EFFECT OF MATERNAL WEIGHT GAIN ON SMALL FOR GESTATIONAL AGE INFANTS

DAO WEIANGKHAM

A THESIS SUBMITTED IN PARTIAL FULFILLMENT
OF THE REQUIREMENTS FOR
THE DEGREE OF MASTER OF SCIENCE (PUBLIC HEALTH)
MAJOR IN INFECTIOUS DISEASES AND EPIDEMIOLOGY
FACULTY OF GRADUATE STUDIES
MAHIDOL UNIVERSITY
2005

ISBN 974-04-5923-4

Thesis

entitled

EFFECT OF MATERNAL WEIGHT GAIN ON SMALL FOR GESTATIONAL AGE INFANTS

Dao Weiangkham
.....
Miss Dao Weiangkham
Candidate

N. Pichainarong
.....
Assoc.Prof. Natchaporn Pichainarong,
Dr.P.H. (Epidemiology)
Major-Advisor

P. Kerdmongkol
.....
Miss Patcharaporn Kerdmongkol,
D.N.Sc.
Co-advisor

Wisit Chaveepojnkamjorn
.....
Assoc.Prof. Wisit Chaveepojnkamjorn,
D.V.M.,M.P.H.
Co-advisor

Somchai Tan
.....
Assoc.Prof.Somchai Tanawattanajareon,
M.D.
Co-advisor

Rassmidara Hoonsawat
.....
Assoc. Prof. Rassmidara Hoonsawat,
Ph.D.
Dean
Faculty of Graduate Studies

Kulaya Narksawat
.....
Assoc. Prof. Kulaya Narksawat,
D.D.S.,M.P.H.,M.Sc.
Chair
Master of Science (Public Health)
Major in Infectious Disease and
Epidemiology
Faculty of Public Health

Thesis

entitled

EFFECT OF MATERNAL WEIGHT GAIN ON SMALL FOR GESTATIONAL AGE INFANTS

Was submitted to Faculty of Graduate Studies, Mahidol University
for the degree of Master of Science (Public Health)
Major in Infectious Disease and Epidemiology
on
April 1, 2005

Dao Weiangkham
.....
Miss Dao Weiangkham
Candidate

N. Pichainarong
.....
Assoc.Prof. Natchaporn Pichainarong,
Dr.P.H. (Epidemiology)
Chair

Somjai Puttapitukpol
.....
Asst. Prof. Somjai Puttapitukpol,
D.N.S.
Member

P Kerdmongkol
.....
Miss Patcharaporn Kerdmongkol,
D.N.Sc.
Member

Wisit Chaveepojnkamjorn
.....
Assoc.Prof. Wisit Chaveepojnkamjorn,
D.V.M.,M.P.H.
Member

Somchai Ta
.....
Assoc.Prof.SomchaiTanawattanajareon,
M.D.
Member

Ramm Hoon
.....
Assoc. Prof. Rassmidara Hoonsawat,
Ph.D.
Dean
Faculty of Graduate Studies
Mahidol University

C. Chaikittiporn
.....
Assoc. Prof.Chalermchai Chaikittiporn,
Ph.D. (Epidemiology)
Dean
Faculty of Public Health
Mahidol University

ACKNOWLEDGMENTS

I would like to express my deep appreciation and sincere gratitude to Assoc.Prof.Dr. Natchaporn Pichainarong my major advisor for her guidance invaluable advice, supervision, sharing experience and encouragement. I also would like to express my appreciation and gratitude to my co – advisor, Dr. Patcharaporn Kerdmongkol, for her kindness, useful guidance, valuable suggestion and comment. I would like to sincerely thank to my co – advisor, Assoc.Prof.Wisit Chaveepojnkamjorn, for his helpful comments, guidance and encouragement throughout this study.

I am very grateful to my co – advisor, Dr. Somchai Tanawattanajareon, for his helpful advice, assistance, concern and support.

I would like to express my special thanks to Asst.Prof.Dr. Somjai Puttapitukpol, for her helpful advice.

It is impossible to mention all the kindness and helpfulness of lecturers, and staff of Epidemiology Department especially Miss Mathuros Tipayamongkholgul for their helps which made this study possible.

My special thank to all phycians, nurses and staff of Nawamintharachinee 5th floor, King Chulalongkorn Memorial Hospital for their cooperation.

Special thankful and deeply indebted to my parents, my brother and my family for their love, warmth and support, encouragement and helping me to complete this thesis.

Dao Weiangkham

EFFECT OF MATERNAL WEIGHT GAIN ON SMALL FOR GESTATIONAL AGE INFANTS.

DAO WEIANGKHAM 4536365 PHPH/M

M. Sc. (PUBLIC HEALTH) MAJOR IN INFECTIOUS DISEASE AND EPIDEMIOLOGY

THESIS ADVISORS: NATCHAPORN PICHAINARONG, Dr. P. H. (EPI.), PATCHARAPORN KERDMONGKOL D. N. Sc., SOMCHAI TANAWATTANAJAREON, M.D., WISIT CHAVEEPOJNKAMJORN, D.V.M., M.P.H.

ABSTRACT

This hospital based case control study was conducted at The King Chulalongkorn Memorial Hospital, Bangkok, from April 1, 2004 to August 31, 2004. The objective of this study was to determine the relationship between factors of maternal weight gain and small for gestational age infants. One hundred and twenty patients with small for gestational age infants comprised the study group, and 120 patients without small for gestational age infants comprised the control group. They were matched at a ratio 1:1 by children gender. Multiple logistic regression analysis indicated that, after adjusting for other variables in the model, only five variables were significantly associated with small for gestational age infants: maternal weight gain during the third trimester (OR = 1.89, 95%CI 1.11 - 3.19), maternal pre weight < 44 kgs (OR = 2.32, 95%CI 1.18 - 4.54), maternal total weight gain < 10 kgs (OR = 2.16, 95%CI 1.13 - 4.12), height < 150 cms (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).

This hospital based case control study confirmed many risk factors, especially maternal weight gain the development of small for gestational age infants. This result can be utilized in programs of prevention and control in family planning, antenatal care and postnatal care units, particularly in the more aggressive management of maternal weight gain.

KEY WORDS: SMALL FOR GESTATIONAL AGE INFANTS / MATERNAL WEIGHT GAIN

62 P. ISBN 974-04-5923-4

ผลของน้ำหนักตัวมารดาที่เพิ่มขึ้นขณะตั้งครรภ์ กับการเกิดทารกน้ำหนักตัวน้อยแบบไม่สมอายุครรภ์ (EFFECT OF MATERNAL WEIGHT GAIN ON SMALL FOR GESTATIONAL AGE INFANTS)

ดาว เวียงคำ 4536365 PHPH / M

วท.ม. (สาธารณสุขศาสตร์) สาขาวิชาเอกโรคติดเชื้อ และวิทยาการระบาด

คณะกรรมการควบคุมวิทยานิพนธ์: ณัฐจาพร พิชัยณรงค์, ส.ด., พัชราพร เกิดมงคล , D.NSc., สมชาย ธนวัฒนาเจริญ, พ.บ. , วิศิษฏ์ ฉวีพจน์กำจร, สพ.บ. , สม.

บทคัดย่อ

การศึกษาแบบ hospital based case control ซึ่งทำการศึกษาในโรงพยาบาลจุฬาลงกรณ์สภากาชาดไทย ตั้งแต่วันที่ 1 เมษายน ถึง 31 สิงหาคม 2547 เพื่อศึกษาปัจจัยด้านน้ำหนักตัวแม่ที่เพิ่มขณะตั้งครรภ์กับการเกิดทารกน้ำหนักตัวน้อยแบบไม่สมอายุครรภ์ กลุ่มศึกษาได้แก่มารดาที่คลอดทารกน้ำหนักตัวน้อยแบบไม่สมอายุครรภ์ จำนวน 120 คน และกลุ่มควบคุม ได้แก่ มารดาที่คลอดทารกน้ำหนักตัวปกติจำนวน 120 คน จับคู่แบบ 1:1 ด้วยทารกเพศ เดียวกันกับกลุ่มศึกษา

ผลการศึกษาภายหลังการวิเคราะห์โดยใช้ multiple logistic regression เพื่อหาความสัมพันธ์ระหว่างปัจจัยด้านน้ำหนักตัวแม่ที่เพิ่มขณะตั้งครรภ์กับการเกิดทารกน้ำหนักตัวน้อยแบบไม่สมอายุครรภ์ โดยควบคุมตัวแปรกวนที่มีอิทธิพลต่อการเกิดโรค พบว่าปัจจัยที่มีความสัมพันธ์กับการเกิดทารกน้ำหนักตัวน้อยแบบไม่สมอายุครรภ์ได้แก่ น้ำหนักมารดาที่เพิ่มขึ้นไตรมาสที่ 3ของการตั้งครรภ์ (OR = 1.89, 95%CI 1.11-3.19) น้ำหนักมารดาก่อนตั้งครรภ์ < 44 ก.ก. (OR = 2.32, 95%CI 1.18 - 4.54), น้ำหนักมารดาเพิ่มขึ้นรวมขณะตั้งครรภ์ < 10 ก.ก. (OR = 2.16, 95%CI 1.13 - 4.12), ส่วนสูง < 150 ซ.ม. (OR = 2.14, 95%CI 1.12 - 4.07), ประวัติการคลอดทารกน้ำหนักตัวน้อย (OR = 4.38, 95%CI 1.39 - 13.82) ตามลำดับ

จากผลการศึกษานี้แสดงถึงปัจจัยโดยเฉพาะปัจจัยด้านน้ำหนักแม่ขณะตั้งครรภ์ที่มีผลต่อการเกิดทารกน้ำหนักตัวน้อยแบบไม่สมอายุครรภ์ ข้อเสนอแนะ ควรดำเนินป้องกันและควบคุมโรค เช่นการให้คำปรึกษาแนะนำในหน่วยวางแผนครอบครัว หน่วยฝากครรภ์ และหลังคลอด โดยเฉพาะการควบคุมน้ำหนักตัวของสตรีตั้งครรภ์

62 หน้า ISBN 974-04-5923-4

CONTENTS

	Page
ACKNOWLEDGEMENTS	**iii**
ABSTRACT	**iv**
LIST OF TABLES	**viii**
LIST OF FIGURES	**ix**
CHAPTER	
1 INTRODUCTION	
Background	1
Objectives	3
Hypothesis	4
Variables	4
Definition of Variables	5
2 REVIEW OF THE LITERATURE	
Small for gestational age infants	8
Aetiological of Small for gestational age infants	8
Diagnosis	10
Treatment	11
Maternal weight gain	12
Research relevant to small for gestational age infants	17
Conceptual Framework	24
3 MATERIALS AND METHODS	
Study Design	25
Study Population	25
Inclusion Criteria	26
Exclusion Criteria	26
Sample Size	26

CONTENTS (CONTINUED)

	Page
Data collection	27
Ethical Consideration	28
Data analysis	28
4 RESULTS	
General Characteristics	29
The association and effect of various factors and small for gestational age infants	32
The effect of various factors and small for gestational age infants by multivariate analysis	36
5 DISCUSSION	
Discussion	39
Discussion on study design	39
Discussion on study result	40
6 CONCLUSION AND RECOMMENDATIONS	
Conclusion	45
Recommendations for the result application	46
Recommendations for the further Study	47
REFERENCE	**48**
APPENDIX	53
BIOGRAPHY	62

LIST OF TABLES

Tables		Page
1	Report of Local Administration Department 1997-2001	2
2	Live birth rate of SGA and perinatal death in King Chulalongkorn Memorial Hospital 1998-2001	2
3	Recommended weight gain by BMI	13
4	General distribution of average weight gain	14
5	The general characteristics between case and control	31
6	Comparison of behavior factors between case and control	32
7	Comparison of illness factors between case and control	34
8	The association between maternal risk factors and SGA adjusting for other variables	35

LIST OF FIGURES

Figure		Page
1	Conceptual framework	24

CHAPTER 1
INTRODUCTION

There are several health problems which need to be solved in Thailand. Particularly, maternal and child health, regarding as a crucial public health problems that will be effected on developing country. Low birth weight infants (< 2,500 gms) have 4-10 times higher morbidity and mortality rate than normal infants (2,500- 4,000 gms) (1). Additionally, two-third of deaths in four weeks of life are infants weighing 2,500 gm at birth or less (2). The less the weight of infants are, the higher mortality rate is.

Low birth weight (LBW) is characterized in two group; 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 risk of getting pain due to body system defects which are caused by prematurity such as hyaline membrane disease, infectious disease, respiratory distress syndrome, premature labor, brain haematoma, and hypoglycemia. The SGA group has often faced of asphyxia while laboring and other complications such as, macronium strained caused persistence of the fetal circulation, hypoglycemia, and congenital malformations are much more than the first group. Moreover, neurological and growth development SGA. Therefore, the researcher was interested in conducting study in SGA infants study (Table 1-2).

Table 1 The live birth rate of Local Administration Department in Thailand, 1997-2001.

Year	Live birth rate	Perinatal death rate	Live birth rate of SGA
1997	14.8	3.7	13.5
1998	14.7	4.9	12.5
1999	12.3	6.6	13.5
2000	12.5	6.2	13.7
2001	12.7	6.5	13.1

Source: The Local Administration Department / Ministry of Public Health, 2001

Table 2 The live birth rate of SGA and perinatal death rate in King Chulalongkorn Memorial Hospital, 1998-2002.

Year	Live birth rate	Live birth rate of LBW/1,000	Perinatal death/1,000
1998	12,091	1,169 (96.7)	136 (11.3)
1999	11,412	1,023 (89.6)	109 (9.6)
2000	11,733	1,074 (91.5)	125 (10.5)
2001	10,822	975 (90.1)	124 (11.4)
2002	10,124	992 (97.9)	109 (10.2)

Source: Medical Record, King Chulalongkorn Memorial Hospital, 1998 - 2002

Data from two sources have preciously indicated that there were declination on both delivery and the amount of SGA. Regarding, amount of SGA or perinatal death, it is unlikely to decrease although medical technology and treatment are getting more advance. It is important for health care practitioners, mothers, and involved people to determine SGA.

The causes of SGA are unknown. However, there were many epidemiological studies demonstrated various factors of SGA. One of the main factors was maternal weight gain. Furthermore, Nuchprayoon et al. (1987) and the study of S. Strauss and Dietz (1999). Found that pregnancy weight gain was significantly related to infants birth weight. Thus, researcher was quite interested in studying about this factor (3-4). Besides, the study frame was selected in King Chulalongkorn Memorial Hospital since there are 10,000 deliveries each year, which is enough to conduct a research, keep track, analyze, and interpret the data. In addition, the result of this research will be used for appropriate treatment in the future.

Objectives

General objective

To identify the maternal weight gain and risk factors associated with small for gestational age infants in King Chulalongkorn Memmorial Hospital in 2004.

Specific objectives

1.To study the association of total pregnancy weight gain toward the incidence of SGA infants.

2.To study the association of pregnancy weight gain in each trimester toward the incidence of SGA infants.

3. To study the association of maternal socio-economic status toward the incidence of SGA infants.

4. To study the association of maternal biological characteristic toward the incidence of SGA infants.

5. To study the association of medical and obstetric factors toward the incidence of SGA infants.

Hypotheses

1. Total pregnancy weight gain is associated with SGA infants.
2. Weight gain in each trimester is associated with SGA infants.
3. Maternal socio-economic status is associated with SGA infants.
4. Maternal biological characteristics are associated with SGA infants.
5. Medical and obstetric factors are associated with SGA infants.

Variables

Dependent Variable

The incidence of SGA

Independent Variables

Total pregnancy weight gain, weight gain in each trimester**,** maternal age, prenatal care, occupation, education, family income, history of pregnancy induced hypertension, maternal height, gravidity, history of vaginal bleeding, previous labor, smoking/ passive smoking, and complication during pregnancy.

Definitions

Small gestational age infant (5) is defined as baby born with birth weight of less than 2,500 grams and gestational age >37weeks.

Appropriate gestational age infant (5) is defined as baby born with birth weight of more than or equal 2,500 grams and gestational age >37weeks.

The first trimester (5) means the trimester extends from the last menstrual period through the first 14 weeks of pregnancy.

The second trimester (5) means the trimester extends from the first trimester through 26 weeks of pregnancy.

The third trimester (5) means the trimester extends from the end of second trimester until term or 40 weeks of gestation.

Prepregnancy weight (5) means the weight before pregnancy.

Prepregnancy weight is evaluated with median value of weight gain as follow:

Poor	< 44	kgs
Good	44-55	kgs
Obesity	> 55	kgs

Pregnancy weight gain of the first trimester (5) means the weight gain from the last menstrual period through the first 14 weeks of pregnancy.

Pregnancy weight gain of the second trimester (5) means the weight gain from the first trimester through 26 weeks of pregnancy.

Pregnancy weight gain of the third trimester (5) means the weight gain from the end of second trimester until term or 40 weeks of gestation.

Weight gain in each trimester is evaluated with median value of weight gain in each trimester as follow:

Weight gain during the first trimester

Good	≥ 2,000	gms
Poor	< 2,000	gms

Weight gain during the second trimester

Good	≥ 4,100	gms
Poor	< 4,100	gms

Weight gain during the third trimester

Good	≥ 5,450	gms
Poor	< 5,450	gms

Total weight gain (5) is estimated by subtracting the weight before pregnancy from the last measured weight.

Total weight gain is evaluated with median value of weight gain as follow:

Poor	< 10	kgs
Good	10-16	kgs
Obesity	> 16	kgs

The last weight (5) means the maternal weight gain before mother delivery.

The last weight is evaluated with median value of weight as follow:

Poor	< 55	kgs
Good	55-69	kgs
Obesity	> 69	kgs

Education : the level of education which belong to pregnant women. In data collecting, it would be divided into four categories:

Uneducated: No education at all, the meaning is that cannot read or write (no education).

Primary: those who have passed primary education (low education)

Secondary: those who have passed secondary education (moderate education).

University or collage: those who have joined college or university (high education).

Marital status:

the marital status of pregnant women will be divided into two categories:

Unmarried (unmarried women included single pregnant women, divorced and widowed).

Married.

Complication during pregnancy:

Malaria: as diagnosis by a physicians (blood test positive or the mother had malarial treatment).

Antepartum means haemorrhage presence of vaginal bleeding before labour (based on the diagnosis of physicians).

Preeclampsia means triad of hypertension (which systolic was higher than or equal to 140 mm Hg or diastolic was higher than or equal to 90mm Hg), and proteinuria. (proteinuria > 0.3 grams in 24 hours urine or 0.1 grams/ liter, based on the diagnosis of a physicians).

Anemia means clinical condition in which blood hemoglobin level is below 11 grams percentage.

CHAPTER 2

REVIEW OF THE LITERATURE

Review of Literature Included the Following Topics :

1.Small for gestational age infants

2.Maternal weight gain

3.The research relevant to small for gestational age infants

Small for Gestational Age Infants

Between 3% and 10% of live births each year are described as SGA. In addition, oldest children who have short stature and underweight may be labeled SGA by their physicians. There are many variances in the definition of SGA, but generally, SGA describes a child whose birthweight and/or length is/was less than the 3rd percentile (with age adjusted for prematurity). In addition, when ultrasound evidence demonstrated poor fetal growth while in-utero, an infant is also described as being “IUGR" (intrauterine growth restriction). These definitions are descriptive terms and are not specific diagnoses. The factors behind why an infant is born SGA are quite complex. The factors include fetal (such as genetic syndromes), maternal (such as substance use or infection), placental, and/or demographic (mother's age, income level, race). But setting aside these possible reasons, the fact is that 9 out of 10 infants born SGA do experience catch-up growth by the age of 2 years, and usually by 6 months of age. It is the smaller subset of SGA children, the 1 of 10 who fail to achieve catch-up growth by age 2, that will focus on short SGA child. These include "idiopathic" SGA children who are small for unknown reasons, namely parents who have normal height, history of non-smoking/non-drinking, lab tests have ruled out known causative factors, etc. It can be frustrating to be the parent of a short SGA child, you want answers to why your child isn't growing. We hope to offer information on SGA children, and to answer some of the possible questions you may have regarding SGA.

SGA is a term used to describe a baby who is smaller than the usual amount for the number of weeks of pregnancy. SGA babies usually have birth weights below the 10th percentile for babies of the same gestational age. This means that they are smaller than 90 percentile of all other babies of the same gestational age.

SGA babies may appear physically and neurologically mature but are smaller than other babies of the same gestational age. SGA babies have proportionately small (equally small all over) or have normal length and size but have lower weight and body mass. SGA babies have full term (37 to 41 weeks), or postterm (after 42 weeks of pregnancy).

Causes of Small for Gestational Age (SGA)

Although some babies are small because of genetics (their parents are small). Most SGA babies are small because of fetal growth problems that occur during pregnancy. Many babies with SGA have a condition called intrauterine growth restriction (IUGR). IUGR occurs when the fetus does not receive the necessary nutrients and oxygen needed for proper growth and development of organs and tissues. IUGR can begin at any time in pregnancy. Early-onset IUGR is often due to chromosomal abnormalities, maternal disease, or severe problems with the placenta. Late-onset growth restriction (after 32 weeks) is usually related to other problems.

Some factors that may contribute to SGA and/or IUGR as follows:

Maternal factors:

- high blood pressure
- chronic kidney disease
- advanced diabetes
- heart or respiratory disease
- malnutrition, anemia
- infection
- substance use (alcohol, drugs)
- cigarette smoking

Factors involving the uterus and placenta:

-decreased blood flow in the uterus and placenta

-placental abruption (placenta detaches from the uterus)

-placenta previa (placenta attaches low in the uterus)

-infection in the tissues around the fetus

Factors related to the developing baby(fetus):

- multiple gestation (twins, triplets, etc.)
- infection
- birth defect
-chromosomal abnormality

Pathology

When the fetus does not receive enough oxygen or nutrients during pregnancy, overall body and organs growth is limited, and tissue and organ cells may not grow as large or as numerous. Some of the conditions that cause SGA and IUGR restrict blood flow through the placenta. This can cause the fetus to receive less oxygen than normal, increasing the risks for the baby during pregnancy, delivery and afterwards.

Babies with SGA and/or IUGR may have problems at birth including the followings:

- decreased oxygen levels
- low Apgar scores (an assessment that helps identify babies with difficulty adapting after delivery)
- meconium aspiration (inhalation of the first stools passed in utero) which can lead to difficulty breathing
- hypoglycemia (low blood sugar)
- difficulty maintaining normal body temperature
- polycythemia (too many red blood cells)

Diagnosis for Small for Gestational Age (SGA)

The baby with SGA is often identified before birth. During pregnancy, a baby's size can be estimated in different ways. The height of the fundus (the top of a mother's uterus) can be measured from the pubic bone. This measure in centimeters

which usually corresponds with the number of weeks of pregnancy after the 20th week. If the measurement is low for the number of weeks, the baby may be smaller than expected.

Although many SGA babies have low birth weight, they are not all premature and may not experience the problems of premature babies. Other SGA babies, especially those with IUGR, appear thin, pale, and with loose, dry skin. The umbilical cord is often thin, and dull-looking rather than shiny and fat. They sometimes have a wide-eyed look.

Other diagnostic procedures may include the following:

- **Ultrasound;** Ultrasound (a test using sound waves to create a picture of internal structures) is a more accurate method of estimating fetal size. Measurements can be taken of the fetus' head, abdomen and compared with a growth chart to estimate fetal weight. The fetal abdominal circumference is a helpful indicator of fetal nutrition.

-**Doppler flow**; Another way to interpret and diagnose IUGR during pregnancy is Doppler flow, which use sound waves to measure blood flow. The sound of moving blood produces wave-forms that reflect the speed and amount of the blood as it moves through a blood vessel. Blood vessels in the fetal brain and the umbilical cord blood flow can be checked with doppler flow studies.

-**Mother's weight gain**; A mother's weight gain can also indicate a baby's size. Small maternal weight gains in pregnancy may correspond with a small baby

-Gestational assessment; Babies are weighed within the first few hours after birth. The weight is compared with the baby's gestational age and recorded in the medical record. The birth weight must be compared to the gestational age. Some physicians use a formula for calculating a baby's body mass to diagnose SGA.

Treatment of Babies Who are Small for Gestational Age (SGA):

Specific treatment for SGA will be determined by your pediatrics based on:

- your baby's gestational age, overall health, and medical history
- extent of the condition your baby's tolerance for specific medications, procedures, or therapies.
- expectations for the course of the condition

- your opinion or preference

Babies with SGA may be physically more mature than their small size indicates. But they may be weak and less able to tolerate large feedings or to stay warm. Treatment of the SGA baby may include:

- temperature controlled beds or incubators
- tube feedings (if the baby does not have a strong suck)
- checking for hypoglycemia (low blood sugar) through blood tests
- monitoring of oxygen levels

Babies who are SGA and are also premature may have additional needs including oxygen and mechanical help to breathe.

Maternal Weight Gain:

Institute of Medicine (IOM)

Institute of Medicine (IOM). A subcommittee appointed to focus on nutritional status and weight gain evaluated the scientific evidence and formulated recommendations for desirable weight gain during pregnancy. The committee released the report Nutrition During Pregnancy in 1990 (6).

Since release of the IOM report (6) few studies have dealt with the effects of biological factors on maternal weight gain. There is a lack of consistent findings concerning relationships of birth interval, parity, prepregnancy weight or body mass index (BMI), height, and physical activity to maternal weight or weight gain. (The IOM prenatal weight gain recommendations adjust only for prepregnancy BMI.) (Table 3).

Table 3 Recommended weight gain by BMI

BMI	**Weight gain**	
BMI (weight for height)	**kg**	**lb**
Low = less than 19.8	12.5-18	28-40
Normal= 19.8-26.0	11.5-16	25-35
High = 26.0-29.0	7-11.5	15-25
0bese = greater than 29	No less than 6.8 kg or 15 pounds	

Source: Institute of Medicine, Commmitee on Nutritional StatusDuring Pregnancy and Lactation. (1990). Nutrition during pregnancy: Weight gain and nutrient supplement, Pts.1 and 2. Washington, D.C., National Academy Press.

Weight gain by pregnant women consists of water, protein, and fat. Both Keppel KG (7) and Lederman (8) indicate that water gain, which probably represents lean tissue gain, is a predictor of birth weight, but fat gain is not. Thus, measurements of maternal water gain may predict birth weight better than measurements of composite weight gain. The total amount of weight gained, the composition of gain, and the rate of energy metabolism all differ amount healthy pregnant women. The composition of gain and rate of energy metabolism may affect infant birthweight (9).

A number of studies have examined sociodemographic and psychosocial characteristics in relation to prenatal weight gain (10-11). However, interrelationships among such risk factors as age, parity, income, maternal education, race, and ethnic background complicate interpretations of findings. Reporting on research in progress, Olson (12) made a strong case for cross-disciplinary, integrative perspectives when conducting intervention - relevant research on both gestational weight gain and postpartum weight loss.

Table 4 General distribution of average weight gain

Component	Weight	
	Kilogram	pounds
	Fetal components	
Fetus	3.2-3.4	7.0-7.5
Placenta	0.5-0.7	1.0-1.5
Amniotic fluid	0.9	2.0
Total weight gain	4.6-5.0	10.0-11.0
	Maternal components	
Uterus	1.1	2.5
Breasts	0.7-1.4	1.5-3.0
Blood volume	1.6-1.8	3.5-4.0
Maternal fat store	1.8-4.3	4.0-9.5
Extracellular fluid	1.6-2.3	3.6-5.0
Total weight	6.8-10.9	15.0-24.0
	Total Average Weight Gain	
Fetal plus maternal components	11.4-15.9	25.0-35.0

Source: Nichols,F.,and Zwelling, E.(1997).Maternal-newborn nurseing:Theory and Practice.Philadelphia: W.B.Saunders.

Infant Outcomes

When maternal weight gain is within the IOM-recommended range, the incidence of small for gestational age infants and/or low birthweight births is reduced (13-14). Recent studies examined the relationship between rate of weight gain (15). together with other factor (16-17) and small-for-gestational-age and/or preterm birth. The evidence concerning the effect of maternal weight gain on gestational duration is inconsistent (18). If maternal weight gain does affect gestational duration, the effect is small-there has been no temporal decline in the incidence of preterm delivery, despite an impressive trend of higher weight gains over this interval (19).

Several recent studies on the pattern of gestational weight gain, especially late pregnancy weight gain, suggest associations with infant outcome. Johnston and Kandel (20) and Abrams and colleagues (21) have described positive relationships between second trimester or third trimester weight gains and birthweight: Increased rates of gain were associated with larger fetal size, and lower rates of gain with smaller size. Other investigators have noted that risk of preterm birth is approximately doubled when third trimester rate of gain is low or inadequate (15,21).

A group of studies suggests an inverse relationship between both infant weight and proportional size at birth and the risk of long-term adverse health outcomes such as hypertension, obesity, glucose intolerance, and cardiovascular disease (22). Initial results are intriguing and may warrant further investigation.

Optimal gestational weight gain varies

There is a wide variation in the amount of weight gained by women who give birth to live, optimally grown infants. Women who gain as little as 16 pounds (7.3 kg) or as much as 40 pounds (18.2 kg) do give birth to healthy babies. This wide variation indicates that other factor salso have an impact on the birth weight and health of the newborn.

Low gestational weight gain

Women who do not gain enough weight in the second and third trimesters of their pregnancy are more likely to give birth to small-for-gestational- age infants (full-term infants weighing less than 5 lbs. 8 oz. or 2,500 grams at birth). After birth, these babies may not gain weight at an adequate rate and may also show delayed development. There is also a direct link between low weight gain and fetal or infant mortality. The effect of first-trimester weight gain or weight loss on the health of the newborn is unclear.

Very high gestational weight gain

Women who gain too much weight during pregnancy are more likely to have a high-birth-weight infant (more than 8 lbs. 12 oz. or 4,000 grams). This, in turn,

increases the risk of labor and delivery problems such as forceps or cesarean delivery and other birth trauma.

Weight-for-height status

The effect of gestational weight gain on fetal growth is modified by the mother's prepregnancy weight for height. Weight gain has far more of an effect on the growth of a fetus in thin women than it does in overweight and obese women. In addition, infants born to women with low prepregnancy weight for height are typically smaller than infants born to women with high prepregnancy weight for height, even when the women gain the same amount of weight during their pregnancies. For these reasons, women with low prepregnancy weight for height need to gain more weight during pregnancy than those who are overweight or obese.

Guidelines for Singleton Pregnancy

The goal for weight gain should be a range, not a single number. Counseling should also promote healthy diet to achieve the recommended weight gain. Women should aim for a steady rate of gain which follows the curve on the weight gain chart appropriate for their prepregnancy weight status**.** During the second and third trimesters, the recommended rate of gain is approximately 1 pound (about 0.4 kg) per week for women with a desirable prepregnancy weight. Women who were under-weight at conception should try to gain slightly more than 1 pound (about 0.5 kg) per week, while overweight women need to gain about 1 pound(about 0.3 kg) per week. The "Range of Prenatal Weight Gain" chart (WIC-4) used in WIC clinics is useful for educating women about appropriate weight gain. With a brief explanation, women will be able to understand the concept of maintaining their weight gain within the shaded range. A slightly lower or higher rate of weight gain than recommended is not cause for alarm, as long as a progressive increase in weight approximates the recommended rate of gain. Gains of less than 1 pound (about 0.5 kg) per month for obese women and less than 2 pounds per month (about 1 kg) for women of normal weight require evaluation. Gains greater than 6.5 pounds (about 3 kg) per month also should be investigated. Once measurement error is eliminated as a reason for inappropriate weight gains, the real cause should be determined. If it is determined that

inappropriate weight gain is not the result of overeating or under-eating, then a woman should be referred to her physician for evaluation. If inappropriate weight gain is the result of dietary behaviors, then corrective actions should be developed and implemented jointly with the woman. The plan may include counseling on how to modify her food intake or activity pattern. Any sudden increase in weight may be due to fluid retention in the tissues, called edema. Neither the calories nor the salt intake of women with edema should be restricted.

The Research Relevant to Small for Gestational Age Infants

Constitutionally small mothers

Small women typically have smaller babies. If a woman begins pregnancy weighing less than 100 pounds, the risk of delivering a small-for-gestational-age infant is increased at least twofold (23). Data from a longitudinal study of all births during one week in 1958 in England, Wales, and Scotland indicate that there are intergenerational effects on birthweight that are transmitted through the maternal line (24). Klebanoff MA et al. (25) also reported that reduced intrauterine growth of the mother is a risk factor for reduced intrauterine growth of her children. Whether or not the phenomenon of a small mother giving birth to a small infant is nature or nurture is unclear. Brooks and co-authors (1995) analyzed 62 births after ovum donation to examine the relative influence of the donor versus the recipient on birthweight. They concluded that the environment provided by the mother was more important than her genetic contribution to birthweight. Cryopreservation of embryos does not adversely affect fetal or postnatal growth (26).

Poor maternal weight gain and nutrition

In the woman of average or low weight, lack of weight gain throughout pregnancy may be associated with fetal growth restriction (23). Lack of weight gain in the second trimester is strongly correlated with decrease birthweight (27). If the mother is large and otherwise healthy, however, below-average maternal weight gain without maternal disease is unlikely to be associated with appreciable fetal growth restriction.

Social deprivation

The effect of social deprivation on birthweight is interconnected to the effects of associated lifestyle factors such as smoking, alcohol or other substance abuse, and poor nutrition. Wilcox and associates (28), in a study of 7,493 British women, found that the most socially deprived mothers had the smallest babies. Similarly, Dejin-Karlsson et al. (29) revealed prospective studied, a cohort of Swedish women found that lack of psychosocial resources influenced the risk of growth-restricted infants. Almost 100 years ago, Williams, commenting in the first edition of this text (30), wrote: “The social condition of the mother and the comforts by which she is surrounded also exert a marked influence upon the child's weight, heavier children being more common in the upper walks of life”.

Prenatal care

Wierenga et al. (31) reported in a nationwide prospective survey on very preterm and very low birthweight infants in the Netherland, the incidence of cot death in infants discharged alive was 15%. The posnatal age at death in this infants did not differ significantly from age at death in other cot death infants.Using a case control design, possible risk factors associated with cot death were identified lower maternal age at first pregnancy, maternal smoking during pregnancy; hypothermia of the infant immediately after birth; decreased number of white blood cells and thrombocytes in the infant on the fifth day of life. Intrauterrine hypoxia is hypothesized as the entity common to these factors.

Maternal Weight Gain

Richard and William. (4) showed that low maternal weight gain during pregnancy has been suggested as cause of intrauterine growth retardation (IUGR). However pregnancy weight gain and fetal growth vary greatly throughout pregnancy. We examined the relationship between maternal weight gain in individual trimesters to the risk of IUGR in 10,696 women enrolled in the National collaborative Perinatal Project (NCPP) and the Child Health and Development Study (CHDS). Low weight gain was defined as <-0.1 kg/wk for the first trimester and <0.3 kg/wk for the second

and third trimeaser. IUGR was defined as a birthweight <2,500 gms in full-term infants. Low weight gain in the first trimester was not associated with and increased risk of IUGR. After controlling for confounding factors (matermal height, body mass index, parity, race, toxemia, diabetes), low weight gain in the second trimester was associated with a relative risk of IUGR of 1.8 (1.3-2.6) in the NCPP cohort and 2.6 (1.6-4.1) in the CHDS cohort. Similarly, low weight gain in the third trimester was associated with a relative risk of IUGR of 1.7 (1.3-2.3) in the NCPP cohort and 2.5 (1.7-3.8) in the CHDS cohort. After correcting for weight gain in other trimesters, this increased risk remained. Increased risk of IUGR was observed with low second and third trimester weight gain across the spectrum of maternal body mass index. The risk of low weight gain in the second or third trimester was significantly lower in teenagers and significantly greater in over weight women and women aged 35 years or older. Low weight gain in either the second or third trimester was associated with a significantly greater risk of IUGR in two distinct cohorts. We conclude that increased awareness of matermal weight gain in middle and late pregnancy is critical to identifying infants at risk for IUGR.

Study of Lawton et al. (32) in a retrospective analysis of 158 women considered normal, low-risk pregnancies, 30 women gave birth to infants with a birthweight less than the 10^{th} percentille for gestation. These 30 women had significantly poorer mean in weight (0.99 kg) between 28 and 32 weeks gestation than the other 128 women (1.95 kg) who gave birth to infants with birthweights above the 10^{th} percentile for gestation. There was no statistically significant difference in booking weight, overall weight gain or other variables associated with low birtweight between the two groups of women which suggests that poor matemal weight gain specifically between 28 and 32 weeks gestation may predict small for gestational age infants.

Shapiro et al. (33) ascertained whether increased weight gain during pregnancy resulted in higher birthweight infants. A database was constructed from valid data of a sample of 159 healthy women between 19 to 37 years of age. The inclusion criteria were: maternal age of 19-37 years, ten gestations (37-42 weeks), a baseline weight obtained at 0-15 weeks gestation, and a final weight obtained within 2 weeks of delivery. Weight gain was calculated by subtracting baseline weight from the final

weight. A documented height enabled calculation of BMI. A negative screen for gestational diabetes was required. The results confirmed that excessive matemal weight gain in pregnancy (>35 lbs), does result in higher birth weight infants.

Cogswell et al. (34) studied the association between increased gestational weight gain and birth weight outcomes for low-income women. A total of 53,541 single, live infants delivered from 1990 to 1991 to white, black, and hispanic women in eight states were evaluated. Multiple logistic regression was used to calculate risk of low and high birthweight (>4,500 gms), adjusting for selected factors. The association between gestational weight gain a birthweight varied by prepregnacy body mass index. Risk for low birth weight decreased with increasing weight gain for average-weight women. There was no reduction in risk for low birth weight however, beyond weight gains of 30 to 34 pounds for overweight women and 15 to 19 pound for very-overweight women. Risk for high birthweight, however, increased with increasing weight gain all three groups. They concluded that very-overweight women (body mass index >29 kg/m^2) may be net from an upper guideline of 25 pounds of weight gain to help reduce risk for high birthweight.

Judith et al. (35) showed that pregnant planing were followed by clinic visits and questionnaires through delivery. This study includes 389 women and their singleton infants born at a gestational age of ≥ 241 day. In multiple regression analyses including a variety of potential confounders, matemal weight gain in the first and second trimesters predicted newborn weight (1-kg weight gain in the first trimester predicted a 31-g increase in newborn weight, $p<0.0007$ and 1-kg weight gain in the second trimester predicted a 26-g increase in newborn weight, $p<0.007$), but weight gain in the third trimester did not. Newborn ponderal index (kg/m^3) was predicted by weight gain in the first (1-kg weight gain predicted and added 0.21 units, $p<0.0003$) and third (1-kg weight gain predicted an added 0.12 units, ($p<0.003$) trimesters but not in the second trimester. Newborn weight was 211 g lower ($p<0.006$) and ponderal index 1.2 units lower ($p<0.02$) in infants born to women who lost weight in the first trimester.

Risk Factors

Scott et al. (36) showed that relative and attributable risks were calculated to assess the potency of different maternal factors associated with intrauterine growth retardation in individual pregnancies and in the population as a whole. In multiparous women, the most important factor for the total population was the slow fetal growth rate demonstrated in previous pregnancies. Moderate or severe preeclampsia gave a high individual risk, but because of its low prevalence the contribution to small-for gestational-age (SGA) pregnancies as a whole was low. Smoking and hypertension without preeclampsia each trebled the individual risk, and made a substantial contribution to the overall population of SGA babies. Other factors were low matemal height, weight, and weight gain in pregnancy. When adjustment has been made for matenal size, smoking, pathological factors, and siblings' birthweight, the effect of social class became insignificant. The remaining causes of SGA pregnancies are likely to be single factors of large effect such as major congenital abnormalities and uterine abnormalities. If the pathological factors of smoking, hypertension and preeclampsia could be prevented, the number on SGA pregnancies in this population would be reduced by about 50%.

Bendict et al. (37) studied to examine the current perinatal correlates and neonatal morbidity associated with intrauterine grouth failure among neonates born at term gestation.compared 372 small for gestational age (SGA, birth weight $<10^{th}$ percentile) infants born at term gestation to 372 appropriate for gestational age controls (AGA, birth weight 10^{th} to 90^{th} percentile) matched by sex, race, and gestational age within 2 weeks. Compared with AGA controls, significant ($p < 0.05$). SGA infants had significantly higher rates of hypothermia (18% versus 6%) and symptomatic hypoglycemia (5% versus 1%). These neonatal problems remained significant even when medical or pathologix causes of intrauterine growth failure, including pregnancy hypertension, multiple gestation, and congenital malformations, were excluded. Despite higher rates of pregnancy complications among mothers of SGA infants, the rates of neonatal adverse outcomes are low. However, SGA infants remain at risk hypothermia and hypoglycemia and require careful neonatal surveillance.

Victoria and Michael. (38) revealed small for gestational age, singleton newborns (birth weight below the tenth percentile for gestational age) born at 37-42 weeks' gestation were identified by medical record discharge coding. We excluded gestations complicated by structural or chromosomal abnormalities, maternal diabetes mellitus, preeclampsia, chronic hypertension, asthma, or renal, edocrine, or autoimmune disease. Three low-risk, appropriate for gestational age (AGA) fetuses, matched for gestational age at delivery, were selected randomly for each SGA fetus and served as controls. Maternal and neonatal data were abstracted via medical record review. Statistical analysis included $\chi 2$ test, Fisher exact test, and analysis of variance. The SGA newborn from an uncomplicated pregnancy delivered at term has increased neonatal Morbidity compared with AGA comnterpart.

An unmatched case controlled study of Nuchprayoon et al. (3) was designed to survey the maternal risk factors for low birth weight at term. Two hundred and one mothers, having singleton births, born alive with birth weight under 2,500 grams but fulfilling the criteria of the at term appearances (>37 weeks of gestation) according to the pediatrician's examination within 24 hours after birth, were identified selected at Chulalongkorn Hospital, Bangkok and Panasnikom Hospital, Cholburi as cases. Controls consisted of thost mothers having babies born alive with birth weight between 2,500-4,000 grams, who were born before and after the LBW infants according to the registry of births each day during October 1984 to March 1986.

More than 25 variables regarding maternal characteristics and their previous and current pregnancies were selected for comparison between cases and controls. This study indicated that low birth weight at term was significantly associated with the following risk factors in descending order: family of no income, hypertension during, pregnancy, residence in factory weight gain less than 10 kgs. No significant associations were found with maternal age, interpregnancy interval, condition of work during pregnancy, accidental events, mild illness, cigarette smoking or even the use of amenogoge during pregnancy, or a history of previous abortion.

Maternal nutrition and socio- economic status.

Roland and Staffan. (39) reported that birthweight is the most important determinant of mortality and morbidity in the neonatal period and may have an

influence on health in adult life. The high rate of low birthweight in developing countries is therefore a major health problem. Maternal malnutrition is usually assumed to be a causal factor but other environmental factors are also involved. In this study were analysed maternal nutritional and socio-economic factors as determinants of birthweight in term infants from a rural African society characterized by a high rate of chronic malnutrition. Relations of maternal weinght, gestational weight gain, parity, socio-economic status and infant sex with birthweight were analysed in 1,477 women and child pairs. The selected women were followed from early pregnancy and had an uncomplicated delivery at term of a living singleton child. The gestational weight gain was 5.6 kg (SD 6.0) and the mean birthweight 2,933 kg (SD 4.08). Maternal weight, representing the maternal long term nutritional situation, was the most important independent determinant of birthweight, accounting for 13.0% of the variance in birthweight. The weight gain, representing the short-term nutritional situation, explained only 5.6% of the variance. Birthweight increased by 20g (CI 1.8-2.3) for each kg maternal weight and by 15g (CI 1.2-1.8) for each kg gestational weight gained. The socio-economic difference in birth weight was 153 g (CI 1.09-1.96) 88 of which (CI 4.8-12.8) remained unexplained after adjustment for differences in maternal weight, parity and gender. Improved long-term nutritional situation and living conditions seems to be the most important prerequisites to counteract low birthweight in developing countries.

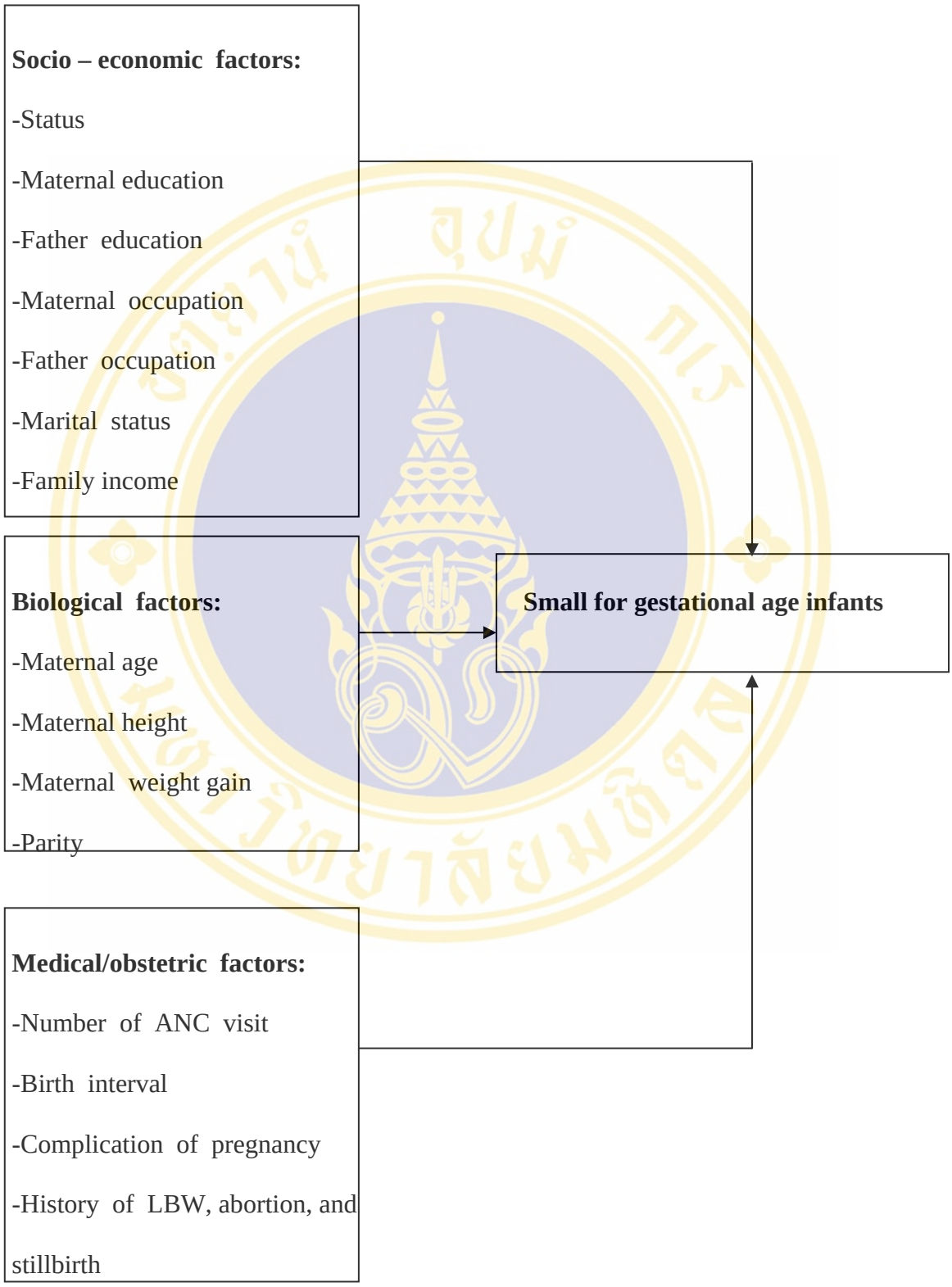

Figure 1 Conceptual framework

CHAPTER 3
MATERIALS AND METHODS

Study Design

This study is a hospital based matched case-control study, which involved the comparison of a group of pregnant women with gestational age ≥ 37 weeks who delivered a single small for gestational age infant (SGA group) April 1st to August 31st 2004 in King Chulalongkorn Memorial Hospital with another group of pregnant women with gestational age ≥ 37 weeks who delivered a single normal birth infant (AGA group).

Study Population

The study population included all pregnant mothers and their babies who delivered singleton birth and all newborn delivered in King Chulalongkorn Memorial Hospital from April 1st to August 31st 2004.

Sampling Technique

SGA group: Small gestational age infant group was obtained from the maternal delivery records of King Chulalongkorn Memorial Hospital. Because low rate of eligible babies who could be enrolled to this study, all SGA babies were included to this study except they are exclusion criteria.

Comparison group: comparison group was chosen from the neighbors of cases to ensure that mothers of both groups had the same life-style, which was considered to influence the birth weight. The process of selecting controls was

as follows: After SGA cases were selected in King Chulalongkorn Memorial Hospital and the address of cases were recorded, then comparison groups who admitted close to cases were chosen from list of normal birth weight babies delivered in the same period of time.

Inclusion criteria

1.Single pregnancy

2.Term pregnancy (gestational age ≥ 37 weeks)

3.Last menstrual period is certain or ultrasound confirm

Exclusion criteria

1.Multiple pregnancy

2.Systemic diseases such as heart disease, diabetes mellitus, renal disorders.

3.Congenital abnormalities

4.Fetal death

Sample Size

Sample size calculation was based on the following information: The pregnant mothers and their babies who delivered singleton birth and all newborn delivered in King Chulalongkorn Memorial Hospital. November 1st 2003 to March 31st 2004 in maternal weight gain normal group from 67 persons have SGA 6 persons and in maternal weight gain abnormal group from 33 persons have SGA 7 persons. The sample size was calculated using Lemeshow is formula (40).

Sample size was determined by using the following formula:

$$n = \frac{\left\{ Z_{\alpha/2}\sqrt{2P(1-P)} + Z_{\beta}\sqrt{P_1(1-P_1) + P_0(1-P_0)} \right\}^2}{(P_1 - P_0)^2}$$

n : number of cases to be taken

$\mathbf{Z_{\alpha/2}}$: standard normal deviate in two tailed test with $\alpha = 0.05$ (1.96)

$\mathbf{Z_{\beta}}$: standard normal deviate when power of the test is equal to 95% or $\beta = 0.05$ ($\mathbf{Z_{\beta}}$ =1.64)

$\mathbf{P_1}$: Anticipated probability of exposure with low maternal weight gain patient Who have born SGA = 0.53

$\mathbf{P_0}$: Anticipated probability of exposure with normal maternal weight gain Patients who have born SGA = 0.29

$$P = : \frac{0.53+0.29}{2} = 0.41$$

n =106

The adequate sample size is 106 for each group. The researcher will add sample size of 10% in both case and control, therefore total number of sample size is 240.

Instrument

The data was collected from antenatal care record cards, maternal record, cards, newborn card and interview questionnaire which created by the researcher. It is divided into 2 sections: Information from interview and record:

Section 1 Mother information: age, weight, height, education, occupation, status, family income, past history, complication of 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.

Data Collection

This study used secondary data from the hospital admission records of mother and child institute in King Chulalongorn Memorial hospital. Relevant information on maternal socio-economic, biological, and medical factors available on records of hospital were extracted and copied into data recording form. The study sample were all eligible mothers admitted into the institute during April 1st to August 31st 2004.

Ethical Consideration

1. All patients had an explanation about objective, method, significance of this study from the researcher until they understood and willing to participate in this study. All willing patients signed up the consent form**.**

2. This study was approved by 2 ethical committee, first ethical committee of Mahidol University and second Researchers Involving Human Subjects Committee, at Faculty of Medicine, Chulalongkorn University.

Data Analysis

1.Descriptive statistics such as frequency, percent, mean and standard deviation were used to describe the studies subjects

2.Analytic statistics:

Difference 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 was used to define each associated factor with small for gestational age infants by calculating the odds ratio (OR) and 95% confidence interval of OR.

Multivariate analysis was used to define associated factors with small for gestational age infants after adjusted of confounding factors, by applied multiple logistic regression. In case two variables were very similar and had multicolinearity, only one was included in modeling.

CHAPTER 4
RESULTS

General Characteristics of the Samples

The comparisons of general characteristics between patients with small for gestational age infant (120 cases) and without small for gestational age infant (120 controls) in King Chulalongkorn memorial Hospital could be described in each factor as follows.

General Characteristics of the Babies

Distribution of gender between case group and control group was not different, the ratio between male and female was 1:1 in case group and 1:1 in control group.

The average weight of case group in the study was 2,377 gms and average gestational age 37.96 wks as compared to 3,158 gms and average gestational age 38.99 wks in control group.

Maternal Characteristics

Socio-demographic characteristics

Age

Since the cases and controls were categorical matched by children sex, their percentage distributions were the same pattern. Majority of the subjects in both groups had age group between 20-35 years (69.2 % of the cases and 80% of the controls). Age group less than 35 years was the smallest group with 8.3% of cases and 5.8% of controls. Age of all patients showed no significant difference ($p = 0.157$), average age (Mean $\pm$ SD) of cases and controls were 25.78 ± 5.88 and 26.09 ± 5.27 respectively (Table 3).

Marital status

Majority of both cases and controls were married 98.3% and 99.2% respectively. Among case and control number of persons who were categorized as either widowed or divorced or separated were 1.7% of the cases and 0.8 % of the controls. There was no significant difference between cases and controls (p = 0.569) (Table 3).

Mother education

No significant difference in educational level between cases and controls was found (p = 0.469). Majority of cases and controls were moderate and high education (63.3% and 59.2% respectively). Their education (no and low education) in both cases and control were the small group with 36.7% of cases and 40.8% of controls (Table 3).

Father education

No significant difference in educational level between cases and controls was found (p = 0.684). Majority of cases and controls were moderate and high education (58.4% and 63.3% respectively). Their education (no and low education) in both cases and control were the small group with 41.7% of cases and 36.7% of controls (Table 3).

Mother occupation

Most of the samples in both cases and control groups were employee with 52.3% and 56.7 % respectively. Government office showed the lowest percentage in both cases (1.7%) and controls (1.7%). There was no significant difference between cases and controls (p = 0.237) (Table 3).

Father occupation

Most of the samples in both cases and control were employee with 92.5% and 87.5 % respectively. Government officers showed the lowest percentage in both cases (0.8 %) and controls (5%). There was no significant difference between cases and controls (p = 0.156) (Table 3).

Family income

Family income of cases and controls were not significantly different (p = 0.078). A big group of study subjects had income 5,000-10,000 baht per month among case and control with 49.2% and 53.3% respectively. The smallest groups of family income was lower than 5,000 baht per month among cases and controls with 8.3% and 15.8% respectively (Table 3).

Table 3 The general charecteristics betweeen case and control group

Charecteristic	case		control		p-value[a]
	n	%	n	%	
Age (yrs)					0.157
< 20	27	22.50	17	14.20	
20-35	83	69.20	96	80.00	
>35	10	8.30	7	5.80	
Mean(SD) .	25.78(5.88)		26.09(5.27)		
Marital status					0.569
Married	118	98.30	119	99.20	
Windowed/Divorced	2	1.70	1	0.80	
Mother education					0.469
No and Low	44	36.70	49	40.80	
Moderate and High	76	63.30	71	59.20	
Father education					0.684
No and Low	50	41.60	44	36.70	
Moderate and High	70	58.40	76	63.30	
Mother occupation					0.237
Housewife	48	40.20	36	30.00	
Employee	63	52.30	68	56.60	
Merchant	7	5.80	14	11.70	
Government Officer	2	1.70	2	1.70	
Father occupation					0.156
Employee	111	92.60	105	87.50	
Merchant	4	3.30	7	5.80	
Government Officer	1	0.80	6	5.00	
No occupation	4	3.30	2	1.70	
Family income (bath/month)					0.078
< 5,000	10	8.30	19	15.80	
5,000-10,000	59	49.20	64	53.30	
>10,000	51	42.50	37	30.80	

[a] Pearson's chi-square test

Behavioral factors

Smoking cigarette, caffeine consumption and alcohol consumption

Smoking cigarette, caffeine consumption and alcohol consumption had no significant difference between cases and controls (p = 0.370, 0.112 and 0.121 respectively) (Table 4).

Table 4 Comparison of behavior factors during pregnancy between case and control

Behavior factors	case		control		p-value
	n	%	n	%	
Cigarette smoking					0.370[b]
Never	116	96.70	119	99.20	
Ever	4	3.30	1	0.80	
Caffeine consumption					0.112[a]
Never	90	75.00	100	83.30	
Ever	30	25.00	20	16.70	
Alcohol consumption					0.121[a]
Never	109	92.20	115	96.00	
Ever	11	8.80	5	4.00	

[a] Pearson's chi-square test

[b] Fisher's exact test

The Association and Effects of Various Factors and Small for Gestational Age Infants

Table 5 and 6 showed the univariate analysis among potential risk factors and small gestational age infants. The detail were as follows:

Third trimester weight gain

The patients with third trimester weight gain less than 5,450 gms was 1.96 times to develop small for gestational age infant compared to those with a third trimester weight gain more than 5,450 gms.(OR=1.96, 95%CI 1.17-3.27).

Pre weight

The patients with pre weight gain less than 44 kgs was 2.58 times to develop small for gestational age infant compared to those with weight gain 44-55 kgs. (OR = 2.58, 95%CI 1.35 - 4.94).

Total weight

The patients with total weight gain less than 10 kgs was 1.98 times more likely to develop small for gestational age infant compared to those with total weight gain 10-16 kgs. (OR = 1.98, 95%CI 1.06 - 3.68).

Height

The patients with height less than 150 cms was 2.27 times more likely to develop small for gestational age infant compared to those with height more than 150 kgs.(OR = 2.27, 95%CI 1.21- 4.26).

History of Low birth weight

The patients with history of low birth weight was 4.46 times more like to develop small for gestational age infant compared to those history of LBW.
(OR = 4.46, 95%CI 1.44 - 13.77).

Table 5 Comparison of illness factors between case and control

Illness factors	case		control		p-value
	n	%	n	%	
Children					0.154[a]
<2	103	85.80	100	83.30	
≥2	17	14.20	20	16.70	
Parity					0.360[a]
<2	95	79.20	89	74.20	
≥2	25	20.80	31	25.80	
History of abortion					1.000[b]
<2	119	99.20	119	99.20	
≥2	1	0.80	1	0.80	
History of fetal death					0.653[b]
No	117	97.50	118	98.30	
Yes	3	2.50	2	1.70	
History of low birth weight					0.003[b*]
No	104	86.70	116	96.70	
Yes	16	13.30	4	3.30	
History of preterm					0.614[b]
No	114	95.00	118	98.30	
Yes	6	5.00	2	1.70	
Birth interval (month)					0.367[a]
<24	73	60.80	65	54.20	
24-48	17	14.20	15	12.50	
>48	30	25.00	40	33.30	
Past history					0.624[a]
No	110	91.70	112	93.30	
Yes	10	8.30	8	6.70	
Complication					0.194[a]
No	109	90.80	115	95.80	
Yes	11	9.20	5	4.20	

* Statistical significance at p-value < 0.05

[a] Pearson's chi-square test

[b] Fisher's exact test

Table 6 The association between maternal risk factors and SGA

Variable	Case number	%	Control number	%	OR	95% CI	p-value[a]
Weight gain 1st trimester(gms)							
<2,000	73	52.50	66	47.50	1.27	0.76-2.12	0.360
≥2,000	47	47.50	54	53.50	1		
Weight gain 2nd trimester (gms)							
<4,100	66	53.70	57	46.30	1.35	0.81-2.24	0.246
≥4,100	54	46.30	63	53.70	1		
Weight gain 3rd trimester (gms)							
<5,450	70	58.30	50	41.70	1.96	1.17-3.27	0.010*
≥5,450	50	41.70	70	58.30	1		
Pre weight (kgs)							
<44	45	37.50	19	15.80	2.58	1.35-4.94	0.004*
44-55	55	45.80	60	50.00	1		
>55	20	16.70	41	34.20	0.53	0.27-1.01	0.056
Last weight (kgs)							
<55	25	20.80	32	26.70	0.71	0.38-1.35	0.307
55-69	62	52.70	57	47.50	1		
>69	33	27.50	31	25.80	0.97	0.53-1.79	0.945
Total weight (kgs)							
<10	45	37.50	24	20.00	1.98	1.06-3.68	0.031*
10-16	53	44.20	56	46.70	1		
>16	22	18.30	40	33.30	0.58	0.30-1.10	0.097
Height (cms)							
<150	36	30.00	19	15.80	2.27	1.21-4.26	0.010*
≥150	84	70.00	101	84.20	1		
History of Low birth weight							
Yes	104	86.70	116	96.70	4.46	1.44-13.77	0.009*
No	16	13.30	4	3.30	1		

*Statistical significance at p-value< 0.05
[a]Pearson's chi-square test

The Effect of Various Factors and Small for Gestational Age Infants by Multivariate Analysis

After performing the crude analysis, the factors considered to be significantly associated with small for gestational age infants were third trimester weight gain, pre 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 weight gain, maternal last weight gain, maternal total weight gain, height and history of low birth weight. Where very similar six variable 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 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 weight, maternal total weight gain, height and history of low birth weight significantly were associated with small for gestational age infant shown as follows (Table 7):

Maternal weight gain during the third trimester

For maternal weight gain during the third trimester, univariated analysis showed increase risk of small for gestational age infants (OR = 1.96, 95%CI 1.17 - 3.28). After adjustment for other potential risk factors, there was a significant decreased association between maternal weight gain during the third trimester and small for gestational age infants. Those with maternal weight gain during the third trimester had (OR = 1.89, 95%CI 1.11 - 3.19). The risk of small for gestational age infants of compare with who had more than 5,450 gms, with p = 0.019.

Maternal pre weight

For maternal pre weight gain, univariated analysis showed that maternal pre weight gain level <44 kgs increase risk of small for gestational age infants (OR = 2.58, 95%CI 1.35 - 4.94). After adjustment for other potential risk factors, there

was a significant decreased association between maternal pre weight gain and small for gestational age infants. Those with maternal pre weight gain <44 kgs had (OR = 2.32, 95%CI 1.18 - 4.54). The risk of small for gestational age infants of compare with who had more than 44 - 55 kgs, with p = 0.014.

Maternal total weight gain

For maternal total weight gain, univariated analysis showed that maternal total weight gain level less than 10 kgs increase risk of small for gestational age infants (OR = 1.98, 95%CI 1.06 - 3.68). After adjustment for other potential risk factors, there was a significant increased association between maternal pre weight gain and small for gestational age infants. Those with maternal total weight gain less than 10 kgs had higher risk of small for gestational age infants compare with who had more than 12-16 kgs (OR = 2.16, 95%CI 1.13 - 4.12), with p = 0.019.

Height

The risk of small for gestational age infants was significant greater in the patient with height (<150 cms) than those height (≥150cms) (OR = 2.27, 95%CI 1.21 - 4.26). After control by logistic regression for other potential factors, those with height (<150 cms) still had an decreased risk of small for gestational age infants (OR = 2.14, 95%CI 1.12 - 4.07).

History of low birth weight

The risk of small for gestational age infants was significant greater in the patients with history of low birth weight than those without LBW (OR = 4.46, 95%CI 1.44 - 13.77). After control by logistic regression for other potential factors, those with history of LBW still had an decreased risk of small for gestational age infants (OR= 4.38, 95%CI 1.39 - 13.82).

Table 7 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 1st trimester (gms)[a]					
<2,000	1.27	0.76-2.124	1.34	0.79-2.29	0.274
≥2,000	1		1		
Weight gain 2nd trimester (gms)[a]					
<4,100	1.35	0.81-2.24	1.31	0.79-2.22	0.308
≥4,100	1		1		
Weight gain 3rd trimester (gms)[a]					
<5,450	1.96	1.17-3.28	1.89	1.11-3.19	0.019*
≥5,450	1		1		
Pre weight (kgs)[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 (kgs)[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 (kgs)[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 (cms)[b]					
<150	2.27	1.21-4.26	2.14	1.12-4.07	0.020*
≥150	1		1		
History of low birth weight[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

CHAPTER 5

DISCUSSION

A case-control study explored the association between risk factors of maternal weight gain and small for gestational age infants.

The controls were matched by children gender as cases, thus the confounding for to effect are correspondingly eliminated or minimized. The hospital controls were used because there are a number of important practical and scientific advantages. The first is that they are easily identified and readily available in sufficient numbers, thus minimized the costs and effort which involved in their assembly. Second, because they are more likely to be aware of antecedent exposures or events than healthy individuals. In this respect their comparability to cases with accuracy report will reduce the potential of recall bias. Finally, hospital controls, as cases, are more likely to cooperate than healthy individuals, thus minimized bias due to non-response (41).

In this study, the two groups of small for gestational age infants were selected from Navamintharachinee 5th floor, King Chulalongkorn Memorial Hospital, which they had been diagnosed and treated by the same standard method and instrument, this can minimized selection bias.

Small for gestational age infants diagnosed were selected, since they were born, the expects that recent diagnosis will be more uniform than those drawn from different time periods.

One of the most important method 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 (41).

The limitation of this study is that the source of data was from the routine hospital records, due to which only limited number of variables were included in the study. Therefore routine recording system in King Chulalongkorn Memorial hospital should be improved enormously in order to get a valid database for epidemiological

investigation. The result of this study, which reflects situation for cases in the hospital, has to be generalized very carefully to general populations. So more studies should be conducted in various hospitals, health centers, and home deliveries.

Owing to the fact that some factors affecting birth weight are multifactorial and interrelated. Whenever possible, the effects of confounding factors should be controlled.

Disscussion on Study Results

Maternal weight gain of first trimester

Maternal weight gain of first trimester is not clearly as a risk factors in the development of small for gestational age infants in this study.

Association between maternal weight gain of first trimester and small for gestational age infants was not significant. Maternal weigth gain of first trimester less than 2,000 gms was 1.27 more likely to develop small for gestational age infants (OR = 1.27, 95%CI 0.76 - 2.12) (Table 7) compared to those with a maternal weight gain of first trimester more than 2,000 gms. After simutaneously adjust for multiple variables by multiple logistic regression analysis, it was not significant (OR = 1.34, 95%CI 0.79 - 2.29) (Table 7).This finding coincide with previous study (4). However, some studies found no relationship between the maternal weight gain of first trimester and the small for gestational age infants (4). Some studies found the relationship between the maternal weigth gain of first trimester and the small for gestational age infants (35).

Maternal weight gain of second trimester

Association between maternal weight gain of second trimester and small for gestational age infants had no significance. Maternal weight gain of second trimester less than 4,100 gms was 1.35 more likely to develop small for gestational age infants (OR = 1.35, 95%CI 0.81 - 2.24) (Table 7) compared with more than 4,100 gms. After simutaneously adjust for multiple variables by multiple logistic regression analysis, it was not significant (OR = 1.31, 95%CI 0.79 - 2.22) (Table 7). This finding coincide with previous study (4, 36).

Maternal weight gain of third trimester

Relationship between maternal weight gain of third trimester and small for gestational age infants was statistically significant. Maternal weight gain of third trimester less than 5,450 gms were 1.96 likely to develop small for gestational age infants (OR = 1.96, 95%CI 1.17 - 3.28) (Table 7) compared with more than 5,450 gms. After simutaneously adjust for multiple variables by multiple logistic regression analysis, it was significant (OR = 1.89, 95%CI 1.11 - 3.19) (Table 7). This finding agree with previous study (4, 36).

Maternal pre weight

This present study showed that maternal pre weight gain < 44 kgs was associated with small for gestational age(OR = 2.58, 95%CI 1.35 - 4.94) (Table 7) but after adjusting for the effect of other variables, the relation between maternal pre weight gain and small for gestational age infants was also found significant maternal pre weight between < 44 kgs. (OR 2.32, 95%CI 1.18 - 4.54) (Table 7). The relation between maternal pre weigth and small for gestational age infants has been found in other study (33).

Maternal last weight gain

In this study, maternal last weight gain < 55 kgs, ≥ 62 kgs was not associated with small for gestational age (OR = 0.71, 95%CI 0.38 -1.35, OR = 0.97, 95%CI 0.53 -1.79, respectively) (Table 7) but after adjusting for the effect of other variables, the relation between maternal last weight gain and small for gestational age infants was also found significant in subjects who had maternal pre weight gain of < 55 kgs, ≥ 62 kgs (OR = 0.67, 95%CI 0.34 - 1.29, OR = 1.01, 95%CI 0.54 - 1.88, respectively) (Table 7). The association between maternal pre weight gain and small for gestational age infants has been found in several studies (33-34).

Maternal total weight gain

Maternal total weight gain was found significant in subjects who had maternal total weigth gain < 10 kgs increase risk of maternal weight gain (OR = 1.98, 95%CI

1.06 - 3.68) (Table 7). After adjusting for the effect of other variables, the relation between maternal total weigth gain and small for gestational age infants was also found significant in subjects who had maternal total weight gain < 12 kgs (OR 2.16, 95%CI 1.13 - 4.12) (Table 7).The relationship between maternal total weight gain and small for gestational age infants has been found in several stidies (33-34).

Height

Mothers who had height less than 150 cms were commonly identified as risk factors for low birth weight when compared with height more than 150 cms.This result agree with the study of Singh et al. (42)

History of low birth weight

This study showed the association between previous LBW ($p = 0.009$). previous LBW had OR = 4.46, (95%CI 1.44 - 13.77) times higher risk to delivery SGA baby than those who never had, this result is similar as Kaltreider et al. (43) Previous LBW is one criteria to identification of high risk pregnancy. It might be due to the foetal environment, the state of the uterus in utero, the endocrinal and biological changes occurring during those pregnant women. Early and efficient diagnosis of high risk complications of pregnancy could be reduced LBW by increasing the availability of family planning services and providing accurate information to women, health care workers and the community.

Antenatal care

Many studies have found that inadequate antenatal care was significantly associated with LBW and SGA baby (8-9,12). This study was not found a statistical significant association between mothers who attended ANC less than or equal 4 times and the occurrence of a LBWand SGA baby. ($p = 1.000$). Because most study subject had ANC $\geq$ 4 time has a beneficial effect on birth weight by timely diagnosis and treatment of pregnancy complication. So importance of ANC visit more than 4 time must be emphasized to protective LBW and SGA.

Birth interval

A statistical association between short birth interval pregnancies and LBW delivery has been established in previous studies (12, 22-23). A short birth interval since previous birth might lead to poor pregnancy outcome, nutritional depletion inadequate physiological recovery and breast-feeding. The interval of birth was no statistically significant (p = 2.017), contradict to Phimphachanh (22). Adequate birth interval of < 24 months is the majority group (60.8% in SGA, 54.2%in NBW).This could be the reason for no association between birth interval and SGA.

Complication of pregnancy

Many studies found that complication of pregnancy was significantly associated with LBW and SGA babies (12, 18, 21). The risk of a LBW babies among mothers who had a complication during pregnancy was not significant (p = 0.194). This result contradict by Chumnijirakij T study (12). Because complication mothers who are the smallest group (9.2% in SGA, 4.2% in NBW) which could be the reason for no association.The important of early ANC lead to timely diagnosis and properly treatment, which may reduce SGA.

Age

Age of mother was no statistically significant (p = 0.157), difference to the study of Suthuvoravat et al that the risk between maternal and LBW at Ramathibodi Hospital, Thailand, was significantly higher among teenage < 20 years old (44). Although age, particularly very young age may exert indirect effect by influencing physical growth (weight, height). Because of physical and anatomical growth during this age is still not completed growth; nutrition and personal behavior. Older women may not at an increased risk of their age alone but age > 35 years may augment the impact of other risk factors like parity, birth interval, and nutrition.

Socio-economic factors

There was no association between maternal occupation and SGA .This result was contradicted to Chumnijirakij T study (45), in which she has found higher risk of

giving low birth weight babies among labour/farmer than housewives.However,in Prasad L in Napal study (46) found higher risk of giving low birth among housewife than non housewife. This might be due to in work overload and work over time per day in their own work after government or non government working time.

Education of mother

Some studies mentioned that the level of education had directly or indirectly effected on the babies birthweight (44,46). There was no association between level of education and SGA (p = 0.684). Because mothers who had a moderate and high education were majority group (58.3% in SGA, 63.3%in NBW). This could be the reason for no association. But education might be due to the cultural believe during pregnancy, mothers is not eat so much in order to get a small baby which lead to ease in delivery. This may lead to intrauterine growth retardation which is caused by nutritional depletion. In addition, illiteracy and low education lead the women to non compliance in medical treatment and self care.

Marital status

There are no association between marital status and SGA (p = 0.569). Because married mothers were majority group (98.3% in SGA, 99.2% in NBW), this could be the reason for no association.

CHAPTER 6
CONCLUSION & RECOMMENDATIONS

A hospital based case control study was conducted from the period of April 1st to August 31st 2004 at Navamintharachinee 5th floor, King Chulalongkorn Memorial Hospital, Bangkok. There were 2 major purposes. First, to define factors associated with small for gestational age infants. Second, this study was conducted to determine the relation among maternal weight gain and other factors which was associated with small for gestational age infants.

One hundred and twenty patients with SGA were a case group and 120 patients without small gestational age infants were a control group. The case was selected by a newly diagnostic of small gestational age infants. Controls were matched 1:1 by children sex group. Majority of subjects were married and middle age (20-35 years). Most of them graduated from primary school with no occupation and have family income 5,000-10,000 bath. All subjects were reviewed and their medical record were reviewed by the researcher. The variables included in the study were age, marital status, education, occupation, income cigarette smoking, caffeine consumption, alcohol consumption, past history of pregnancy, antenatal care, height, first trimester weight gain, second trimester weight gain, third trimester weight gain, pre weight, last weight, total weight gain.

In univariate analysis, the factors found to be significantly associated with, small for gestational age infants were Maternal weight gain during the third trimester, pre weight, total weight gain, height and history of low birth weight.

After adjusting for the possible confounder, five factors were significantly associated with small for gestational age infants. Maternal weight gain during the third trimester were associated with small for gestational age infants (OR = 1.89, 95% CI 1.11-3.19), Pre weight gain < 44 kgs were associated with small for gestational age infants (OR = 2.32, 95% CI 1.18 - 4.54), total weight gain < 10 kgs was found to be significant compare with total weight gain 12-16 kgs (OR = 2.16, 95% CI 1.13 – 4.12).

Maternal height were associated with small for gestational age infants (OR = 2.14, 95% CI 1.12 - 4.07) Maternal have history of low birth weight were associated with small for gestational age infants (OR = 4.38, 95% CI 1.39 -13.82).

Based on the finding of this study, 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 were suggested with the hope that they would contribute to a reduction in small for gestational age infants by King Chulalongkorn Memorial Hospital activities (family planning program) with improving health education, and providing more health services. Despite some limitation in this study, the researcher still feel that the results obtained are useful for understanding risk factors associated with the occurrence small for gestational age infants babies which is one of the health problems of King Chulalongkorn Memorial Hospital in Thailand.

Recommendation for the Results Application

1. The limitation of this study is that the source of data was the routine hospital record, due to which only limited number of variables were included in the study. Moreover, because of inadequate filling in certain spaces in hospital records, the number of completed record for the analysis was very small. Therefore routine recording system in King Chulalongkorn Memorial Hospital should be improved enormously in order to get a valid database for the epidemiological investigation. The result of this study, which reflects situation for population in the hospital, has to be generalized very carefully to other populations.
2. This study is that the source of data about maternal weight gain was from the pregnant women, due to which only limited remember of weight gain were included in the study. Moreover, because of the maternal of developing countries who attended ANC to be lated so data from maternal pre weight gain, weight gain during the first or second trimester was lost or not certain.
3. The result from this study suggest the base line data and factors of maternal pre weight gain contributing to small for gestational age infants. Family planing for prepregnant women is and established factor to improve pregnancy outcome because these women should be made health conscious through health education

about prepregnant mothers and appropriate nutrition due to weight gain in normal stretch before pregnant.

4. The reduce the incidence of small for gestational age infants this result can be utilized in program of prevention and control, particularly in more serious management of maternal weight gain.
5. Patients with small for gestational age infants should be treat promptly and has special monitoring to reduce severe small for gestational age infants.

Recommendations for the Further Study

1. The relationship between small for gestational age infants and risk factors need to be investigated in a cohort study.
2. The results in this study represent only small for gestational age infants at King Chulalongkorn Memorial hospital. The result should be confirmed with the data of small for gestational age infant in the other hospitals in different areas of the country.
3. Some factors such as cigarette smoking, caffeine and alcohol consumption were not found associated with small for gestational age infants in this study but it is strongly recommended that in further study.

REFERENCES

1. Chiswick ML. Commentary on current WHO definitions used in perinatal statistics. British Journal of Obstetrics and Gynaecology 1979; p 887-93.
2. Mccormick, M.C. The contribution of low birthweight to infant mortality and chilhood morbidity. New England Journal of Medicine 1985; p 82-90.
3. ทัสสนี นุชประยูร, ปัญญา กีรติหัตถยากร, ส่าหรี จิตตินันท์, เติมศรี ชำนิจารกิจ, สมรัตน์ ชาญฤทธิ์ และเกษม ทรงจิตร์รัตน์. ปัจจัยเสี่ยงของมารดาที่ให้กำเนิดทารกน้ำหนักตัวน้อย. จุฬาลงกรณ์เวชสาร 2530; 31(10) :174- 83.
4. Richard S. Strauss and William H. Dietz. Low maternal Weight gain in the Second or Third Trimester Increases the Risk for intrauterine Growth Retardation . Joumal of nutrition 1999; 129: 988 -95.
5. ธีรา ตัณฑวานิช. การดูแลระหว่างตั้งครรภ์ ใน สุขิต เผ่าสวัสดิ์, ศุภวัฒน์ ชุติวงศ์, ดำรง เหรียญประยูร และ สุทัศน์ กลกิจโกวินท์ (บรรณาธิการ), สูติศาสตร์ ภาควิชาสูติศาสตร์-นรีเวชวิทยา คณะแพทยศาสตร์จุฬาลงกรณ์มหาวิทยาลัย, 2531.
6. Subcommittee on Nutritional Status and Weight Gain During Pregnancy and Subcommittee on Dietary Intake and Nutrient Supplements During Pregnancy: Nutrition During Pregnancy, Part I and II Washington, DC. National Academy Press 1990.
7. Keppel KG, Taffel SM. Pregnancy-related weight gain and retention: Implications of the 1990 Institute of Medicine guidelines. American Journal of Public Health.1993; 83:1100-3.
8. Lederman SA. The effect of pregnancy weight gain on later obesity. Obstetrics and gynecology 1993; 82:148-55.

9. King JC, butte NF, Bronstein MN, Kopp LE, Lindquist SA. Energy metabolism during pregnancy: Influence of maternal energy status. American Journal Of clinical Nutrition 59 (suppl) 1994; 4395-9.

10. Casanueva E, Legarreta D, Diaz-Barriga M, Soberanis Y, Cardenas T, Iturriaga A, Lartigue T, Vives J. Weight gain during pregnancy in adolescents: Evaluation of a non-nutritionl intervention. Revista de Investigation Clinical 1994; 46:157-61.

11. Stevens-Simon C, Nakashima II, Andrews D.Weight gain attitudes among pregnant adolescents. Journal of Adolescent Health 1993; 14: 369-72.

12. Olson C. Preliminary data presented at the Maternal Weight Gain Meeting, McLean, Virginia 1996; May.

13. Cogs well ME, Serdula MK, Hungerford DW, Yip R. Gestational weight gain among average-weight and over weight women: What is excessive. American Journal of Obstetrics and Gynecology 1995; 172: 705-12.

14. Parker JD, Abrams B. Differences in postpartum weight retention between black and white mothers. Obstetrics and Gynecology 1993; 81: 768-74.

15. Siega Riz AM, Adair Ls, Hobel CJ. Maternal underweight status and inadequate rate of weight gain during the third trimester of pregnancy increases the risk of preterm delivery. Journal of Nutrition 1996; 126: 146-53.

16. Abrams B, Newman V. Small-for-gestational-age birth: Maternal predictors and comparison with risk factors of spontaneous preterm delivery in the same cohort. American Journal of Obstetrics and Gynecology 1991; 164: 785-90.

17. Virji SK, cottington E. Risk factors associated with preterm deliveries among racial groups in a national sample of married mothers. American Journal of Perinatology 1991; 8: 347-53.

18. Kramer MS. Effects of energy and protein intakes on pregnancy outcome: An overview of the research evidence from controlled clinical trials. American Journal of clinical Nutrition 1993; 58: 627-35.

19. Taffel SM, Keppel KG, Jones GK. Medical advice on maternal weight gain and actual weight gain: Results from the 1988 National Maternal and Infant Health Survey. Annals of the New York Academy of Sciences 1993; 678: 293-305.

20. Johnston CS, Kandell LA. Prepregnancy weight and rate of maternal weight gain in adolescents and young adults. Journal of the American Dietetic Association 1992; 92: 1515-7.

21. Hickey CA, Cliver SP, McNeal SF, Hoffman HJ, Golden berg RL. Prenatal weight gain patterns and spontaneous preterm birth among nonobese black and white women. Obstetrics and Gynecology 1995; 85:909-14.

22. Barker DJP. Fetal origins of coronary heart disease. British Medical Journal 1995; 311: 171- 4.

23. Simpson JW. Lawles RW, Mitchell AC:Responsibillity of the obstetrician to the fetus,2. Influence of prepregnancy weight and pregnancy weight gain on birth weight.Obstet Gynecol 1975; 45: 481.

24. Emanuel I, Alberman HEF, Evans SJ: Intergeneretional studies of human birth weight from the 1958 birth cohort, 1. Evidence for a multi regressional effect, Br J Obstet Gynaecol 1992; 99: 67.

25. Klebanoff MA, Schulsinger C, Mwdnick BR, Secher NJ. Preterm and small for gestaional age birth across generation. AM J Obstet Gynecol 1997;176: 521.

26. Wennerholm UB. Albertsson-Wikland K, Bergh C, Hamberger L, Niklasson A, Nilsson L, Thirringer K, WennergrenM, Wikland m:Postnatal growth and health in children born after cryo preservation of embryos. Lancet 1998; 351: 1085.

27. Abrams B, Selvin S: Maternal weight gain pattern and birth weight.Obstet Gynecol 1995; 86: 163.

28. Wilcox MA.Smith SJ.Johnson IR, Maynard PV, Clivers : The effect of social deprivation on birth weight,excluding physiologicaland pathological effect, BrJ Obstet Gynaecol 1995; 102: 918.

29. Denjin Karlsson E, Hanson BS, Ostergren PO, Lindgren A,Sjobreg NO, Marsal K:Association of a lack of phychosocial resouces and the the risk of giving birth to small for gestational age infant:A stress hypothesis, BR J Obstet Gynaecol 2000; 107: 89.

30. William JW, Obstetrics: A Text-Book for Student and Practitioners, 1 st ed. New York. Appleton 1903; 133.

31. Wierenga H, Brand R, geudeke T, Van gein HP, van der Harten H, Verloove-vanhorick SP- Prenatal risk factors for cot death in very preterm and small for gestational age infants ; Early Hum DEV. 1990 June; 23 (1) : 15 –26.

32. Lawton FG, Mason GC, Kelly KA, Ramsay IN, Morcwood GA. Poor maternal weight gain between 28 and 32 weeks gestation may predict small for gestational age infants. Br J Obstet Gynaccol. 1998: 95 (9) : 884 -7.

33. Shapiro C, Sutija VG, bush j: Effect of maternal weight gain on infant birth weight . J Peringat med. 2000 : 28 (6) : 428-31.

34. Cogswell ME, Serdula MK, Hungerford DW, Yip R. Gestational weight gain among average weight and overweight women what is excessive. Am J obstet gynecol. 1995 ; 172(2) : 705 -12 .

35. Judith E brown, Maureen A Murtaugh, David R Jacobs, Jr and Heler C Margellos. Variation in newborn size according to pregnancy weight change by trimester. American Joumal of Clinical Nutrition 2002; 7(6): 205 –9.

36. Scott A, Moar V, Ounsted M. The relative contributions of different maternal factors in small – for – gestational – age pregnancies . Eur J Obstet gynecol reprod Biol 1981 sep ; 12 (3) : 157 -65.

37. Benedict A, Doctor MD[a], Mary Ann O' Riordan MS[a], H. Lester Kirchner PhD[a] , dineh Shah MD[b] and Maureen Hack MB, ChB[a]. Perinatal correlates and neonatal outcomes of small for gestational age infants born at term gestation. American Journal of obstetrics and Gynecology 2001; 185: 652 – 9.

38. Victoria K. Minior and Michael Y. Divon. fetal Growth Restriction at term: Myth or Reality. Obstetrics and gynecology 1998; 92(8): 57- 60.

39. Roland Andersson and Staffan bergstrom. Maternal nutrition and socio – economic status as determinan ot birthweight in chronically matnourished African woman . Tropical Medicine and International Health 1997; 11: 1080-7.

40. Lemshow S, Hosmer DW, Klar J, Lwanga SK.Adequacy of sample size in health studies. World Health Organization 1990.

41. Henneekens CH, Buring JE.Epidemiology in medicine.USA.Little, Brown and company 1987; 132-323.

42. Singh M et al. Determinants of birth weight in a referral hospital of North india (A Brief Report). J Obstet Gynaecol 1992; 38:89-91.

43. Kaltreider DF, Johnson JWC. Patient at high risk of low birth weight delivery. Am J Obstet Gyaecol 1976; 251-6.

44. Suthuvoravat S, Chuturactinder K. Risk factor relate with low birth weight at Ramathibodi Hospital (Bangkok). J Med. Association Thailand 1988; 2: 6-11.

45. Chumnijarakij T. Maternal risk factors for low birth weight in new borns in Thailand 1988; 34-43.

46. Prasad L. Maternal factors related to LBW in Zonal Hosspital, Birat Negar, Nepal (M.S. thesis in Public Health). Faculity of graduated Studies, Mahidol University 1995; 56-8.

47. Upreti SR. Maternal factors contributing to LBW at MCH Hospital Region 1, Bankok. .S. thesis in Public Health, Faculity of Graduated study, Mahidol University 1995; 46-50.

APPENDIX

APPENDIX A

Mahidol University

Faculty of Public Health

Department of Epidimiology

Effect of Maternal Weight Gain on Small for Gestational Age Infants

Number of interview……..….

HN…….

[ ] Case (Small gestatinal age infant)

[ ] Control (Normal birth weight)

MOTHER

1. Name of mother …….
2. Hospital registration no. ……
3. Age of mother …… years
4. High of mother……..cms
5. Mothernal weight gain

   weight before pregnancy….kgs.

   first trimester…..kgs.

   second trimester…..kgs.

   third trimester…..kgs.

   last weight ….kgs

   total weight gain……kgs

6.Occupation of mother

[ ] 1. Housewife

[ ] 2. Government officers

[ ] 3. Employee

[ ] 4. Merchant

[ ] 5. Other, specify …….

7.Occupation of father

[ ] 1. Employee

[ ] 2. Government officers

[ ] 3. Merchant

[ ] 4. Other, specify …….

8.Educational level of mother

[ ] 1. No education or Primary

[ ] 2. Secondary

[ ] 3. Higher secondary and above

9.Educational level of father

[ ] 1. No education or Primary

[ ] 2. Secondary

[ ] 3. Higher secondary and above

10.Family income……..baht/month

11.Gravida ……

12.Parity …….

13.Birth spacing……mount

14. Abortion ……

[ ] 1. No

[ ] 2. Yes

15. Low birth weight ……

[ ] 1. No

[ ] 2. Yes

16. Fetal death……

[ ] 1. No

[ ] 2. Yes

17. Preterm labour ……

[ ] 1. No

[ ] 2. Yes

18. Smoking cigarette

[ ] 1. No

[ ] 2. Yes

19. Drinking alcohol

[ ] 1. No

[ ] 2. Yes

20. Drinking cafeine

[ ] 1. No

[ ] 2. Yes

21. ANC visit

[ ] 1. No

[ ] 2. Yes

22.Total No. of visit ……

23.Complications of pregnancy

[ ] 1. No

[ ] 2. yes

24.Types of complications

[ ] 1. Hypertension

[ ] 2. Prom

[ ] 3. Others, specify …….

25.Past history of pregnancy

[ ] 1. No

[ ] 2. yes

26.Types of complications

[ ] 1. Hypertension

[ ] 2. Prom

[ ] 3. Nephritis

[ ] 4. Measle

[ ] 5. DM

[ ] 6. Heart

[ ] 7. Others, specify …….

INFANT

1.Date of delivery ……

2.Time of birth ……

3.Gestational age at birth …….weeks

4.Gender of infant

[ ] 1. Male

[ ] 2. Female

5.Birth weight …….. gms.

6.Types of delivery

[ ] 1. Normal delivery

[ ] 2. Vacuum extraction

[ ] 3. External version

[ ] 4. Breech delivery

[ ] 5. Caesarean section

[ ] 6. Others, specify ……

7.Characteristic of baby

[ ] 1. SGA

[ ] 2. AGA

APPENDIX B

INFORMATION SHEET

My name is Dao Weiangkham. I am a graduate student of Master of Science (pupblic health), Major in Infectious Disease and Epidimiology, Facculty of public Health, Mahidol University. Iam study about effect of maternal weight gain on small for gestational age infants.

I invited you to participate in the research. This study provide baseline information and guideline to smalll for gestational age infant prevention and control for health mother. Answer the question base on what you really do or felling.You can refuse to answer any question that you do not want to answer without any obligation.No identificatifying information will betaken (such as name), individual questionare results will be kept completely confidential to the researchers. Imdividual questionnaires will be distroyed and all results will br grouped together for analysis by the researcher.

If you have any question about this study or others problem, you can contact me all time.Although you refuse to participate in this study, it will not influence the availality of future medical care. Your participating in the study is entirely voluntary and you free to refuse to take part of with draw at any time with out effecting or jeopardizing your medical care.

Thank you for your participation

Miss Dao Weiangkham

Researcher

Please keep contact me at Nawamintharachinee 5th floor, King Chulalongkorn Memorial Hospital, 02-2564807-8

INFORMED CONSENT FORM

At…….

Date……..

Name……

Address……

……..

1. I were revealed about the research, Effect of Maternal Weight Gain on Small for Gestational Age Infants, by Miss Dao Weiangkham (researcher).
2. My consent to participate in voluntary and was not intimidated or deceived by the researcher.
3. I have been given explanation regarding the objectives and methodology of the study possible risk and benefit that may occur to myself upon the participation in this study.
4. I were ensured by the researcher, my identity will be kept confidential and used only for research purposes.
5. I have been given information if I am injured and effected as result of being in this study, treatment will be available. The researcher or/and sponsor will pay the cost of this care.
6. I have been given information that I am free to withdraw my consent and discontinue my participation in this study at any time. This decision on my part will not influence the availability in number 5.
7. The researcher explored the detial in this study through the benefit and possible risk that may occure to myself upon the participation in the study. The researcher agreement with the detail mentioned in number 5.

I have read, the above information. The content and meaning of this information has been explained to me. I am sign in this consent form while the witness and the researcher being here.

Signature……(Respondent/information)

Name…… ..

Signature…….(Researcher)

Name……...

Signature……..(Witness)

Name……..

Remarks

1) Incase of participants can not read, before signing consent or take finger prints, the researcher read and explained to them about the study, the details of infirmation sheet and informed consent form.

2) Parents or patient is legally authorized respressentative can sign informed consent, in case of participant have an age less than 20 years.

BIOGRAPHY

NAME	Miss Dao Weiangkham
DATE OF BIRTH	April 29, 1976
PLACE OF BIRTH	Phayao, Thailand
INSTITUTIONS ATTENED	Thai red cross college. 1996-1999 Bachelor of Nursing
POSITION & OFFICE	Nawamintharachinee 5th floor King Chulalongkorn Memorial Hospital
ADDRESS	King Chulalongkorn Memorial Hospital, Bangkok