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Effect of maternal weight gain on small for gestational age (SGA) infants

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Objective : *To study the association between maternal weight gain and small for gestational age (SGA) infants in King Chulalongkorn Memorial Hospital.*

Study design : *Hospital based matched case control study.*

Setting : *King Chulalongkorn Memorial Hospital*

Subjects : *One hundred and twenty patients with small for gestational age infants were recruited into the study group, and 120 patients without small for gestational age infants were recruited as the control group.*

Method : *The data were collected from antenatal care record cards, maternal charts, newborn charts and interview questionnaire which was created by the researchers. The data were subsequently divided into two sections:*

Section 1 : Maternal information: age, weight, height, education, occupation, status, family income, past history, complications during pregnancy and the behavioral factor such as, smoking, caffeine and alcohol consumption.

Section 2 : Newborn information: gestational age, weight, gender, type of labor and characteristic.

Main outcome measures: maternal weight before pregnancy and before delivery, weight gain during gestational age and infant birth weight.

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Result : *Five variables were significantly associated with SGA infants: maternal weight gain during the third trimester (OR = 1.89, 95 % CI 1.11 - 3.19), maternal pre-pregnancy weight < 44 kg (OR = 2.32, 95 % CI 1.18 - 4.54), maternal total weight gain < 10 kg (OR = 2.16, 95%CI 1.13 - 4.12), height < 150 cm (OR = 2.14, 95 % CI 1.12 - 4.07), the patients with history of low birth weight (OR = 4.38, 95 % CI 1.39 - 13.82).*

Conclusion : *Maternal weight gain during the third trimester, maternal pre-pregnancy weight < 44 kg, maternal total weight gain < 10 kg, height < 150 cm, the patients with history of low birth weight were significantly associated with SGA infants.*

Keywords : *Small for gestational age (SGA), Maternal weight gain.*

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ดาว เวียงคำ, ณัฐจาพร พิชัยณรงค์, วิศิษฏ์ ฉวีพจน์กำจร, พัชราพร เกิดมงคล, สมชาย ธนวัฒนาเจริญ. ผลของน้ำหนักตัวมารดาที่เพิ่มขึ้นขณะตั้งครรภ์กับการเกิดทารกน้ำหนักตัวน้อยแบบไม่สมอายุครรภ์. จุฬาลงกรณ์เวชสาร 2548 พ.ย; 49(11): 647 – 55

วัตถุประสงค์ : *เพื่อศึกษาความสัมพันธ์ระหว่างน้ำหนักของมารดาที่เพิ่มขณะตั้งครรภ์กับทารกแรกเกิดที่มีน้ำหนักตัวน้อยแบบไม่สมอายุครรภ์*

รูปแบบการวิจัย : *การศึกษาแบบ Hospital based matched case-control study*

สถานที่ทำการวิจัย : *โรงพยาบาลจุฬาลงกรณ์*

กลุ่มตัวอย่าง : *กลุ่มศึกษาได้แก่มารดาที่คลอดทารกน้ำหนักตัวน้อยแบบไม่สมอายุครรภ์ จำนวน 120 คน และกลุ่มควบคุม ได้แก่ มารดาที่คลอดทารกน้ำหนักตัวปกติจำนวน 120 คน จับคู่แบบ 1:1 ด้วยทารกเพศ เดียวกันกับกลุ่มศึกษา*

วิธีดำเนินการวิจัย : *เก็บรวบรวมข้อมูลจากกลุ่มตัวอย่างโดยใช้แบบสัมภาษณ์ แบบบันทึกข้อมูลและเครื่องมือทางการแพทย์ ประกอบด้วยส่วนที่ 1 ข้อมูลส่วนมารดา ได้แก่ ข้อมูลด้านประชากร ด้านเศรษฐกิจและสังคม อายุ น้ำหนักที่เพิ่มขณะตั้งครรภ์ ประวัติการเจ็บป่วย ประวัติการตั้งครรภ์ โรคต่าง ๆ ที่พบขณะตั้งครรภ์ และส่วนที่ 2 ข้อมูลของทารก ได้แก่น้ำหนักแรกคลอด อายุครรภ์ ลักษณะทารก แรกคลอด รวบรวม และตรวจสอบข้อมูล เพื่อนำสู่การวิเคราะห์ต่อไป*

ตัววัดที่สำคัญ : *น้ำหนักมารดาก่อนตั้งครรภ์ น้ำหนักมารดาที่เพิ่มขึ้นในแต่ละไตรมาส น้ำหนักชั่งครั้งสุดท้ายก่อนคลอด น้ำหนักเพิ่มรวมขณะตั้งครรภ์*

ผลการวิจัย : *พบว่าปัจจัยที่มีความสัมพันธ์กับการเกิดทารกน้ำหนักตัวน้อยแบบไม่สมอายุครรภ์ได้แก่ น้ำหนักมารดาที่เพิ่มขึ้นไตรมาสที่ 3 ของการตั้งครรภ์ (OR = 1.89, 95 % CI 1.11-3.19) น้ำหนักมารดาก่อนตั้งครรภ์ < 44 กก. (OR = 2.32, 95 % CI 1.18 - 4.54), น้ำหนักมารดาเพิ่มขึ้นรวมขณะตั้งครรภ์ < 10 กก. (OR = 2.16, 95 % CI 1.13 - 4.12), ส่วนสูง < 150 ซม. (OR = 2.14, 95 % CI 1.12 - 4.07), ประวัติการคลอดทารกน้ำหนักตัวน้อย (OR = 4.38, 95 % CI 1.39 - 13.82) ตามลำดับ*

สรุป : *หญิงตั้งครรภ์ ที่มีน้ำหนักเพิ่มขึ้นน้อยในไตรมาสที่ 3 ของการตั้งครรภ์, น้ำหนักมารดาก่อนตั้งครรภ์ < 44 กก., น้ำหนักมารดาเพิ่มขึ้นรวมขณะตั้งครรภ์ < 10 กก., ส่วนสูง < 150 ซม., มารดาที่มีประวัติการคลอดทารกน้ำหนักตัวน้อย เป็นปัจจัยที่มีผลต่อการเกิดทารกน้ำหนักตัวน้อยแบบไม่สมอายุครรภ์*

คำสำคัญ : *ทารกน้ำหนักตัวน้อยแบบไม่สมอายุครรภ์, น้ำหนักของมารดาที่เพิ่มขณะตั้งครรภ์*

There are several health problems which need to be solved in Thailand, particularly, maternal and child health problems. Low birth weight infants (< 2,500 gm) have 4 -10 times of the morbidity and mortality rates of normal infants (2,500 - 4,000 gm).[1] Additionally, two-thirds of infant deaths in the first four weeks of life are infants weighing 2,500 gm at birth or less.[2]

Low birth weight (LBW) is categorized into 2 groups: appropriate for gestational age (AGA) and small for gestational age (SGA). The AGA group is preterm delivery with respect to their gestational age. These infants tend to take a higher risk of having complications caused by prematurity such as respiratory distress syndrome (hyaline membrane disease), infectious disease, premature labor, brain hematoma, and hypoglycemia. The SGA group, which were defined as infants whose weights were below the 10th percentile for their gestational age, has often faced of asphyxia while laboring and other complications such as, meconium stained amniotic fluid, persistence of the fetal circulation, hypoglycemia, and congenital malformations, much more than those in the first group. Therefore, the researchers were interested in conducting a study on SGA infants.

The causes of SGA are unknown. However, there were many epidemiological studies which demonstrated various factors associated with SGA. One of the main factors was maternal weight gain. Several studies stated that pregnancy weight gain was significantly related to infants' birth weight.[3,4] Thus, the researchers were really interested in this factor, anticipating that the result of this research could be applied in the future.

Materials and Methods

The study population included pregnant women and their babies who were delivered by singleton birth and were admitted on the 5th floor of Nawamintharachinee Building, and all newborns delivered at King Chulalongkorn Memorial Hospital from April 1st to August 31st , 2004.

Case group: SGA infant group was obtained from maternal delivery records of King Chulalongkorn Memorial Hospital all SGA infants were included to this study except those who were disqualified by the exclusion criteria.

Control group: Control group was chosen from the neighboring cases to ensure that the mothers of both groups had the same life-style, which was considered influential on birth weight. The process of selecting the control group was as follows: after SGA cases were selected, the comparison group who were admitted close to the cases were chosen from the list of normal birth weight infants delivered at the same period of time.

Inclusion criteria

1. Singleton pregnancy
2. Term pregnancy (gestational age $\geq$ 37 weeks)
3. Last menstrual period is ascertained or ultrasound confirmed gestational age

Exclusion criteria

1. Multiple pregnancy
2. Systemic diseases, such as heart disease, diabetes mellitus, renal disorders, etc.
3. Congenital abnormalities
4. Fetal death

The data were collected from antenatal care record cards, maternal charts, newborn charts and

interview questionnaire which was created by the researchers. The data were subsequently divided into 2 sections:

Section 1: Maternal information: age, weight, height, education, occupation, status, family income, past history, complications during pregnancy and behavioral factors, such as smoking, caffeine and alcohol consumption.

Section 2: Newborn information: gestational age, weight, gender, type of labor and characteristics.

Descriptive statistics such as frequency, percent, mean and standard deviation were used to describe the study subjects. Differences in mean variables were compared by using t-test or Mann-Whitney U test. Proportions were compared with Chi-square test or Fisher exact test. Univariate analysis

Table 1. The general characteristics between case and control groups.

Characteristics	Case		Control		P value[a]
	N	%	N	%	
Age (years)					0.157
< 20	27	22.5	17	22.5	
20-35	83	69.2	96	69.2	
> 35	10	8.3	7	5.8	
Mean (SD)	25.8 (5.9)		26.1 (5.3)		
Marital status					0.569
Married	118	98.3	119	99.2	
Widow/divorced	2	1.7	1	0.8	
Mother education					0.469
No and low	44	36.7	49	40.8	
Moderate and high	76	63.3	71	59.2	
Father education					0.684
No and low	50	41.6	44	36.7	
Moderate and high	70	58.4	76	63.3	
Mother occupation					0.237
Housewife	48	40.2	36	30.0	
Employee	63	52.3	68	56.6	
Merchant	7	5.8	14	11.7	
Government officer	2	1.7	2	1.7	
Family income (baht/month)					0.078
< 5,000	10	8.3	19	15.8	
5,000-10,000	59	49.2	64	53.3	
> 10,000	51	42.5	37	30.8	

[a] Pearson's chi-square test

was used to define each associated factor with small for gestational age (SGA) infants by calculating the odds ratio (OR) and 95 % confidence interval of OR. Multivariate analysis was used to define associated factors with SGA infants after adjusted of confounding factors, by applied multiple logistic regression. In the case that there were two variables were that were very similar and had multicolinearity, only one would be included for modeling.

Results

General characteristics of the samples

The comparisons of general characteristics between patients with SGA infants (120 cases) and those without SGA (120 controls) at King Chulalongkorn Memorial Hospital were described based on specific factor as follows.

General characteristics of the infants

Distribution of gender between case and control group was not different, the ratio between male and female was 1:1 in both groups. The average weight of case group in the study was 2,377 gm and average gestational age 37.96 wks as compared to 3,158 gm and average gestational age 38.99 wks in control group, respectively. Socio-demographic characteristics were shown in table 1.

Maternal behavioral factors

Smoking cigarette, caffeine consumption and alcohol consumption had no significant difference between cases and controls (p = 0.370, 0.112 and 0.121, respectively) as shown in table 2.

After performing the crude analysis, the factors considered to be significantly associated

Table 2. Comparison of behavioral factors during pregnancy between case and control groups.

Behavioral factors	Case		Control		P value[a]
	N	%	N	%	
Cigarette smoking					0.370[a]
< 20	116	96.7	119	22.5	
20-35	4	3.3	1	69.2	
Caffeine consumption					0.112[b]
Never	90	75.0	100	83.3	
Ever	30	25.0	20	16.7	
Alcohol consumption					0.121[b]
Never	109	92.2	115	96.0	
Ever	11	8.8	5	4.0	

[a] Fisher's exact test

[b] Pearson's chi-square test

Table 3. The association between maternal risk factors and SGA adjusting for other variable.

Variable	Crude OR	95% CI	Adjusted OR	95% CI	P value
Weight gain in 1st trimester (gm)[a]					
<2,000	1.27	0.76-2.124	1.34	0.79-2.29	0.274
≥2,000	1		1		
Weight gain in 2nd trimester (gm)[a]					
<4,100	1.35	0.81-2.24	1.31	0.79-2.22	0.308
≥4,100	1		1		
Weight gain in 3rd trimester (gm)[a]					
<5,450	1.96	1.17-3.28	1.89	1.11-3.19	0.019*
≥5,450	1		1		
Pre-pregnancy weight (kg)[a]					
<44	2.58	1.35-4.94	2.32	1.18-4.54	0.014*
44-55	1		1		
>55	0.53	0.27-1.01	0.55	0.28-1.08	0.083
Last weight (kg)[a]					
<55	0.71	0.38-1.35	0.67	0.34-1.29	0.235
55-69	1		1		
>69	0.97	0.53-1.79	1.01	0.54-1.88	0.972
Total weight gain (kg)[a]					
<10	1.98	1.06-3.68	2.16	1.13-4.12	0.019*
12-16	1		1		
>16	0.58	0.30-1.10	0.71	0.36-1.38	0.321
Height (cm)[b]					
<150	2.27	1.21-4.26	2.14	1.12-4.07	0.020*
≥150	1		1		
History of LBW[c]					
Yes	4.46	1.44-13.77	4.38	1.39-13.82	0.011*
No	1		1		

*p value< 0.05, Chi-square test

[a] adjusted for Height, History of low birth weight

[b] adjusted for History of low birth weight, weight gain during the third trimester

[c] adjusted for Height, weight gain during the third trimester

with SGA infants were third trimester weight gain, pre-pregnancy weight, last weight, total weight gain, height and history of low birth weight. This association might be influenced by confounding factors. In order to get rid of the potential confounders, unconditional multiple logistic regression was provided by controlling for effect of maternal weight gain of first trimester, maternal weight gain of second trimester, maternal weight gain of third trimester, maternal pre-pregnancy weight, maternal last weight, maternal total weight gain, height and history of low birth weight. Where very similar six variables were selected for inclusion modeling (co-linearity) such as maternal weight gain of first trimester, maternal weight gain of second trimester, maternal weight gain of third trimester, maternal pre-pregnancy weight, maternal last weight and maternal total weight gain.

After controlling for confounding factors, five risk factors, namely maternal weight gain during the third trimester, maternal pre-pregnancy weight, maternal total weight gain, height and history of low birth weight significantly were associated with SGA infant as shown in table 3.

Discussion

A hospital based case control study was conducted from April 1st to August 31st, 2004 on the 5th floor of Nawamintharachinee Building, King Chulalongkorn Memorial Hospital, Bangkok. There were two major purposes, i.e., to define factors associated with SGA infants and to determine the relation among maternal weight gain and other factors which were associated with SGA infants. The controls were matched by infants' gender as cases, thus some confounding factors were correspondingly eliminated or minimized. The hospital controls were used because there were a number of important practical and scientific advantages. First, they were easily identified and readily available in sufficient numbers, thus minimized the cost and effort which involved in their assembly. Second, they were more likely to be aware of antecedent exposures or events than healthy individuals. In this respect, their comparability to the cases with accuracy report will reduce the potential of recall bias. Lastly, hospital controls, as cases, are more likely to cooperate than healthy individuals, thus minimized bias due to non-response.[5] In this study, both groups were recruited from the 5th floor of Nawamintharachinee Building, King Chulalongkorn Memorial Hospital, which they were diagnosed and treated by the same standard on the expectation that this could minimize selection bias.

One of the most important methods to minimize bias in the data collection instruments is close-ended question. Furthermore, the major hypothesis under investigation was masked to minimize the potential recall bias by the subjects or the interview.[5]

The limitation of this study is that the source of data was routine hospital records, which only limited the number of variables that could be included in the study. Therefore, routine recording system at King Chulalongkorn Memorial Hospital should be improved in order to get a valid database for epidemiological investigation. Moreover, because of late attending to antenatal care clinic in developing countries, data concerning maternal pre-pregnancy weight, weight gain during the first or second trimester were absent or not certain.

Relationship between maternal weight gain in the third trimester and SGA infants was statistically significant. This finding agreed with previous studies.[4,6] Like the study of Shapiro et al.[7], maternal pre-pregnancy weight was also found associated with SGA infants. Many studies have found that inadequate antenatal care was significantly associated with LBW and SGA infants.[8,9] However, there was no statistically significant association between mothers who attended ANC less than or equal to four times and the occurrence of LBW and SGA infants in this study.

The results of this study, which reflects situation for cases in the hospital, have to be carefully generalized to the general population. More studies should be conducted in various hospitals, health centers, and home deliveries. However, owing to the fact that some factors affecting birth weight are multifactorial and interrelated, the effects of con-founding factors should be controlled wherever possible. Moreover, the enlargement of the information contents of education and communication related to reproductive health, expanding and improving the provision of family planning services should be performed with the hope that they would contribute to a reduction in SGA infants. Despite some limitation in this study, the researchers feel that the results are useful for the understanding of risk factors associated with the occurrence of SGA infants which is one of the most common health problems of King Chulalongkorn Memorial Hospital and in Thailand.

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