at the antenatal care (ANC) clinics of two centers, Maharaj Nakorn Chiang Mai Hospital and The Maternal-Child Health Care Center and followed-up through their routine attendance through to delivery between January 1989 and October 1990. At that time, only two public centers provided ANC in Chiang Mai province. All women who attended ANC and delivered at the two centers were included consecutively. Sociodemographic and other background data were collected at recruitment retrospectively, using

structured and pre-tested questionnaires. Further information was collected at subsequent visits and after delivery using additional pre-tested questionnaires. The present study was carried out by a consortium consisting of the Research Institute for Health Sciences (RIHES) Chiang Mai University and staff of two medical centers. The present study was approved by the Human Experimentation Committee (currently the Faculty of Medicine's Research Ethics Committee, Chiang Mai University). To achieve the 95% confidence level and 90% power to detect a risk ratio of 1.8 (assuming the prevalence of risk factors in normal birth weight and LBW is 18% and 10% respectively), the sample size requirement was 2,200[8,9].

Inclusion criteria included pregnant women who attended ANC at the two study centers (Maharaj Nakorn Chiang Mai Hospital, and the Maternal-Child Health Care Center and having a gestational age (GA) less than or equal to 24 weeks. Exclusion criteria included pregnant women recruited in the present study who did not give birth at either of the two selected study centers. Twin deliveries, stillbirths, and abortions were excluded.

Outcomes

GA was assessed from reported of last menstrual period (LMP) and fundal height. In case of uncertainty, ultrasound measurement was also used. Dubowitz scoring for GA assessment was used for LBW babies. Birth weight was measured by using digital scale (SECA®Itin Scale Co., Inc., USA), that allowed the infant to lie was used to measure the infant's weight. The capacity was 10 kg, measured to the nearest 20 gm. Scales were standardized using a set of known weights. LBW defined as an infant with weight at birth less than 2,500 gm. A premature infant was one whose gestational age was less than 37 weeks. The small for gestational age (SGA) defined in the birth weight was below the 10th percentile for its GA, using the intrauterine growth curve[10]. The grouping of LBW infants into preterm (premature) and small for gestational age (SGA) categories was determined by pediatricians.

The risk factors

There were four main groups of risk factors.

A. Demographic and biomedical factors consisted of previous birth history, complications of this pregnancy including obstetric complications, medical complications, gynecological complications, and surgical complication

B. Maternal status factors included age, weight and height, mid upper arm circumference (MUAC), triceps skinfold, and blood pressure

C. Socio economic and environmental factors included the education-occupation of wife and husband, and household income (baht/month)

D. Nutritional information was collected by two methods, the 24-hour food recall method and the food frequency method[11], using pre-tested questionnaire forms. Each subject was interviewed three times, at 10-12, 22-24, and 32-34 week gestation. Because the inclusion criteria allowed recruitment up to 24 weeks gestation, the first interview was carried out when the first visit was in the second trimester in some cases. The number of interviews actually achieved at each time was dependent upon the ANC visit pattern of the individual women, and not all interviews were achieved in all cases. The interview time for both questionnaire forms was about 15 minutes per subject.

Each respondent was asked to recall all food consumed during the previous day and to estimate quantities in ordinary measures or servings. In order to increase the accuracy of quantities of food consumed, the pregnant subject was provided with measuring cups or other devices to aid the estimation. Using Thai Food Tables[12-14], overall intakes at the three trimesters were calculated as energy, protein, fat, and carbohydrate.

Data collation, processing, and analysis

Primary data (completed questionnaire forms and clinical records) were coded and collated in the statistics section of RIHES. Data processing and analysis were carried out at the statistics section using the analysis package STATA. The principal techniques used were tabulation, logistic regression, and ordinary regression. Statistical testing was by Chi-squared tests, z-tests, t-tests, and F-tests 95%, which p-value < 0.05 was set for statistical significant. Confidence limits were quoted where appropriate, derived by standard methods and from the results of regression modeling.

Results

Two thousand six hundred twenty three pregnant women were eligible as having enrolled for antenatal care at 24 weeks or less gestation. At the end, 2,336 (89.1%) of these gave birth at the two centers (1,332 at Maharaj Nakorn Chiang Mai hospital and 1,004 at the Mother-Child Health Care Center). One

hundred fifty two more were excluded for a variety of reasons such as nine had GA greater than 24 weeks after re-examination, 14 delivered twins, 11 had stillbirths, 71 had abortions, and 15 had fetal deaths in utero. Furthermore, maternal information from the delivery was missing for eight; there was no record of birth weight for 20, and no record of baby's gender for four. Thus, the data of 2,184 pregnant subjects who delivered live born babies were used for analysis in the present study.

General characteristics

Of the 2,184 subjects, 57.4% and 42.6% were recruited in the Maharaj Nakorn Chiang Mai Hospital and the Maternal-Child Health Care Center respectively. The majority (88.4%) lived in Chiang Mai province and the remainder in nearby provinces (Lamphun, Chiang Rai, Lampang, Phayao, Mae Hong Son, Phitsanulok, and Samut Sakorn provinces). Most were Buddhists. The average age was 25.57 years with a standard deviation of 4.65.

The majority (78.1%) had attended school up to grade 6, with very few with no school education. Approximately 1/3 of the women were housewives, and the most common occupation among the rest was agricultural work. Household incomes were not high, almost one half having an average monthly income of 2,500 baht or less.

The average gestational age, height, weight, body mass index (BMI), mid arm circumference and triceps skinfold were 14.48 weeks, 152.15 cm, 49.72 kg, 21.46 kg/m^2, 24.43 cm and 17.85 mm (Table 1). The mean GA at birth of their infants was 39.09 weeks. At the onset of labour, the mean weight was 59.27 kg. The mean blood pressures were slightly increased from those on first visit. They were 112.45 mmHg and 71.36 mmHg for systolic and diastolic respectively.

Table 1. Gestational age (GA), maternal anthropometry, blood pressure (BP) (n = 2,184)

Variable	Mean (SD)
Gestational age (weeks)	14.48 (4.65)
Height (cm)	152.15 (5.03)
Weight (kg)	49.72 (7.13)
Body mass index, BMI (kg/m^2)	21.46 (2.76)
Mid upper arm circumference (cm)	24.43 (2.54)
Triceps skinfold (mm)	17.85 (5.88)
BP systolic (mmHg)	112.45 (9.06)
BP diastolic (mmHg)	71.36 (7.10)

Among the 2,184 live newborns in the present study, 1,169 (53.5%) were boys and 1,015 (46.5%) girls. The mean values of birth weight at birth was 3,002 (standard deviation 440, range 590 to 5,150) and the average GA was 39 weeks. The incidence of LBW in term infant (GA more than or equal to 37 weeks) was 5.0% (94/1,876) and in preterm infants (GA less than 37 wks) was 34.7%. The overall percentage of LBW infants was 9.2% (201/2,184).

Risk factors analysis

Univariate analysis

Possible risk factors for LBW were considered in this section. They were considered one at a time, then for their joint effect in LBW. Eighteen potential risk factors were significantly associated with LBW infant (Table 2). According to socioeconomic risk factors, there was generally little evidence of association, with the only one reaching statistical significance being the husband's occupation as a skilled craftsman. This rather surprising association did not have any self-evident explanation. Food intake questionnaires were administered to each subject attending for ANC in each trimester. No significant evidence for association between dietary intake and birth weight was found.

Multivariate analysis

The joint effect of those among the risk factors that attained statistical significance in the above tables was assessed by multiple logistic regression. The joint effect of initial BMI and weight gain was included using interaction terms. Backward elimination was used to remove factors from the model until a group jointly statistically significant was reached. These factors, with their odds-ratios for LBW are shown in Table 3. The prevalence rates of each risk factor were also shown, which, taken with the odds ratio, indicated its relative importance. The rate of LBW rate was 9.0%. The largest odds ratio was for the combination of low initial BMI and low weight gain in the second trimester, at 11.25. Low attendance at ANC was also an important risk factor, this time affecting more women. Low maternal height, non-use of contraception and nulliparity had lower odds ratios, but affected far more women.

Discussion

The overall rate of LBW was found to be 9.2%, just over half of these being born at term. This rate in Thailand has not changed much in the last 20

Table 2. Results for each of the various demographic and biomedical risk factors. For each level of each factor, the numbers of women are shown with the percentages low birth weight, and the risk ratios for low birth weight with 95% confidence intervals (n = 2,184)

Factor	No.	% LBW	Risk ratio (95% CI)	Mean BW (SE), grams
Age (year)				
15-19	183	7.1	0.77 (0.45-1.32)	2,963.4 (32.9)
20-34	1,914	9.2	1	3,005.1 (9.9)
35 or more	87	12.6	1.37 (0.70-2.42)	3,013.8 (56.7)
Weight at 1st enrollment (kgs)				
Less than 45.0	573	14.0	1.86 (1.42-2.42)	2,871.5 (18.0)
45.0 or more	1,610	7.5	1	3,048.0 (10.8)
Height at 1st enrollment (cms)				
Less than 150.0	680	11.8	1.46 (1.12-1.91)	2,912.7 (15.6)
150.0 or more	1,502	8.1	1	3,042.2 (11.6)
BMI at 1st enrollment (kgs/m^2)				
Less than 18.5	227	16.7	1.93 (1.39-2.67)	2,872.4 (30.7)
18.5-24.9	1,726	8.7	1	2,994.9 (10.3)
25.0 or more	229	5.7	0.65 (0.38-1.13)	3,182.5 (30.3)
MUAC at 1st enrollment (cms.)				
Less than 22.5	448	14.1	1.78 (1.35-2.36)	2,891.8 (21.6)
22.5 or more	1,724	7.9	1	3,031.3 (10.4)
Parity (not including this pregnancy)				
0	1,259	10.4	1.37 (1.04-1.81)	2,952.6 (12.1)
1 or more	922	7.6	1	3,069.6 (14.7)
Previous LBW				
Primigravid - none	1,259	10.4	2.10 (1.37-3.23)	2,952.6 (12.1)
Multigravid - no LBW before	465	5.0	1	3,141.8 (20.3)
- LBW before	81	19.8	3.99 (2.21-7.22)	2,868.6 (51.9)
Smoking habit before pregnancy				
Cigarette + keeyo	5	20.0	2.18 (0.38-12.66)	2,918.0 (192.4)
Cigarette only	36	2.8	0.30 (0.04-2.10)	3,145.6 (65.0)
Keeyo only	15	26.7	2.91 (1.24-6.81)	2,910.0 (161.1)
None	2,128	9.2	1	3,000.4 (9.5)
Alcohol consumption before pregnancy				
Yes	183	7.1	0.77 (0.45-1.32)	2,963.4 (32.9)
No	1,914	9.2	1	3,005.1 (9.9)
Number of attendance ANC (times)				
Less than 4	106	30.2	6.07 (4.15-8.88)	2,691.1 (74.8)
4-8	839	12.6	2.54 (1.88-3.44)	2,919.4 (14.9)
Greater than 8	1,207	5.0	1	3,084.4 (10.8)
Contraception past 12 months				
Any contraception	1,587	8.13	0.63 (0.48-0.83)	3,020.1 (10.8)
None	554	12.82	1	2,945.9 (19.7)
Monilial vaginitis				
Yes	46	17.4	1.93 (1.01-3.67)	2,990.9 (81.3)
No	2,106	9.0	1	3,000.9 (9.5)
Rheumatic heart disease				
Yes	5	40.0	4.38 (1.48-12.92)	2,780.0 (289.0)
No	2,147	9.1	1	3,001.2 (9.5)
Hookworm, Strongeloides				
Yes	17	23.5	2.59 (1.09-6.16)	2,761.8 (131.4)
No	2,135	9.1	1	3,002.6 (9.5)

LBW = low birth weight; BW (SE) = birth weight (standard error of the mean); BMI = body mass index; MUAC = mid upper arm circumference; ANC = antenatal care

Table 2. (cont.)

Factor	No.	% LBW	Risk ratio (95% CI)	Mean BW (SE), grams
Pregnancy-induced hypertension				
Yes	63	20.6	2.33 (1.41-3.85)	2,865.9 (65.4)
No	2,089	8.9	1	3,004.8 (9.5)
Weight gain during 2nd trimester (gm/wk)				
Less than 300	402	14.4	1.93 (1.44-2.59)	2,900.8 (22.7)
300 or more	1,648	7.5	1	3,033.3 (10.3)
Weight gain during 3rd trimester (gm/wk)				
Less than 300	389	11.0	1.24 (0.90-1.72)	2,947.2 (21.9)
300 or more	1,713	8.9	1	3,013.5 (10.7)
Pregnancy weight gain (kg)				
Less than 10	826	12.1	2.52 (1.71-3.70)	2,918.7 (14.7)
10 or more	665	4.8	1	3,130.5 (15.2)

LBW = low birth weight; BW (SE) = birth weight (standard error of the mean); BMI = body mass index; MUAC = mid upper arm circumference; ANC = antenatal care

Table 3. Multiple risk factor model for low birth weight

Variable	Odds ratio	95% CI	% prevalence
Biomedical factors			
BMI at 1st ANC of 25.0 kg/m^2 or more	0.49	0.24-0.96	10.32
BMI at 1st ANC less than 18.5 kg/m^2 and weight gain during 2nd trimester less than 300 grams/wk	11.25	5.77-21.94	2.24
Maternal height less than 150 cm	1.77	1.27-2.48	31.56
Maternal age less than 20 years	0.33	0.15-0.73	7.68
No contraception used in past 12 months	1.63	1.15-2.31	25.42
Parity 0 (not include this pregnancy)	1.46	1.03-2.08	58.87
Attending ANC less than 4 times	11.04	5.79-21.02	3.10
Attending ANC 4-8 times	3.34	2.34-4.76	38.50
Complication during pregnancy			
Monilial vaginitis	3.14	1.32-7.46	2.09
Hookworm, strongeloides, anemia (iron deficiency)	4.93	1.47-16.50	0.80
Pregnancy-induced hypertension	4.02	2.01-8.04	2.94

years, the incidence rate of LBW among newborns dropped from 10.2% in 1990 to 8.2% in 1996 but had gradually increased in 1997 to 2005 and reach a peak of 9.3% in 2006[3,4]. Therefore, it seems the result of the present study in 1990 is still valid now. This rate is not unduly high, for example, the LBW rate in the United Kingdom is of the order of 8% in 2006[15]. However, the question must arise as to how representative this sample is of the general population. It is based on women who attended for ANC and delivered in two principal government maternity hospitals, and who enrolled for ANC early enough to qualify for admission to the present study. Both locally and nationally[3,4,16], about 40% of births in the period before the present study were at home. In addition, nationally, just over 20% received no ANC[16], and of those who did, many will have enrolled too late for the present study and will tend to be among those with less attendance overall. Taking these factors in combination, it is very likely that 9.2% underestimates the true prevalence of LBW in the whole population at the time, and that LBW is a greater problem than this rate alone suggests.

Despite these reservations about the representativeness of the overall rate of LBW, the relationships between this outcome and the various risk factors that have been determined in the present study are likely to be reasonably general for the population. In univariate analysis (Table 2), among

these factors, low weight, height, BMI, and mid-arm circumference at enrolment were all associated with LBW, underlining the importance of adequate nutritional status, and adequate height. There was the expected effect of nulliparity and of previous LBW. The effect of keeyo (local hand-made cigarettes) smoking is strong although few women reported this practice; it may well be a proxy for lower socio-economic status. Lower ANC attendance was also an important predictor of LBW. Monilial vaginitis, rheumatic heart disease were also associated, but also affected relatively few women. Pregnancy-induced hypertension was more common and linked to LBW. Lower weight gain was also strongly associated. It is noteworthy, however, that socio-economic factors did not feature in the list of confirmed correlates of LBW (with the unexpected exception of husband being a craftsman). The factors that were found to correlate were maternal anthropometry, nutrition, and clinical factors. It is possible that the selection of hospital attendees is, in part, responsible for the paucity of socio-economic correlates.

Based on the multivariate incidence rate analysis, the two largest odds ratio (Table 3) was for low initial BMI with low weight gain in the second trimester and low attendance at ANC. The data point to the possibility of screening high-risk pregnant women based on their enrolment BMI and weight gain in the second trimester, would presumably include nutritional counseling. It would be important to establish a low rate of low weight gain as soon as possible in the pregnancy, and the operational aspects of this may need development. In addition, the importance of ANC attendance should be made among pregnant women.

The factors in the final multivariate model (Table 3) might provide a possibility of creating a risk score on them and validated in future prospective cohort. The score will consist of a weighted sum of the various factors (the weights being determined by the coefficients on the log scale in logistic analysis). The cut-point will be found by the technique of the receiver operating characteristic curve, though the trade off between cutoff and the relative costs of misclassification, as at risk or not at risk, will need further investigation. There is a case to be made for not including all the factors in Table 3, but focusing on those that can be measured in the first part of the pregnancy, in the creation of a score. This will ensure that routine use of the score classifies women early enough in the pregnancy for effective intervention.

Limitation

Following the present study, the authors analyzed and summarized the result in a report and now the authors were about to start follow-up 20 years cohort on the relationship between birth weight and metabolic syndrome as well as vascular diseases. The authors therefore published this paper for the reference of any future studies in this area. The most recent available statistics of LBW (2006) in Thailand was still similar in the present study[3], so the authors believed the result was still valid and generalizable. In addition, data for maternal Thai risk factors for LBW for consecutive study is still needed[17]. The present study also examined data for both biochemical and hematological laboratories, but this did not involve every participant (subset study). Therefore, the authors did not report it in the present study.

Conclusion

The present study showed that low initial BMI and low weight gain in the second trimester related to the occurrence of LBW. The policy to counteract with these risk factors needs to be explored further. The possibility of developing a scoring system for detecting women of elevated risk of LBW on the basis of a combination of antenatal factors is also to be pursued.

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Potential conflicts of interest

None.

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Appendix.

Investigators in Chiang Mai Low Birth weight Study Group

Principle investigator: Pien Chiowanich

Writing committee: Ampica Mangklabruks, Amaraporn Rerkasem, Antika Wongthanee, Kittipan Rerkasem, Pien Chiowanich, Piyamitr Sritara, Sakda Pruenglampoo, Tada Yipintsoi, Theera Tongsong, Tom Marshall, Watcharee Tantiprabha

Co-investigators:

Chiang Mai University: Busaya Gothwichian, Jutamas Sudasana Na Ayutthaya, Pien Chiowanich, Prapasri Rungsiyanond, Prasong Tienboon, Ratanaporn Sekararithi, Sungwal Rugpao, Suree Simarak (Faculty of Medicine) Adung Silprasert, Antika Wongthanee, Cholticha Ruangyuttikarn, Kanittha Thaikla, Monjun Wichajarn, Nipaporn Pinmas, Porsi Leelaput, Rassamee Keawvichit, Sakda Pruenglampoo, Somluck Nimsakul, Sukunya Linpisarn, Surinda Kawichai, Vimolphan Likit-ekarat (RIHES) Sunitya Chatkupta (Faculty of Dentistry) Mayuree Pechara-aksorn (Faculty of Associated Medical Sciences), Putchong Kuntolbutra (Faculty of Social Sciences)

The Ministry of Public Health: Aram Limtrakul, Atchara Varopas, Kannika Bangsainoi, Rajit Huansuriya, Soisa-ang Sethavanich, Somchai Laohawattana, Valai Chatawan (Health Promotion Center (Region 10)-previously the Maternal-Child Health Care Center), Nikorn Boontan (Hod Community Hospital)

การศึกษาปัจจัยเสี่ยงต่อการคลอดทารกน้ำหนักน้อยในภาคเหนือ

กลุ่มวิจัยศึกษาน้ำหนักแรกเกิดน้อยเชียงใหม่

***ความเป็นมา**: อุบัติการณ์ทารกแรกเกิดน้ำหนักตัวน้อยในภาคเหนือพบได้บ่อย*
***วัตถุประสงค์**: เพื่อเป็นการศึกษาอุบัติการณ์และปัจจัยเสี่ยงต่อการเกิดทารกแรกเกิดน้ำหนักตัวน้อย*
***วัสดุและวิธีการ**: ในระหว่างปี พ.ศ. 2532-2533 การศึกษานี้ได้เชิญสตรีตั้งครรภ์ที่มีอายุครรภ์น้อยกว่า 24 สัปดาห์เข้าร่วมการศึกษา การศึกษานี้ได้รวบรวมข้อมูลปัจจัยเสี่ยงต่อการเกิดทารกแรกเกิดน้ำหนักตัวน้อยได้แก่ น้ำหนักส่วนสูง รูปร่าง สุขภาพร่วมกับภาวะแทรกซ้อนระหว่างตั้งครรภ์ของมารดา เศรษฐฐานะ และภาวะโภชนาการ หลังจากนั้นได้ติดตามมารดาจนคลอดบุตรโดยน้ำหนักและขนาดของทารกได้รับการบันทึก การวินิจฉัยภาวะคลอดทารกน้ำหนักน้อยใช้เกณฑ์น้ำหนักแรกคลอดน้อยกว่า 2,500 กรัม*
***ผลการศึกษา**: การศึกษานี้วิเคราะห์จากข้อมูล 2,184 มารดาที่ตั้งครรภ์เข้าร่วมการศึกษา พบว่า อุบัติการณ์ของภาวะคลอดทารกน้ำหนักน้อยพบร้อยละ 9.2 (201/2,184) และการศึกษานี้พบว่ามารดาที่มีมีดัชนีมวลกายน้อยกว่า 18.5 กิโลกรัมต่อตารางเมตรและน้ำหนักเพิ่มน้อยกว่า 300 กรัมในช่วงการตั้งครรภ์ช่วง 3-6 เดือน เป็นปัจจัยเสี่ยงที่สำคัญที่สุดต่อการเกิดภาวะทารกแรกเกิดน้ำหนักตัวน้อย ปัจจัยอื่นที่มีความสำคัญเช่นกัน ได้แก่ จำนวนการมาติดตามการรักษาที่คลินิกฝากครรภ์น้อยกว่า 4 ครั้ง การติดเชื้อราในช่องคลอด การพบพยาธิปากขอและพยาธิสตรองจิลอยดิสในอุจจาระ และภาวะความดันโลหิตสูงช่วงตั้งครรภ์*
***สรุป**: การศึกษานี้พบว่ามารดามีดัชนีมวลกายน้อยกว่า 18.5 กิโลกรัมต่อตารางเมตร และน้ำหนักเพิ่มน้อยกว่า 300 กรัม ในช่วงการตั้งครรภ์ 3-6 เดือน เป็นปัจจัยเสี่ยงที่สำคัญที่สุดต่อการเกิดภาวะทารกแรกเกิดน้ำหนักตัวน้อย ผลการศึกษานี้น่าจะทำไปสู่การใช้ประโยชน์ในการสร้าง model ไปทำนายว่าการคลอดใดจะมีโอกาสเกิดภาวะทารกแรกเกิดน้ำหนักตัวน้อย และหาทางป้องกัน*