MATERNAL RISK FACTORS FOR LOW BIRTH WEIGHT NEWBORNS IN THAILAND

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FACULTY OF MEDICINE
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BANGKOK, THAILAND.

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ACKNOWLEDGEMENTS

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INTRODUCTION

Low birth weight (LBW) is a major maternal and child health (MCH) problem in Thailand. According to the Health Division Statistics, Ministry of Public Health, Thailand. The proportion of LBW newborns in 1982[1] was 10.3% with minor variations within the five major regions of the country. This condition is known to be associated with poor child development, both physical and intellectual alike, increased perinatal and infant mortality, neurological and other disabling sequelae as well as economic loss.

As the majority of LBW newborns in Thailand are of the small-for-date type, identification of the maternal risk factors would aid in providing health education to women to minimize the chance of having LBW babies.

Recognizing the potential value of such study, the Family Health Division, Ministry of Public Health, in cooperation with the Faculty of Medicine and The Institute of Health Research, Chulalongkorn University, therefore, have worked out the present study project.

It is the policy of the Family Health Division, Ministry of Public Health, Thailand to emphasize the problem of MCH services and delivery. The government policy as expressed in the proposed Sixth five Year Development Plan (1987-1992) has set a target of having 60% of newborns weighing over 3,000 grams by the end of the period. By identifying the maternal risk factors for LBW newborns in Thailand, the present study would help provide information in the design of Health Education Programs to minimize the factors associated with this problem, and in the provision of additional guidance to the government in such areas as the need for nutritional supplement or the treatment of infections during pregnancy. The Ministry of Public Health would be receptive to receiving these data and give due consideration to mounting to appropriate programs.

PUBLIC HEALTH ORGANIZATION OF THAILAND

The Ministry of Public Health (MOPH), Thailand largest health service's provider, oversees a widespread network of hospitals and rural health centres reaching out to all 73 provinces. In principle, it has major responsibility of taking care of health problems of the whole population. The ministry, which is situated in Bangkok, is organized into six major components. The Family Health Division which is one of the technical divisions of the Department of Health, provides MCH and FP care. District and provincial hospitals are provided and each geographic region includes a comprehensive facility. These MCH regional centres are under supervision of the Family Health Division, Ministry of Public Health. At present there are 5 MCH regional centres, one in each geographical region of Thailand ; North, North-east, Central and South which provides referral MCH services for the surrounding 8 to 10 provinces. Each region is divided by natural boundaries with distinct socio-economic, cultural and demographic characteristics of people. The North is largely involves in home industry and agriculture.

The North-east shows higher percentage of unemployed than the other regions, while the South contains a largely Muslim and rubber plantation of population. Thus, each region is internally homogeneous and the population surrounding the MCH Centre can be taken as representative of the region. Each MCH regional centre provides teaching and training services for midwifery and also provides technical provision for health personnel in the provinces of its responsibility. Due to the large size of two areas, there are two sub-centres which are located in the North and the North-east provinces of the country under the supervision of the Family Health Division. In addition there is one MCH training centre in Bangkok.

A MCH regional centre is organized into 4 major components as follow :—

1. General administrative section
2. Maternal and child care hospital
3. Promotion of health section
4. College of health and midwifery

The maternal and child care hospital of each MCH regional centre has 300 maternity beds which provides a full range of services particularly for child delivery, OB-GYN and pediatric problems. The hospital also provides out-patient maternal and child care and family planning services. The full hospital staff personnel consists of a director, 20 doctors, 30 nurses, 20 nurse-midwives, 1 nurse-practitioner, 2 social workers, 3 dentists, 5 dental hygienists, 2 pharmacists, 1 assistant-pharmacist, 5 medical technicians and 10 other staffs for a total of 100 personnel. [1]

Population distribution in Thailand is still heavily rural with only 20 percent living in urban areas. However, MCH services are spread throughout the kingdom and about 50 percent of first births occur at government facilities. Many second and the occasional higher birth order may take place at home, reflecting the tastes of women in Thailand. Of those women experiencing a first birth in a government centre (about 70 percent) are from rural areas. This distribution by urban-rural background will be the same for births at the MCH regional centres. Given the low birth rate in Thailand and the high proportion of first births delivered in the government centres, we are assured of a large and generally representative sample of cases for the proposed study. About 70% of middle class and lower class pregnant women chose the MCH regional centre for delivery. These MCH regional centres delivered between 16 and 36 percent of the total live births from each province. are as follows :—

The annual number of live births from 5 MCH regional centres through-out Thailand (1982)

Centre No.	Province	Total Number of live births	Total delivery at MCH Centre (%)∇
1.	Chiangmai	24,405	5,153 (21.1)
2.	Khonkaen	36,368	5,703 (15.7)
3.	Nakornsawann	19,725	4,070 * (20.6)
4.	Ratchburi	17,541	6,220 (35.5)
5.	Yala	8,463	1,714 (20.7)

* The figure is for 1984, this centre was started in late 1983

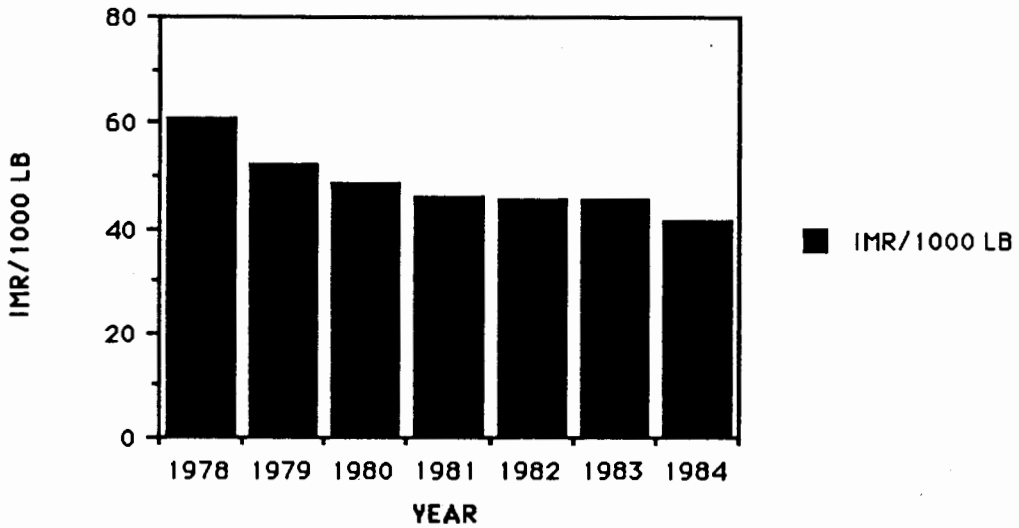
∇ The figures in parenthesis are percentage of total delivery at MCH Centre to the total number of live births

Bangkok is the capital and is located in the central region of Thailand but has the specific characteristics of a large capital city which differ in socio-economic and demographic characteristics from the rest of the central region. Thus Bangkok is included as a special study area in central region of Thailand. There are 10 general government hospitals in Bangkok and Chulalongkorn Hospital is selected as the study area. Chulalongkorn Hospital serves about 10% of pregnant women in Bangkok. Hospital statistics show that 11,849 live births occurred in 1986 at Chulalongkorn Hospital. [2]

The total population of Bangkok in 1986 was 5,468,915 and the total live births equalled 118,510 [3]

Low birth weight is well established as an antecedent of high perinatal and infant mortality. These death rates have decreased during the past 20 years but are still unacceptably high.

The infant mortality rate (per 1000 live birth) in Thailand (1978 - 1984)



STUDY OBJECTIVES

General objective

To identify the maternal risk factors for LBW in infants with an aim to reduce the infant mortality rate and improve child health status in Thailand.

Specific objectives

1. To collect data on the maternal characteristics associated with low birth weight and normal birth weight outcomes of pregnancy in the urban and the rural populations.
2. To identify and to assess the relative importance of the various maternal risk factors for the LBW newborns.
3. To make policy recommendations aiming at reducing the maternal risk factors through future public health intervention programs.

RESEARCH METHODOLOGY

BASIC STUDY DESIGN

The present project is a multicentre unmatched case-control study to provide a research method for investigating factors that may prevent LBW newborns (<2500 grams). Basically the method involves a comparison to discover factors that may differ in the two groups to explain the occurrence of LBW newborns. The underlying factors may either elevate or reduce the risk of LBW newborns. A case-control study can quantify the alteration in risk associated with each factor individually and in combination.

BASIC CONCEPT

Comparison of a group of pregnant women who deliver a single LBW newborns (cases) with another group of pregnant women who deliver a single normal birth weight newborns (controls) for past exposure to a suspected cause of the LBW. Both cases and controls were interviewed by trained interviewers with the same structured questionnaires.

AREA OF STUDY

The study covers all five regions of the country, one MCH centre in each region is chosen. In the central region, Chulalongkorn Hospital Medical School is selected. In the Southern region, the Maharaj Nakornsrithammaraj Hospital is included since the birth rate at the chosen regional MCH centre is rather low.

The reasons for selecting the participating MCH centres are as follows :-

(1) The provinces where the chosen centres are located that represents regions.

(2) Discussions with the centres' staff have revealed the feasibility of integrating the study at the National level.

(3) The areas under study are politically stable.

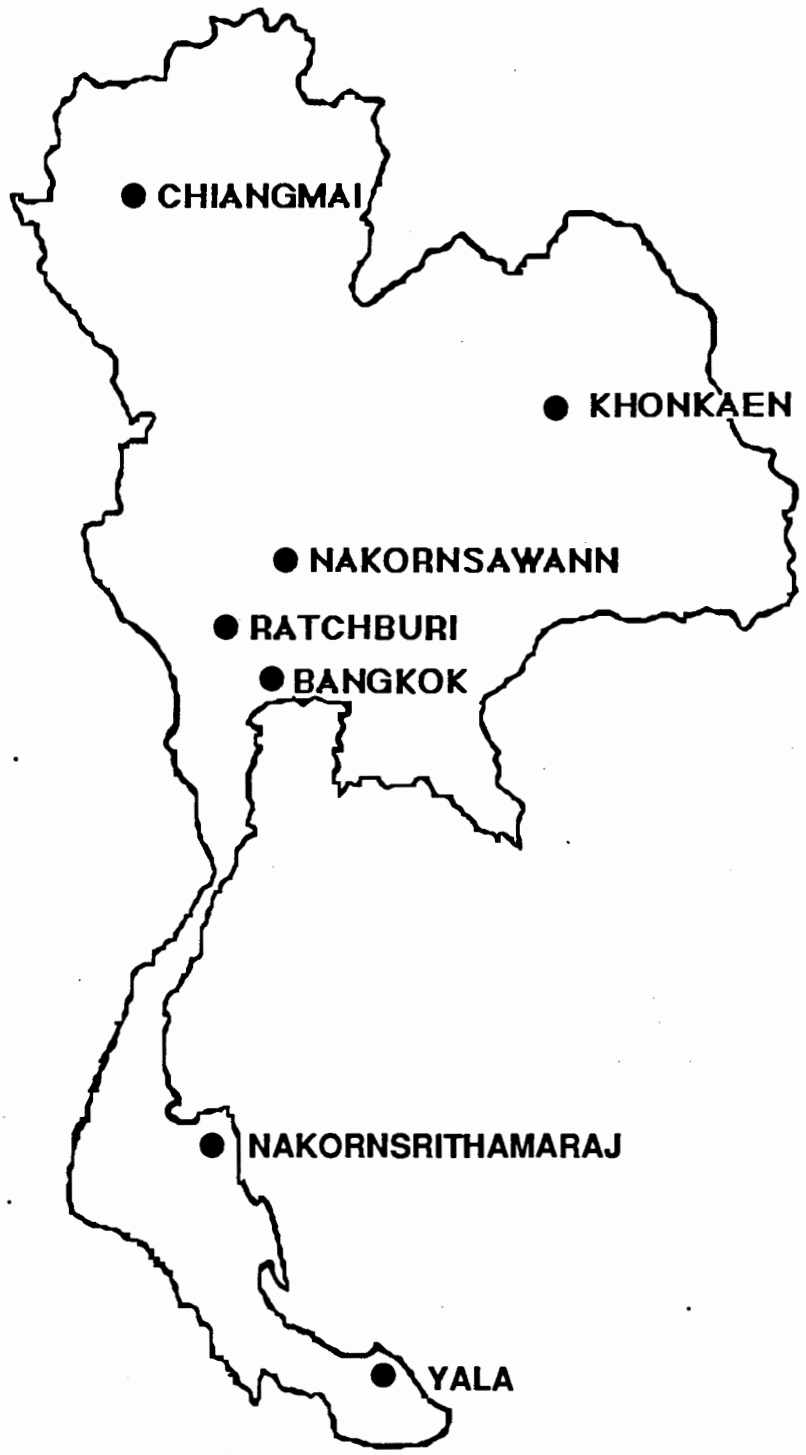
(4) With the exception of personnel training and the provision of certain facilities, the existing local resources needed to carry out the study are adequate.

(5) Full scale MCH services are available and readily accessible.

5 MCH Regional Centres of Thailand

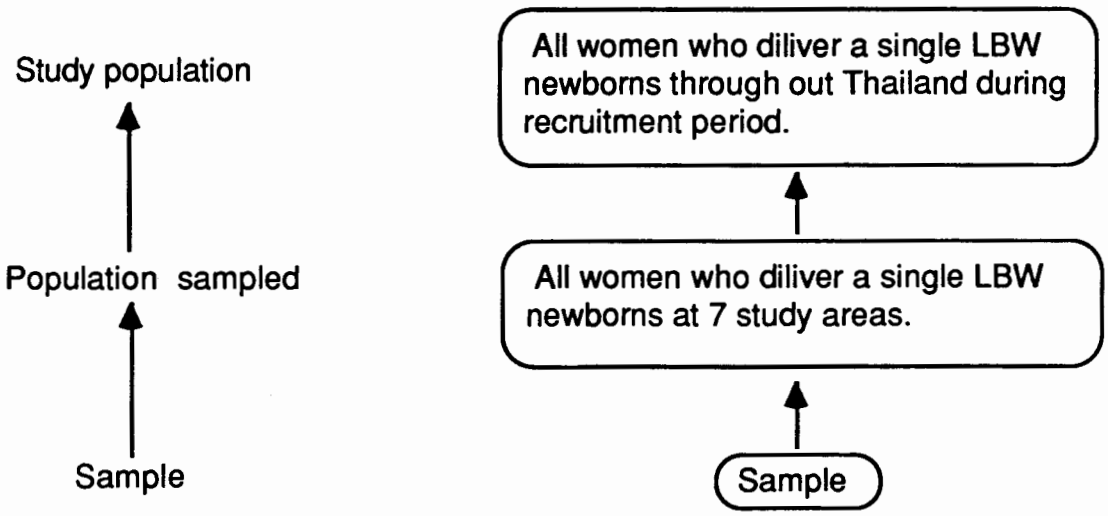
- Chiangmai MCH Centre - North
- Nakornsawann MCH Centre - North
- Khonkaen MCH Centre - North-east
- Ratchburi MCH Centre - Central
- Yala MCH Centre - South

MAP OF THAILAND SHOWING THE 7 AREAS OF STUDY



STUDY POPULATION & SAMPLE, SELECTION OF CASES AND CONTROLS

1. STUDY POPULATION AND SAMPLE



2. SELECTION OF CASES

All pregnant women who deliver a single LBW newborns (Weight < 2500 grams) during the recruitment period from each study area are recruited as cases. Eligible subjects are searched through systematic daily review of the delivery list. A total of 1,500 cases are interviewed by means of structured questionnaires.

3. SAMPLE SIZE is estimated as follows :

Sample size calculation[4]

Sample size for case-control studies

$n = 2\bar{p}\bar{q}(Z_\alpha + Z_\beta)^2 / (P_1 + P_0)^2$

P_0 = Proportion exposed among controls ($\simeq$ 0.15)

R = Relative risk corresponding to the smallest increase or decrease in risk of interest ($\simeq$ 2)

α = Level of significance = .05

$1-\beta$ = Study power, β = .10

$Z_\alpha - Z_\beta$ = Corresponding value of α and β

Calculation

$$P_1 = P_0R / (1 + P_0(R-1))$$
$$= .15 \times 2 / (1+.15(2-1)) = .26$$
$$\bar{p} = \frac{1}{2}(P_1 + P_0)$$
$$= \frac{1}{2}(.26+.15) = .21$$
$$\bar{q} = 1-.21 = .79$$
$$n = 2\bar{p}\bar{q}(Z_\alpha + Z_\beta)^2 / (P_1 + P_0)^2$$
$$= (2 \times .21 \times .79)(1.64 + 1.28)^2 / (.26-.15)^2 = 234$$

Z_α .05 = 1.64 , Z_β .10 = 1.28 (one-sided)

4. SELECTION OF CONTROLS

Controls are selected from pregnant women in the same study areas, with a comparable period of confinement at the same hospitals, who deliver a single normal weight newborn weighing 2500-4000 grams. Two controls render more efficient the stratification required in the analysis and provide an additional insurance against random error obscuring significant findings. All potentially eligible controls are systematically identified by reviewing the delivery records, the two mothers (from the same study area) before and next to the case being chosen.

5. STRUCTURE OF THE QUESTIONNAIRES

The questionnaires are structured, and 30 sets are pretested at each MCH regional centre and at Chulalongkorn Hospital for comprehensibility and flow of information. The pretested questions are reviewed and finalized before putting to use. The same questionnaires are used for both the cases and the controls. All the interviewers undergo a three-day training with the investigators at the Institute of Health Research, during which attempts are made to ensure they do understand every items in the questionnaires and the interviewing techniques as well as the approach to the interviewees. Two research assistants, who are social scientists are employed to closely supervise the interviewers.

6. LIMITATIONS IN THE STUDY

The study results are limited by certain constraint and sample selection, as well as other variables included in the analysis.

(1) Both cases and controls are from urban and rural areas in the provinces where the five regional MCH centres are located. However, as half of all first births and more of the higher order of births in the areas are delivered at home or elsewhere, the study results reflect only the patient populations at the respective MCH centres.

(2) Two risk factors with a high probability of importance cannot be studied in detail, namely maternal nutrition and infections during pregnancy. The former is certainly of great important but cannot be assessed in this study due to lack of suitable quantitative methodology. The role of infections and/or parasitic infestations during pregnancy, likewise, cannot be properly evaluated from the data obtained. It is unknown, for instance, that liver flukes are prevalent in 70 percent of the Northeastern populations, while hookworm with the resultant anaemia is widespread in the South. Both diseases, and the evaluation of their roles will require a more comprehensive study incorporating the necessary laboratory tests.

(3) The confounding effects of the data on the date of the last menstrual cycle, which is used for determining the newborn's gestational age, and on the newborn weight cannot be fully segregated in this analysis, it is not possible to determine accurately if a particular low birth weight infant is born at or short of term. Since the risk factors for the premature and the fullterm newborns may differ in several aspects, the data obtained will be less precise than desired. However, this problem is partly rectified by looking up the date of the last menstrual cycle in the patients' files whenever possible, and avoiding dependence on the mothers' memory alone.

7. DATA COLLECTION

During the immediate post-delivery hospital confinement averaging three days, all eligible cases and controls are interviewed by the trained interviewers. Using the structured questionnaires, data to be collected for descriptive analysis include age, parity, marital status,socio-economic

background, educational attainment, employment, income, urban-rural-residence, reproductive history and illnesses, medication history during pregnancy including contraceptive usage, etc. Maternal attitudes towards the pregnancy and the number of children, health information during pregnancy such as serious illnesses, weight gain, maternal habits (especially alcoholic consumption) and self prohibited food items (in connection with customs or beliefs) during pregnancy are also evaluated. Informations on the reproductive history, such as the number of pregnancies and the length of pregnancy intervals, abortion, perinatal death, foetal anomalies, perinatal illnesses (e.g. vaginal bleeding, preeclampsia and eclampsia) and prenatal care and attendance during pregnancy, are also extracted from the patients' files.

This analytical study assesses possible maternal risk factors for low birth weight newborns. The expected risk factors include maternal age under 19 and ≥ 35, grand multiparity, unwanted pregnancy, low educational attainment, high risk employment such as heavy manual labour, low income, improper food intake during pregnancy, alcohol habits, high birth order of newborn, short pregnancy interval (less than 2 years), previous abortion, previous perinatal death, prenatal risk factors (vaginal bleeding, pre-eclampsia and eclampsia, prolonged pregnancy, poor weight gain during pregnancy) and lack of prenatal care. Maternal height and weight are measured using the usual indices.

8. STATISTICAL ANALYSIS

The analysis of data consists of 2 parts :-

(1) Description of the baseline data

The information obtained at interview is coded, punched and verified at the Data Processing Unit, Institute of Health Research, Chulalongkorn University, Bangkok. Statistical analysis in the form of descriptive summarizing data is made by means of the descriptive statistical methods, including frequency distribution, proportions, rates and ratio, means and standard deviation. Inferential statistics is used to compare variables between cases and controls.

Data processing and tabulation is computerized, utilizing the computer time and other facilities at the Medical Computing Unit, Department of Preventive and Social Medicine, Faculty of Medicine, Chulalongkorn University.

(2) Maternal risk factors and factors correlated for LBW newborns.

Two methods of data analysis are used to estimate the relative important of each independent variable : The Mantel-Haenszel (M-H) procedure and Multiple logistic regression.

The M-H Procedure [5,6,7] is a chi-square based method for combining contingency tables to assess the significance of a particular variables. It provides a chi-square with one degree of freedom, expressing whether LBW appears significantly more (or less) often in cases with the factor than in cases without. The estimate of the odds ratio may differ from estimate provided by Multiple logistic regression (MLR)

Multiple logistic regression[8,9] is a linear regression which uses the logarithm of relative proportion of cases to noncases as the dependent variable. It is closely related to discriminant analysis and may be regarded as an extension of discriminant analysis to a broader class of model [10,11]. The regression coefficient for each independent variable provides an event will occur when a given factor is present to the chance it will occur when the factor is absent. For example, prenatal care with respect to birth weight less than 2500 grams can be interpreted to mean that if all other factors are the same a woman who has not received prenatal care is about five times as likely to give birth to an infant weighing less than 2500 grams as is a woman who has received some prenatal care. Similarly, an odds ratio less than 1.0 means the risk is reduced, rather than increased, if the factor is present.

If the dichotomous variable is denoted by Y, then one can assume that Y takes on the values 0 or 1, when 0 denoted the nonoccurrence of the outcome in question and 1 denotes the occurrence. If X_1,....., X_p are characteristics to be related to the occurrence of this outcome, then the logistic model specifies that conditional probability of LBW (i.e that Y = 1) given the values of X_1,....., X_p is as follows :

$$P(Y = 1 \mid X_1, \ldots\ldots, X_p) = 1/\{1 + \exp(-a - b_1X_1 - \ldots\ldots - b_pX_p)\}$$

Given the values of the characteristics $X_1, \ldots\ldots, X_p$ for members of a population and information concerning which member developed LBW estimates of the logistic coefficients can be derived an interactive maximum likelihood approach.

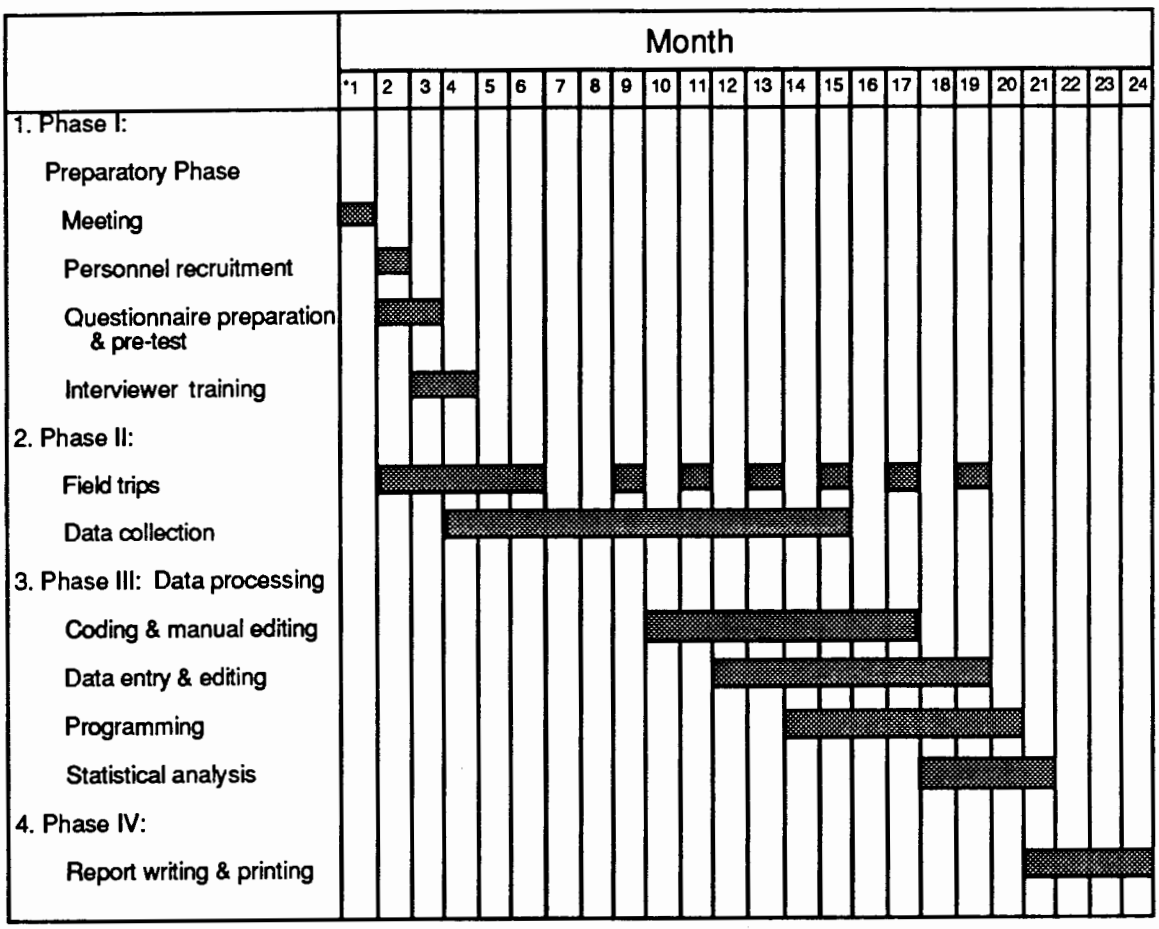
After processing is completed, consecutive screens present the results. The first screen presents the estimated logistic coefficients, their estimated standard errors, and some statistical tests. The statistics shown in the column headed "Z" are the Wald statistics. They are derived by dividing the estimated coefficients by their standard errors. These statistics test whether the particular coefficients is zero and hence whether there is a significant association between the characteristic and the outcome. These statistics are to be compared to a standard normal statistic since they are a symmetrically distributed as a standard normal random variable when the Null hypothesis (That the coefficients is zero) is true.

This first screen also presents a likelihood ratio statistic to test whether all of the coefficients considered jointly are zero. This statistic is distributed as a chi-square independent variables in the logistic model. There are two uses for this statistic : (1) to ascertain whether the value is judged significant, indicating that at least one of the coefficients is not zero ; (2) to judge whether a single independent variable adds significantly to the logistic model containing all of the independent variables other than the one of interest. In this procedure, the likelihood ratio statistic may be used to judge stepwise inclusion or deletion for a particular multivariate model. (Table 31, 34)

The second output screen presents 95 percent confidence interval for the coefficients as shown in table 32 — 35.

The third output screen shows odds ratios associated with the characteristics and their 95 percent confidence limit. (Table 33, 36)

9. TIME SCHEDULE



* 1st Month = January 1986

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1. General description of the study groups

1.1 Area of study

1.2 Maternal characteristics

1.3 Newborn characteristics

1.4 Sex of newborns

Procedure I : Mantel—Haenszel Method

2. Biological factors influencing LBW

2.1 Maternal stature :
weight, height, arm circumference

2.2 Maternal parity

2.3 Maternal age

3. Maternal environmental factors

A. Psycho-social risk factors

3.1 Socioeconomic factors

3.2 Work during pregnancy

3.3 Maternal stress

B. Environmental medical factors

3.4 Interpregnancy interval

3.5 Maternal nutritional factors

3.6 Maternal anemia

3.7 Maternal infections

4. Maternal obstetric factors

4.1 Important maternal obstetric condition during pregnancy

4.2 Maternal cardiovascular disease

4.3 Toxaemia of pregnancy

4.4 Maternal behavioural factors

4.5 Antenatal care attendance

4.6 Foetal factor

4.7 Maternal contraceptive experience

Procedure II : Multiple Logistic Regression Analysis

— Results

— Model recommendation

RESULTS

1. General description of the study groups

1.1 Area of study

1.2 Maternal characteristics

1.3 Newborn characteristics

1.4 Sex of newborns

1. General description of the study groups

1.1 Area of study

Table 1 Number of cases and controls by region

Study site	Cases	Controls	Total
Central region			
Chulalongkorn Hospital	251	536	787
Ratchburi MCH Centre	271	544	815
North region			
Chiangmai MCH Centre	326	672	998
Nakornsawann MCH Centre	306	613	919
Northeast region			
Khonkaen MCH Centre	300	591	891
South region			
Yala MCH Centre	248	502	750
Nakornsrithammaraj-Maharaj Hospital	298	637	935
Total	2,000	4,095	6,095

This study aims to assess the maternal risk factors for low birth weight newborns for Thailand. To achieve this goal, data were collected from MCH centres and general hospitals from each region of Thailand. The study follows as case-control design and includes the above number of cases and controls by region. (Table 1)

1.2 Maternal characteristics

Table 2 Maternal characteristics of cases and controls

Characteristics	Cases (n = 2000)	Controls (n = 4095)
Maternal age ($\overline{X}$ ± SD)	25.0 ± 6.0	25.2 ± 5.1
Maternal education (%)		
≤ 4 years	58.7	56.9
Occupation (%)		
Agriculture	40.2 *	33.9
Religion (%)		
Buddhist	91.6	92.6
Family income/year		
Median (Baht)	13,000	17,000 *
Type of delivery (%)		
Spontaneous	79.4	77.9

* Statistical significance at α = 0.05

In a case- control study it is important that cases and controls are from the same population. To verify this, characteristics of the two groups are compared in Table 2. The two groups are quite similar : the mean age is 25 and most have four years of education. Cases have agricultural occupations slightly more than the controls while the vast majority in both groups are Buddhist. Median annual income/year is markedly lower in the cases (US$ 520) than in the controls (US$ 680). Slightly under 80 % in each group delivered naturally. (Table 2)

1.3 Newborn characteristics

Table 3 Newborn characteristics of cases and controls

Variables	Cases (n = 2000)	Controls (n = 4095)
Sex of new borns (%)		
Male	46.3	53.8
Female	53.7	46.2
Newborns' birth weight (gms)		
$\overline{X} \pm SD$	2178 ± 315	3086 ± 343 *
Newborns' birth length (cms)		
$\overline{X} \pm SD$	45.55 ± 2.99	49.61 ± 2.07 *
Newborns' condition at birth (%)		
Resuscitation needed	9.7	4.0
Congenital anomalies	2.0	0.7

* Statistical significance at $\alpha = 0.05$

Table 3 Shows that the controls delivered more male babies than the cases. The average birth weight of the low birth weight cases is 2200 grams compared with 3100 in the controls. Nearly ten percent of the cases required resuscitation compared to only four percent of the controls. Congenital anomalies were also more prevalent in the cases.

1.4 Sex of newborns

Table 4 Sex of newborns by weight and gestational age

		Cases			Controls		
		Preterm (<37 wks)	Fullterm —	Overterm (> 42 wks)	Preterm (< 37 wks)	Fullterm —	Overterms (> 42 wks)
Weight(gm) by sex of newborn							
Male	n	312	583	12	24	2105	62
	$\overline{X} \pm SD$	1909 ± 392	2306 ± 164	2373 ± 89	2843 ± 298	3125 ± 34	3148 ± 323
Female	n	330	712	10	18	1803	31
	$\overline{X} \pm SD$	1950 ± 386	2292±177	2371±113	2809±316	3049±342	3035±277
Mean difference		-41	14	2	34	76	113

Normally the male foetus grows more rapidly than the female foetus throughout pregnancy. The present study shows the foetus in control group with mean differences of 34 grams at <37 weeks and 76 grams at term, while the LBW newborns group shows female foetus with higher birth weight than male foetus and mean differences of only 14 grams at term. (Table 4)

RESULTS

Procedure I : Mantel—Haenszel Method

2. Biological factors influencing LBW

2.1 Maternal stature :

weight, height, arm circumference

2.2 Maternal parity

2.3 Maternal age

2. Biological factors influencing LBW

2.1 Maternal stature

Table 5 Maternal weight, height and arm circumference before delivery

Factors	Cases	Controls	RR	95% CIRR
Maternal weight (kgs)				
< 45	113	50	7.15	5.27 — 9.70 *
45.0 — 54.9	932	1170	1.00	—
55.0 — 64.9	600	1899	0.40	0.35 — 0.45 *
≥ 65.0	148	722	0.65	0.53 — 0.79 *
Maternal height (cms)				
< 150	585	908	1.41	1.25 — 1.60 *
150.0 — 159.9	1197	2624	1.00	—
≥ 160.0	144	471	0.67	0.55 — 0.82 *
Maternal arm circumference (cms)				
< 20.0	31	31	2.62	1.62 — 4.27 *
20.0 — 24.9	1319	2360	1.46	1.30 — 1.64 *
25.0 — 29.9	587	1535	1.00	—
≥ 30.0	43	130	0.86	0.61 — 1.24

* Statistical significance at $\alpha = 0.05$

Maternal weight prior to delivery is statistically associated with low birth weight (LBW). Mothers who weighed under 45 kilograms (kgs) had 1.32 times greater risk of LBW than mothers whose weight was in the Thai standard range of 45 to 54.9 kgs. Mothers who weighed over 55 kgs also had less risk of LBW than mothers who weighed within the Thai standard.

Mothers whose height is under 150 centimeters (cms) had 1.41 times the risk of LBW than taller mothers. Maternal height ceases to be a LBW risk factor above 160 cms. Arm circumference also predicts LBW. A mother with an arm circumference of less than 20 cms has 2.62 relative risk of LBW while a mother with a circumference of 20 to 24.9 cms has a relative risk of LBW of 1.46 (Table 5)

Table 6 Maternal Quetelet's index

Factors	Cases	Controls	RR	95% CIRR
Maternal Quetelet's index before delivery				
≤20	1696	3259	1.37	1.06 — 1.79 *
21 — 22	194	528	0.97	0.71 — 1.32
23 — 24	80	211	1.00	—
≥ 25	30	97	0.82	0.50 — 1.32

* Statistical significance at $\alpha = 0.05$

This index combines data of maternal weight and height as follows: Quetelet's index = weight(kgs)/height(m.) squared. Table 6 shows that mothers with a value for Quetelet's index under 20 have 1.37 times the risk of LBW than women in the normal range of 23 to 24

2.2 Maternal parity

Table 7 Maternal parity of cases and controls

Factors	Cases	Controls	RR	95% CIRR
Parity				
1	1266	2148	1.72	1.53 — 1.94 *
2 —3	580	1696	1.00	—
≥4	113	248	1.33	1.05 — 1.70 *

* Statistical significance at $\alpha = 0.05$

Mothers of parity one have a relative risk of LBW of 1.72 compared with mothers of parity two to three. Mothers who are delivering their fourth or greater parity child have 1.33 times the risk of LBW than mothers delivering their second or third child. (Table 7)

2.3 Maternal age

Table 8 Maternal age of cases and controls

Factors	Cases	Controls	RR	95% CIRR
Age (years)				
≤ 18	229	285	1.80	1.50 — 2.15 *
19 — 34	1609	3596	1.00	—
35 —39	106	180	1.32	1.03 — 1.68 *
≥ 40	55	34	3.62	2.41 — 5.42 *

* Statistical significance at $\alpha = 0.05$

Young and old age at delivery are risk factors for LBW. Mothers under 19 years, between 35 and 39 and over 40 years have relative risks of LBW of 1.80, 1.32 and 3.62 respectively compared with mothers age 19 to 34. (Table 8)

RESULTS

3. Maternal environmental factors

A. Psycho-social risk factors

3.1 Socioeconomic factors

3.2 Work during pregnancy

3.3 Maternal stress

B. Environmental medical factors

3.4 Interpregnancy interval

3.5 Maternal nutritional factors

3.6 Maternal anemia

3.7 Maternal infections

3. Maternal environmental factors

A. Psycho-social risk factors

3.1 Socioeconomic factors

Table 9 Maternal socioeconomic factors

Factors	Cases	Controls	RR	95% CIRR
Maternal age (years)				
≤ 18	229	285	1.80	1.50 — 2.15 *
19 — 34	1609	3596	1.00	—
35 — 39	106	180	1.32	1.03 — 1.68 *
≥ 40	55	34	3.62	2.41 — 5.42 *
Education (years of schooling)				
0	81	130	1.67	1.22 — 2.28 *
4	1087	2195	1.33	1.13 — 1.56 *
9	563	1079	1.39	1.17 — 1.67 *
≥ 12	254	681	1.00	—
Marital status				
Married with license	600	1547	1.00	—
Married without license	1362	2475	1.42	1.26 — 1.59 *
Divorced, separated, widow	35	73	1.34	0.89 — 2.00
Area of residence				
Residential	1313	2782	1.00	—
Farm	512	899	1.21	1.26 — 1.59 *
Commercial	78	192	0.86	0.66 — 1.13
Factory	43	97	0.94	0.65 — 1.35
Slum	50	118	0.90	0.64 — 1.26

* Statistical significance at $\alpha = 0.05$

Mothers of lower educational attainment (less than high school) have greater risk of LBW than mothers with college education or higher.

Mothers whose marriage is not registered are 1.4 times greater at risk LBW than mothers with registered marriages. Mothers who are divorced, widowed or separated have higher (though not statistically significance) risk of LBW than currently married mothers.

Farm dwellers are 1.2 times more at risk of LBW than residential dwellers. (Table 9)

Table 10 Maternal occupation and family income

Factors	Cases	Controls	RR	95% CIRR
Maternal occupation				
Commercial	181	469	1.00	—
Housewife	550	1232	1.16	0.95 — 1.41
Labour	326	623	1.36	1.09 — 1.69 *
Agriculture	804	1389	1.50	1.24 — 1.82 *
Employee	130	361	0.93	0.70 — 1.23
Others	9	21	1.11	0.50 — 2.47
Working status				
Housewife	555	1233	1.00	—
Civil servant	103	288	0.79	0.62 — 1.02
Private employee	370	716	1.15	0.98 — 1.35
Family business (without salary)	946	1803	1.17	1.03 — 1.32 *
Family income/month (US$)				
< 40	359	575	1.75	1.42 — 2.16 *
40 — 200	1385	2882	1.35	1.13 — 1.61 *
> 200	193	542	1.00	—

* Statistical significance at $\alpha = 0.05$

Laborer and farming occupations are risk factors for LBW when compared to commercial occupations, while mothers with family monthly income of US$ 40 — 200 have a relative risk of LBW of 1.4 over those with higher income. The relative risk increases to 1.8 for mothers with incomes under US$ 40 per month.

Working women without income have 1.17 times the risk of LBW as housewives. (Table 10)

Table 11 Socioeconomic factors of father

Factors	Cases	Controls	RR	95% CIRR
Father's age (years)				
≤ 19	58	67	1.74	1.22 — 2.48 *
20 — 29	1128	2465	1.00	—
30 — 39	563	1338	0.84	0.75 — 0.95*
≥ 40	109	190	1.15	0.90 — 1.47
Education (years of schooling)				
0	48	57	2.16	1.46 — 3.22 *
4	990	1924	1.32	1.14 — 1.53 *
9	551	1117	1.27	1.08 — 1.49 *
≥ 12	335	861	1.00	—
Father's main occupation				
Commercial	192	499	1.00	—
Unemployed	26	28	2.41	1.40 — 4.16 *
Employee	329	814	1.05	0.85 — 1.30
Labour	631	1297	1.26	1.04 — 1.53 *
Agriculture	779	1369	1.48	1.23 — 1.73 *
Others	24	57	1.09	0.66 — 1.31

* Statistical significance at $\alpha = 0.05$

Characteristics of the father of the infant also can predict the risk of LBW. Table 11 shows that age, education and occupation are statistically associated with the risk of LBW.

3.2 Work during pregnancy

Table 12 Working condition, time, distance from home to work place

Factors	Cases	Controls	RR	95% CIRR
Working status				
Housewife	555	1233	1.00	—
Government employee	103	288	0.79	0.62 — 1.02
Private employee	370	716	1.15	0.98 — 1.35
Own business	946	1803	1.17	1.03 — 1.32*
Distance from home to work place (kms)				
No travel	1137	2457	1.00	—
< 1	118	307	0.83	0.66 — 1.04
1 — 4	495	820	1.30	1.14 — 1.49 *
5 — 9	103	197	1.13	0.88 — 1.45
≥ 10	110	256	0.93	0.93 — 1.17
Travelling time from home to work place (hours)				
No travel	1136	2456	1.00	—
< 1	672	1310	1.11	0.99 — 1.25
1 —	109	194	1.21	0.95 — 1.55
2 —	52	75	1.50	1.05 — 2.15 *
≥ 3	10	23	0.94	0.45 — 1.98

* Statistical significance at $\alpha = 0.05$

Mothers whose occupation involves unassisted physical labour have a 1.17 relative risk of LBW over housewives. Furthermore, if the mother has to travel one to four kilometers (kms) to work there is a 1.3 times greater risk of LBW than for mothers who do not have to travel to work. Increased travel time increases risk of LBW : a travel time of 2 to 2.9 hours is associated with a relative risk to LBW of 1.50 compared to no need to travel to work. (Table 12)

Table 13 Condition of road and how to go to work place

Factors	Cases	Controls	RR	95% CIRR
Condition of road				
No travel	1136	2456	1.00	—
Smooth road	472	979	1.04	0.91 — 1.19
Pot—hole sidewalk	373	646	1.25	1.08 — 1.44 *
Up hill sidewalk	15	13	2.49	1.21 — 5.13 *
How to go to work place				
No travel	1136	2456	1.00	—
On foot	513	862	1.29	1.13 — 1.46 *
Bicycle	49	101	1.05	0.74 — 1.47
Motormobile **	256	618	0.90	0.76 — 1.05
Truck	44	58	1.64	1.11 — 2.43 *

* Statistical significance at $\alpha = 0.05$

** Motorcar, motorcycle, bus, train, ship

If vehicle travel to work encounters pot-holes or walking to work is up-hill then the relative risk of LBW increases to 1.25 and 2.49 respectively as compared to mothers who do not have travel to work. Travel to work and travel by truck entail a relative risk of 1.29 and 1.64 for LBW compared to not having to travel to work. (Table 13)

Table 14 Travelling time, condition of road and how to go to work place among those women who travel 1 — 4 kilometers.

Factors	Cases	Controls	RR	95% CIRR
Travelling time (hours)				
< 1	412	716	1.00	—
1 —	57	79	1.25	0.87 — 1.80
≥ 2	24	20	2.09	1.15 — 3.78 *
Condition of road				
Smooth road	231	420	1.00	—
Pot-hole road and - up-hill sidewalk	262	397	1.20	0.96 — 1.50
How to go to work place				
On foot	351	502	1.68	1.28 — 2.21 *
Bicycle	32	60	1.28	0.78 — 2.09
Motormobile	95	228	1.00	—
Truck	17	30	1.36	0.72 — 2.58

* Statistical significance at $\alpha = 0.05$

For those women who travel 1—4 kilometers shows that travelling time of 2 hours and over increases the risk for LBW while pot-hole road, up-hill sidewalk and go on foot are associated with greater risk of LBW than are smooth roads and other means of travel. (Table 14)

3.3 Maternal stress

Table 15 Psychosocial problems during pregnancy

Factors		Cases	Controls	RR	95% CIRR
Had quarrel	Yes	574	1033	1.19	1.06 — 1.34*
	No	1426	3062	1.00	—
Husband hurt	Yes	64	101	1.31	0.95 — 1.79
	No	1936	3994	1.00	—
Had accident					
Yes : during					
1st trimester		83	138	1.26	0.95 — 1.66
2nd trimester		184	286	1.34	1.10 — 1.63 *
3rd trimester		132	329	0.84	0.68 — 1.03
No		1601	3342	1.00	—
Feels sad	Yes	318	531	1.27	1.09 — 1.47 *
	No	1682	3564	1.00	—
Was frightened	Yes	139	254	1.13	0.91 — 1.40
	No	1860	3841	1.00	—
Low family income (US$/month)					
Unemployed husband		26	28	2.41	1.40 — 4.16 *
<40		359	575	1.75	1.42 — 2.16 *
40—200		1385	2882	1.35	1.13 — 1.61 *
>200		193	542	1.00	—

* Statistical significance at $\alpha = 0.05$

Table 15 shows that certain psychosocial factors predispose mothers toward risk of LBW such as arguments with husband, 2nd trimester accidents depression or sadness, low family income and husband unemployment.

B. Environmental Medical Factors

3.4 Interpregnancy interval

Table 16 Interval between last pregnancy to present pregnancy (months)

Factors	Cases	Controls	RR	95% CIRR
Interval (months)				
≤ 6	161	275	1.47	1.18 — 1.84 *
7 — 12	143	338	1.07	0.85 — 1.33
13 — 24	175	510	0.86	0.71 — 1.06
≥ 25	456	1148	1.00	—

* Statistical significance at $\alpha = 0.05$

Mothers who reported an interpregnancy interval of less than six months for the current pregnancy had a relative risk of 1.47 for LBW compared with mothers with a longer interval. (Table 16)

3.5 Maternal nutritional factors

Table 17 Maternal Quetelet's index** before pregnancy

Factors	Cases	Controls	RR	95% CIRR
Quetelet's index				
≤ 20	540	545	3.82	3.27 — 4.26 *
21 — 22	537	771	2.68	2.30 — 3.12 *
23 — 24	499	1140	1.69	1.45 — 1.96 *
≥ 25	424	1634	1.00	—

* Statistical significance at $\alpha = 0.05$

** Quetelet's index = weight (kgs) / height^2 (meter)

The Maternal Quetelet's index before pregnancy is examined in Table 17. A value of less than 25 signals risk of LBW and the risk increases steadily as the value of the index decreases.

Table 18 Food intake during pregnancy

Factors	Cases	Controls	RR	95% CIRR
Amount of food				
As usual	678	1323	1.28	1.14 — 1.44 *
More than usual	964	2407	1.00	—
Less than usual **	357	363	2.46	2.09 — 2.88 *
Kind of extra food				
Same as usual	1114	1984	1.00	—
All kinds	73	180	0.72	0.55 — 0.96 *
Protein	119	297	0.71	0.57 — 0.89 *
Protein & Others	160	351	0.81	0.66 — 0.99 *
Carbohydrate	29	62	0.83	0.53 — 1.30
Carbohydrate & Others	143	353	0.72	0.59 — 0.89 *
Fat	15	16	1.67	0.83 — 3.36
Fruits & minerals	28	59	0.85	0.54 — 1.33

* Statistical significance at $\alpha = 0.05$

** Includes morning sickness, anorexia & others

Mothers who have constant or decreased food intake during pregnancy have a greater risk of LBW than mothers who increase food intake (Table 18). While mother who have extrafood for all kinds including protein, carbohydrates showed less risk of LBW. (Protective)

Table 19 Unnatural and prohibited food intake during pregnancy

Factors	Cases	Controls	RR	95% CIRR
Unnatural food intake				
Yes *	18	32	1.15	0.64 — 2.04
No	1933	3944	1.00	—
Avoid prohibited food				
Yes **	318	644	1.01	0.88 — 1.17
No	1682	3451	1.00	—

* Includes raw food, unusual animal proteins,

** Food that they consider as prohibited food during pregnancy are : animal proteins, pickles, special vegetables & tasty fruits and spicy food

Mothers who have unnatural and prohibited food intake during pregnancy have a small increase risk to LBW than mothers who have not. (Table 19)

Table 20 Pregnancy weight gain (kgs)

Factors	Cases	Controls	RR	95% CIRR
Weight gain (kgs)				
< 5	1314	2222	2.32	2.00 — 2.70 *
5 — 10	433	879	1.94	1.62 — 2.31 *
> 10	253	994	1.00	—

* Statistical significance at $\alpha = 0.05$

Pregnancy weight gain if between five and ten kilograms or less than five kilograms is associated with a relative risk of LBW of 1.94 and 2.32 respectively. (Table 20)

3.6 Maternal anemia

Table 21 Maternal hematocrit

Factors	Cases	Controls	RR	95% CIRR
Hematocrit (%)				
≥ 30 (Normal)	1007	2286	1.00	—
< 30 (Abnormal)	68	99	1.56	1.14 — 2.14 *

* Statistical significance at $\alpha = 0.05$

A hematocrit of under 30 % carries with it a relative risk of LBW of 1.56 . (Table 21)

3.7 Maternal infections

Table 22 Maternal infections

Factors	Cases	Controls	RR*	95% CIRR
Infections				
Respiratory tract infection	18	45	0.82	0.48 — 1.42
VDRL : Reactive	40	70	1.20	0.81 — 1.78
TPHA : Positive	22	43	1.06	0.63 — 1.80
German measles — during pregnancy	2	4	1.02	0.19 — 5.60

Table 22 shows that maternal infection does not increase the risk of LBW. This may be due to small frequency of events.

* Relative risk in each item is calculated separately between the group with and without infection.

RESULTS

4. Maternal obstetric factors

4.1 Important maternal obstetric condition during pregnancy
4.2 Maternal cardiovascular disease
4.3 Toxaemia of pregnancy
4.4 Maternal behavioural factors
4.5 Antenatal care attendance
4.6 Foetal factor
4.7 Maternal contraceptive experience

4. Maternal obstetric factors

4.1 Important maternal obstetric condition during pregnancy

Table 23 Maternal obstetric conditions of cases and controls

Factors	Cases	Controls	RR	95% CIRR
Anomalies of Placenta				
No	1943	4046	1.00	—
Yes	46	31	3.09	2.00 — 4.78 *
Placental weight (gms)				
< 400	592	161	9.78	8.31 —11.50 *
400 — 700	1339	3561	1.00	—
> 700	28	298	0.25	0.17 — 0.36 *
Bleeding pervagina during pregnancy				
No	1910	4037	1.00	—
Yes	90	58	3.28	2.39 — 4.50 *
Previous spontaneous abortion				
No	1687	3507	1.00	—
Yes 1 time	274	514	1.11	0.94 — 1.29
Yes ≥2 times	38	74	1.07	0.72 — 1.59
Previous induced abortion				
No	1920	3916	1.00	—
Yes 1 time	62	162	0.78	0.58 — 1.05
Yes ≥2 times	18	17	2.16	1.13 — 4.13 *
Premature rupture of the membrane				
No	1923	4044	1.00	—
Yes	77	51	3.18	2.26 — 4.46 *

* Statistical significance at $\alpha = 0.05$

An abnormal placenta increase the risk of LBW as does bleeding per vagina during pregnancy. A history of two or more induced abortions is associated with LBW as is premature rupture of the membrane. (Table 23)

4.2 Maternal cardiovascular disease

Table 24 Maternal hypertension

Factors	Cases	Controls	RR	95% CIRR
Maternal hypertension				
Systolic B.P.				
Normal (≤ 140 mm.Hg.)	1875	4011	1.00	—
High (> 140 mm.Hg.)	96	59	3.48	2.55 — 4.76 *
Diastolic B.P.				
Normal (≤ 90 mm.Hg.)	1821	3905	1.00	—
High (>90 mm.Hg.)	150	163	1.97	1.56 — 2.47 *

* Statistical significance at $\alpha = 0.05$

Mother with a systolic blood pressure over 140 mm.Hg.. have 3.48 times the risk of LBW than mothers with lower values. Mothers with diastolic blood pressure over 90 mm.Hg. have a 1.97 relative risk of LBW. (Table 24)

4.3 Toxaemia of pregnancy

Table 25 Toxaemia of pregnancy and convulsion during pregnancy

Factors	Cases	Controls	RR	95% CIRR
Toxaemia of pregnancy				
Yes	2	1	—	—
No	1998	4094	(Not applicable)	
Convulsion during - pregnancy				
Yes	8	5	3.29	1.14 — 9.44 *
No	1992	4090	1.00	—

* Statistical significance at $\alpha = 0.05$

The number of cases and controls with toxaemia of pregnancy were too few to analyze while maternal convulsion increase the risk of LBW.(Table 25)

4.4 Maternal behavioral factors during pregnancy

Table 26 Maternal behavioral factors of cases and controls

Factors		Cases	Controls	RR	95% CIRR
Cigarette smoking					
No		1895	3964	1.00	—
Regular		76	78	2.04	1.49 — 2.79 *
Sometimes		27	51	1.11	0.69 — 1.77
Drug addiction	No	1995	4093	1.00	—
	Yes	5	2	5.13	1.18 — 2.23 *
Coffee or tea	No	1541	3045	1.00	—
	Yes **	459	510	1.78	1.55 — 2.04 *
Alcohol or alcoholic perfusion					
No		1891	3870	1.00	—
Yes — everyday		8	24	0.68	0.31 — 1.51
— sometimes		101	201	1.03	0.80 — 1.31

* Statistical significance at $\alpha = 0.05$

** Includes everyday and sometimes coffee or tea drink

Regular cigarette smoking increase the risk of LBW two-fold while use of drugs (drug addiction) increases the risk of LBW five-fold. Also coffee or tea increases the risk of LBW of 1.78 times compared to mother who did not drink coffee or tea. (Table 26)

4.5 Antenatal care attendance

Table 27 Antenatal care attendance of cases and controls

Factors	Cases	Controls	RR	95% CIRR
Antenatal care attendance				
No visit (no ANC)	229	279	2.26	1.87 — 2.74 *
≤ 4 visits	1024	1771	1.59	1.79 — 1.92 *
> 4 visits	726	2000	1.00	—
First ANC visit & number of visits				
During 1st trimester				
≤ 4 visits	142	255	1.49	1.17 — 1.90 *
> 4 visits	330	885	1.00	—
During 2nd trimester				
≤ 4 visits	508	806	1.73	1.47 — 2.04 *
> 4 visits	348	957	1.00	—
During 3rd trimester				
≤ 4 visits	374	710	1.91	1.34 — 2.73 *
> 4 visits	43	156	1.00	—

* Statistical significance at $\alpha = 0.05$

Lack of prenatal care or having less than four or equal four visits increases the mother 's risk of LBW by 2.26 and 1.59 respectively. The risk of LBW increases with inadequate ANC (≤ 4 visits) regardless the time of first attending ANC. However the earlier of first ANC visit the lesser the risk of LBW among inadequate ANC is shown. (Table 27)

4.6 Foetal factor

Table 28 Congenital malformation of cases and controls

Factors	Cases	Controls	RR	95% CIRR
Congenital malformation				
No	1956	4067	1.00	—
Yes	44	28	3.27	2.08 — 5.13 *

* Statistical significance at $\alpha = 0.05$

The presence of foetal anomalies in the infant is associated with LBW but the causative factor is still uncertain. (Table 28)

Table 29 Summary of maternal risk factors for LBW by M - H procedure

Biological risk factors	Obstetric risk factors
— Weight < 45 kgs	— Placental weight < 400 gms
— Height < 150 cms	— Bleeding during pregnancy
— Arm circumference < 20 cms, and 20 — 24.9 cms	— Previous induced abortion
	— Systolic B.P. > 140 mm.Hg..
— Quetelet's index ≤20	— Diastolic B.P. > 90 mm.Hg..
— Parity 1, and ≥ 4	— Cigarette smoking
— Age ≤ 18,and ≥ 35 years	— Drug addiction
	— Coffee or tea
	— No antenatal care, and number of ANC visit ≤ 4 times
	— Congenital malformation
	— Anomalies of placenta
	— Convulsion during pregnancy
	— Premature rupture of the membrane

The above table summarizes of maternal biological and obstetric risk factors for LBW with statistically significant at $\alpha = 0.05$ (95% confidence interval of relative risk by M - H procedure.)

Table 30 Summary of maternal risk factors for LBW by M - H procedure (Cont.)

Environmental risk factors	
A. Psycho-social factors	B. Environmental medical factors
— Maternal education ≤ 9 years	— Interpregnancy interval < 6 months
— Married without license	— Quetelet's index <25 (pre-pregnancy)
— Occupation : labour	
— Family income/month < US$ 40	— Constant or decreased food intake during pregnancy
— Father's age ≤ 19 years	
— Father's education ≤ 9 years	— Pregnancy weight gain ≤ 10 kgs
— Father's main occupation : Agriculture, and unemployed	— Hematocrit < 30%
— Work Travelling time 2 hours	
— Up-hill sidewalk	
— Maternal stress :	
— Argument with husband	
— 2 nd trimester accidents	
— Depression or sadness	

All maternal environmental risk factors for LBW with statistically significant at $\alpha = 0.05$ (95% confidence interval of relative risk by M-H procedure) was summarized in Table 30.

Procedure II : Multiple Logistic Regression Analysis

— Results

— Model recommendation

Part II : Multiple Logistic Regression Analysis

Using the Mantel - Haenszel method in the procedure I to find the maternal risk factors for LBW newborns, the results of the analysis show that there are about 40 risk factors which are statistically significant ($p < .05$). These factors are : Maternal biological factors, environmental and obstetric and gynecological factors. These factors explain only the risk independently for each variable but do not explain any further association with the LBW. The analysis was continued by using the multivariate analysis to explore the relationship between these factors and the LBW. The best method to analyze these variables is by "Logistic Regression"

From the 40 statistically significant risk factors, by M-H method, the variables which had high nonrespondent, (>50% of total) were excluded, thus only 26 factors remained. They were recategorized to dichotomous variables ie. smoking/non-smoking, before fitting into the logistic model. Software for logistic regression ("LOGRESS") was employed by this study. Double precision is used for the estimation procedure. The program would analyze observations involving individual or grouping. The discriminant analysis shows that there are 10 factors which have the statistically significant relations with LBW. These factors are :—

X_1	=	Maternal weight — kgs	(0 = > 45, 1 = ≤ 45)
X_2	=	Maternal height — cms	(0 = > 150, 1 = ≤ 150)
X_3	=	Systolic B.P — mm.Hg.	(0 = < 140, 1 = ≥ 140)
X_4	=	Maternal age — years	(0 = ≥ 19, 1 = < 19, ≥ 35)
X_5	=	Father's occupation	(0 = other, 1 = labour)
X_6	=	Parity	(0 = 2,3 , 1 = 1, ≥ 4)
X_7	=	Vaginal bleeding	(0 = No, 1 = Yes)
X_8	=	Amount of food intake	(0 = more, 1 = same,less)
X_9	=	Coffee/tea	(0 = No, 1 = Yes)
X_{10}	=	Smoking	(0 = No, 1 = Yes)

This software allows us to find out the coefficient of these factors, standard error and the Z-test to derive the lower—upper limit of the coefficient, the odds ratio and the 95% confidence interval. Tables 31 — 37 show the results.

Table 31 Model I : Predictors of LBW outcome : MLR
Dependent variable : Case (0 = control, 1 = case)
n (cases = 1841, controls = 3939)

Variables			Coefficient	SE	Z
X_1	=	Maternal weight — kgs (0 = > 45, 1 = ≤ 45)	1.3716	.1841	7.45 *
X_2	=	Maternal height — cms (0=>150,1=≤150)	0.3354	.0671	5.00 *
X_3	=	Systolic B.P mm.Hg. (0=<140,1=≥140)	1.3703	.1804	7.59 *
X_4	=	Maternal age (0 =≥ 19, 1 =< 19, ≥ 35)	0.3657	.0808	4.52 *
X_5	=	Father's occupation (0 = others, 1 = labour)	0.2271	.0649	3.50 *
X_6	=	Parity (0 = 2,3 , 1 = 1, ≥ 4)	0.5113	.0633	8.07 *
X_7	=	Vaginal bleeding (0 = No, 1 = Yes)	1.2030	.1843	6.53 *
X_8	=	Amount of food intake (0 = more, 1 = same,less)	0.4274	.0591	7.23 *
X_9	=	Coffee/tea (0 = No, 1 = Yes)	- 0.1797	.0700	2.57 *
X_{10}	=	Smoking (0 = No, 1 = Yes)	0.4961	.1490	3.33 *
Constant			- 1.6743	.0798	xxxxx

Likelihood ratio statistic, df_{10} = 403.203

* Statistical significance at α = .05

Table 31 shows the ten variables: Maternal weight ≤ 45 kgs, maternal height ≤ 150 cms, Systolic B.P ≥ 140 mm.Hg., Maternal age < 19 years and ≥ 35 years, Father's occupation - labourer, Parity = 1, ≥ 4, abnormal vaginal bleeding during pregnancy, same or less amount of food intake during pregnancy, coffee or tea drinking and smoking during pregnancy. These factors showed statistically significant relation to the LBW ($p < .05$) and the likelihood ratio statistic is 403.203 which is highly statistically significant.

Table 32 Model I : Coefficients and 95% Confidence interval : Dependent variable : Case (0= Control, 1 = case)

n (cases = 1841, controls = 3939)

	Variables	Coefficient	95%Confidence interval
X_1 =	Maternal weight — kgs (0 = > 45, 1 = ≤ 45)	1.3716	1.01 — 1.73
X_2 =	Maternal height — cms (0 = > 150, 1 = ≤ 150)	0.3354	0.20 — 0.47
X_3 =	Systolic B.P mm.Hg. (0 = <140, 1 = ≥ 140)	1.3703	1.02 — 1.72
X_4 =	Maternal age (0 = ≥ 19, 1 = < 19, ≥ 35)	0.3657	0.21 — 0.52
X5 =	Father's occupation (0 = others, 1 = labour)	0.2271	0.10 — 0.35
X6 =	Parity (0 = 2,3 , 1 = 1, ≥ 4)	0.5113	0.39 — 0.64
X_7 =	Vaginal bleeding (0 = No, 1 = Yes)	1.2030	0.84 — 1.56
X_8 =	Amount of food intake (0 = more, 1 = same,less)	0.4274	0.31 — 0.54
X_9 =	Coffee/tea (0 = No, 1 = Yes)	- 0.1797	-0.32 — -0.04
X_{10} =	Smoking (0 = No, 1 = Yes)	0.4961	0.20 — 0.79

Table 32 shows the second output screen presenting 95% confidence intervals for the coefficients listed in the first output screen of Model I in Table 31.

Table 33 Model I : Odds ratio and 95% Confidence interval

	Variables	Odds ratio	95%Confidence interval
X_1 =	Maternal weight — kgs (0 = > 45, 1 = ≤ 45)	3.94	2.75 — 5.66 *
X_2 =	Maternal height — cms (0 => 150, 1 = ≤ 150)	1.40	1.23 — 1.60 *
X_3 =	Systolic B.P mm.Hg.(0 = <140, 1 = ≥ 140)	3.94	2.76 — 5.61 *
X_4 =	Maternal age (0 = ≥ 19, 1 = < 19, ≥ 35)	1.44	1.23 — 1.69 *
X5 =	Father's occupation (0 = others, 1 = labour)	1.26	1.11 — 1.43 *
X6 =	Parity (0 = 2,3 , 1 = 1, ≥ 4)	1.67	1.47 — 1.89 *
X_7 =	Vaginal bleeding (0 = No, 1 = Yes)	3.33	2.32 — 4.78 *
X_8 =	Amount of food intake (0 = more, 1 = same,less)	1.53	1.37 — 1.72 *
X_9 =	Coffee/tea (0 = No, 1 = Yes)	0.84	0.73 — 0.96 *
X_{10} =	Smoking (0 = No, 1 = Yes)	1.64	1.23 — 2.20 *

Probability of LBW = .99

* Statistical significance at α = .05

The results of odds ratio and 95% confidence interval indicate the first three risk factors as follows : maternal weight ≤ 45 kgs, systolic B.P ≥ 140 mm Hg. and vaginal bleeding during pregnancy. The other six factors are estimated as significant maternal risk factors for LBW newborns except drinking coffee/tea during pregnancy which will reduce the risk to LBW (Table 33)

Table 34 Model II : Predictors of LBW outcome : MLR for quantitative variables n (cases = 1810, controls = 3883)

		Variables	Coefficient	SE	Z
X_1	=	Maternal height — cms (0 = > 150, 1 = ≤ 150)	0.4154	.0641	6.48*
X_2	=	Systolic B.P mm.Hg.(0 = <140 , 1 = ≥ 140)	1.2909	.1770	7.29*
X_3	=	Maternal age (0 = ≥ 19, 1 = < 19, ≥ 35)	0.4147	.0785	5.23*
X4	=	Parity (0 = 2,3 , 1 = 1, ≥ 4)	0.4788	.0618	7.74*
X5	=	Vaginal bleeding (0 = No, 1 = Yes)	1.1905	.1805	6.60*
Constant			- 1.3086	.0540	xxxxx
		Likelihood ratio statistic. df_5 = 247.4844			

* Statistical significance at α = .05

Table 34 Considers the 5 objective measurements which can be measured clinically into the model II. These variables were maternal height ≤ 150 cms, systolic B.P ≥ 140 mm Hg., maternal age <19 and ≥ 35, the first parity and ≥ 4 and vaginal bleeding during pregnancy. The outcome shows that these 5 factors had a relation to the LBW that is statistically significant ($p < .05$) and the value of likelihood ratio test was 247.48 (Table 34)

Table 35 Model II : Coefficient and 95% Confidence interval.
Dependent variable : Case (0 = control 1 = case)
n (cases = 1810, controls = 3883)

	Variables	Coefficient	95%Confidence intervals
X_1 =	Maternal height — cms (0 => 150, 1 = ≤ 150)	0.4154	0.29 — 0.54
X_2 =	Systolic B.P mm.Hg.(0 = <140, 1 = ≥ 140)	1.2909	0.94 — 1.64
X_3 =	Maternal age (0 = ≥ 19, 1 = < 19, ≥ 35)	0.4147	0.26 — 0.57
X_4 =	Parity (0 = 2,3 , 1 = 1, ≥ 4)	0.4788	0.36 — 0.60
X_5 =	Vaginal bleeding (0 = No, 1 = Yes)	1.1905	0.84 — 1.54

Table 35 presents 95% confidence intervals for the coefficients listed in the first out screen of Model II.

Table 36 Model II : Odds ratio and 95% Confidence interval

	Variables	Odds ratio	95%Confidence intervals
X_1 =	Maternal height — cms (0 = >150,1 =≤ 150)	1.5150	1.33 — 1.72 *
X_2 =	Systolic B.P mm.Hg.(0 = <140, 1 ≥ 140)	3.6360	2.57 — 5.14 *
X_3 =	Maternal age (0 = ≥ 19, 1 = < 19, ≥ 35)	1.5140	1.30 — 1.77 *
X4 =	Parity (0 = 2,3 , 1 = 1, ≥ 4)	1.6141	1.43 — 1.82 *
X5 =	Vaginal bleeding (0 = No, 1 = Yes)	3.2886	2.31 — 4.68 *

Probability of LBW = .92

* Statistical significance at α = .05

Table 36: The odds ratio and 95% confidence interval describe all 5 factors as statistically significant risk factors for LBW newborns.

Table 37 Summary of maternal risk factors for LBW by MLR analysis and recommendation

Risk factors	
Model I	**Model II**
Maternal weight ≤ 45 kgs	Maternal height ≤ 150 cms.
Maternal height ≤ 150 cms	Systolic B.P ≥ 140 mm.Hg.
Systolic B.P ≥ 140 mm.Hg.	Maternal age <19 , ≥ 35 years
Maternal age > 19 , ≥ 35 years	Parity 1, ≥4
Father's occupation : Labourer	Vaginal Bleeding
parity 1, ≥4	
Vaginal Bleeding	
Same or less amount of food intake during pregnancy (vs prepregnancy)	
Coffee/tea drinking during pregnancy	
Smoking during pregnancy	
Recommendation	
General education for girls and eligible women	General education for girls and eligible women
Health education program for pregnant women	Apply prediction model II for LBW at Health Centre and at district Hospitals (After it has been approved to be appropriate)
Apply prediction Model I at the level of provincial and district hospitals (After it has been approved to be appropriate)	

This table summarizes maternal risk factors for LBW by Multiple Logistic Regression Analysis which have been analyzed in two models. Model I consisits of 10 factors and Model II consists of 5 factors.

DISCUSSION

Materials and Methods

This study is national in scope covering all regions of the country. Data from the regional MCH Centres were pooled for analysis. These centres represent the central, north, northeast and south. In addition the data from two general hospitals in the central and south regions were included. The study design is an unmatched case—control study, collecting data retrospectively to determine history of exposure prior to time of study by interview, also relying on data from observation and laboratory results. Thus before beginning the data collection it was necessary to fully brief representatives from the participating institutions on the materials and methods. The importance of collecting quality and complete data was emphasized. The investigators travelled to all the participating institutions to give project orientation and instruction in data collection. In addition two local project investigators from each institution were selected. These individuals participated in a three-day training session at the Institute of Health Research (IHR) , Chulalongkorn University which included role play activities in filling out the project forms. Following this, the regional investigators returned to their respective institutions and pretested the data collection form, and sent back suggestions for revision to the IHR which pooled the recommendations and incorporated these into a single revised form.

All institutions were required to use the same weighing methodology using a balance beam scale. During the data collection the investigators travelled to the regional MCH Centres and general hospitals to observe data collection on site and to provide suggestions for resolving any problems that emerged. The regional investigators had the responsibility of editing and screening all forms for internal consistency and completeness before forwarding the forms to Bangkok for processing. In Bangkok the data were coded, machine edited and processed at the IHR.

Although there has been considerable quantitative analysis of the factors affecting low birth weight, and other descriptive and cohort studies, this study is unique for Thailand in being the first case-control study on this

topic and yields the first data on maternal relative risk for keys factors believed to influence LBW.

The first phase of analysis was the application of Chi-square for the factors associated with birth weight. Next, relative risk analysis was used to assess the association of the risk factors with LBW, the Mantel-Haenszel (M-H) procedure for the odds ratio test was used. A 95% confidence interval of relative risk was used in the analysis.

Logistic regression analysis is used to assess the association between LBW and dichotomous variables. The computer program "Logress" was used to solve the equation to determine the value of the coefficients. Significance was determined by the value of Z. The Logress program also provided likelihood ratio statistics to assess the effect of entering and withdrawing certain variables from the equation in seeking the best fit model. This method is similar to the stepwise inclusion of variables in a multivariate model.

General description of the study groups

In order to assess the maternal risk factors for LBW newborns for Thailand, the cases and controls were recruited following the criteria as mentioned in the methodology part. The important criteria for recruitment is that cases and controls have to come from the same population.

All selected maternal characteristics are shown in Table 2 indicated quite similar characteristics : The mean age, education, religion and type of delivery. This can be explained by the fact that women who lived within the same area have more or less same general characteristics of population. There are some characteristics which differed among cases and controls which are maternal occupation, family income/year. These factors have to be further analyzed for the final conclusion of being maternal risk factors for LBW or not. Also newborn characteristics of cases and controls are described descriptively for sex of newborns, newborn's birth weight and newborn's condition at birth (Table 3). There are more female babies than the male, and this could be explained that the percentage of female birth is higher than of male birth in Thailand. The fact that newborn's birth weight, birth length and newborn's condition at birth will differ among cases and

controls and further statistical analysis is required to assess maternal risk factors for LBW newborns

Sex of newborn

There are many biological factors which can have an affect on the development of the foetus during pregnancy. Sex of the foetus for example can influence birth weight. According to the WHO Report of the meeting on etiology, prevention and social implications of LBW in Geneva in 1975. "The male foetus grows more rapidly than the female foetus throughout pregnancy, with the mean differences of 50 grams at 32 weeks and 150 grams at terms." [12] In the current study, the mean differences in foetal weight by sex for the controls is 34 grams at < 37 weeks and 76 grams at term. No differences are observed for the LBW cases (Table 4). It is possible that disturbance of foetal growth by any of the risk factors can reduce the difference in weights of male and female foetuses.

Procedure I : Mantel-Haenszel method

Biological factors influencing LBW

Maternal weight

Jean Frederick et al have observed that women who weighed less than 50.8 kgs had a spontaneous pre-term birth weight which was almost three times that of the mother who weighed more than 57.3 kgs.[13] In the current study it was found that women who weighed less than 45 kgs had a 7.15 times greater risk of LBW over women weighing 45.0 to 54.9 kgs. This difference is statistically significant at the 95% confidence level as shown in Table 5.

Ingrid Bjerre et al in their study of some biological and social and economic factors in LBW also concluded that lighter women are at greater risk of LBW . [15]

In this study pre-pregnancy weight may be biased in those cases and controls who were in the care of non-participating institutions before delivery and could not accurately remember their weight.

Maternal Height

From a report of WHO it is known that maternal height is a risk factor for LBW. Women with a height over 164 cms will have babies 25 gms heavier than women who are shorter than 158 cms.[12] Jean Fredrick concluded that LBW risk increases three-fold for heights under 158 cms when compared with women over 167 cms. [14] In addition, women shorter than 152.4 cms have two times the risk of LBW than women taller than 172.2 cms.[13] The current Thai study reports similar findings : mothers under 150 cms have 1.41 times the risk of mothers between 150 and 159.9 cms for LBW.

Maternal arm circumference is highly correlated with maternal weight and height. Thus, it is not surprising that women with an arm circumference of less than 20 cms had a 2.62 times risk of LBW compared to women with a circumference between 25 and 29 cms.

Maternal Quetelet's Index

The Quetelet's index is calculated as weight (Kgs)/ height^2 (metres). Women who are short and light will have a low value for this index. In this analysis it was found that women with an index of less than 20 have 1.37 times the risk of LBW than women with an index value between 23 and 24. This relative risk is statistically significant.

Maternal Parity

The results of this study concur with those of the WHO Report for maternal parity. Women of parity one or parity five and higher have a greater risk of LBW than medium parity women.[12] The Thailand study found that mothers of parity one or parity four and above have 1.72 times the risk of LBW than mothers of parity two and 1.33 times the risk of mothers with parity three.

Maternal Age

Normally, women under age 18 are still growing and thus, younger maternal age should be an important risk factor for LBW. Many studies have been done on maternal age and LBW conclude that age under 18 or 19 increases the frequency of LBW [12-18, 25] The current study found that mothers under 19 have 1.8 times the risk of LBW than mothers age 19 to 34.

The WHO Report has also concluded that LBW increases if maternal age is over 35, especially if parity is high as well. [12] In the Thailand study it was found that mother's age 35 to 39 have 1.32 times the risk of LBW than mother's age 19 to 34. This relative risk is statistically significant and increases with maternal age. Table 8 shows that if the mother's age is over 40 then the risk of LBW is 3.62 times that of mother's age 19 to 34.

Maternal Environmental Factors

Social and economic factors such as maternal education, marital status, occupation, labour force participation and monthly household income are shown to be heavily inter-correlated. Low socioeconomic status should be associated with LBW because food intake and proper nutrition may be less in this group while morbidity may be higher as well.

Social factors

In this study maternal and paternal age, education, marital status, occupation and residence are considered (Table 9, 10, 11) Concerning mother's age, the previous studies, both in Thailand and abroad reveal that the appropriate healthy child bearing age is 20-30 years due to maternal health and biological maturity. Bjerre and Varendh's study emphasizes the first child in particular. This study (table 9), confirms that of Bjerre and Varendh that there is greater risk among mothers aged under 19 and 35 and over [15]. Not only mother's age, but also the father's is crucial as supported by our data here (Table 11).

For mother's level of education, the data support the findings of Fedrick and Adelstein's and Victor and Colleague's showing the risk of lower educated mothers (12 years or less) to give LBW births[14,18] (Table 9).

Influences of education on the rate of LBW can be both direct and indirect. Mothers of low or no education may not have adequate knowledge of health care during or before child bearing. While indirectly affecting the rate of LBW, their low level of education keeps them out of the job market or good work, resulting in low income and, in turn, insufficient food for pregnant mothers. In this study, fathers' low education reconfirms that of mothers, (Table 11)

With reference to maternal occupation, Tafari et al acknowledge that mothers who are labourers or the like tend to have LBW.[19] This is substantiated by Chaturachinda's study in Thailand, whose work lists farming, unskilled labourers and housewife as occupations associating with LBW[20] Our study additionally substantiates those mentioned studies in that the reasons can be biological and social. (Table 10) Biologically, LBW arises from insufficient food for the pregnant mothers who spend so much energy in occupations. Socially, labourer mothers have insufficient time or knowledge for behavior that would secure a healthy infant. In this study, fathers' main occupation also supports the findings (Table 11).

Another social factor affecting LBW is marital status. It is hypothesized that the normal legal (licensed) marriages would produce normal infants (weighing over 2500 gms.). Normal marriages refer to the readiness, socially, biologically and psychologically, of the couples engaged. These cases should eventually bring about normal infants. Our data from table 9 seems to confirm the corollary of our hypothesis - revealing that marriages without licenses tend to give rise to LBW. Other similar cases in the same table do not show the same result and may be due to small number.

The last factor under this heading is area of residence. Listed under this name are residential, farm, commercial, factory and slum area. A large number of cases are living on farm and statistical tests show a significantly higher risk of having LBW. Chaturachinda attributed the farm residential risk to lack of knowledge to take good care of oneself during pregnancy[21]. We may add however that farm living could also mean hard physical work, low

income and long distance from health centres, all of which could contribute to LBW.

Economic factors

Economic factors in this study include work status, family income, distance from home to work, road conditions and how to work. As it stands, some economic and social factors cannot be sharply separated. They will be dealt with socially.

Work status and family income . Operationally, by family business is meant work without pay (or pay indirectly to the whole family). Cases in family business can be summed together with those low income families (from US$ 40 to US$ 200 per month) indicating a significant risk of having LBW. The main reason could be traced back to low education, insufficient health care knowledge, and hard physical work discussed earlier. This is also substantiated by unemployed fathers in Table 11.

Work place from home : How far away is the work place ? How long will it take ? How good is the road ? And how do they go to work ? These factors affect, one way or another, the risk of LBW. It is hypothesized that the closer the work place, the better the road to work place and the easier way to work place, the lesser the risk of having LBW. Data in Table 12 and 13 suggest some risk factors, namely, 1 — 4 kms distance, 2 hours travelling, pot-hole and up hill roads, walking and going to work by truck, Some questions need answers, however. Why is travelling 1 — 4 kms a risk factor while 5^+ kms is not ; why is travelling 1 — 2 hours a risk factors while 3 hours is not. We do not have good answers. It could be that the shorter the distance and time more women tend to walk which is harder physically. The longer trips are travelled by easier means e.g. bicycle or bus thereby reducing LBW risk (Table 14).

Psychological factors

In this study, by psychological factors we mean quarrelling, husband's abuse during pregnancy, feeling sad, having accident and feeling frightening during the time of pregnancy. Of these, quarreling, accident and sadness are statistically significant risk factors of having LBW.

Quarrelling during pregnancy . The saying " a sound mind in a sound body" seems to show the close relation between mind and body. Especially the mind and body of the pregnant mothers in this situation, they need not only physical but also psychological care for they are in the fragile state. The smoother the relationship between husband and pregnant wife, the lesser the chance to have LBW. The data from our study (Table 15) confirm the stated hypothesis.

Accident during pregnancy . Our data in table 15 reveal that accident during pregnancy is a risk factor for LBW but the accident has to occur in the second trimester of pregnancy. The first and third trimesters are not risky because of physical strength and familiarity in self-care respectively. That is in the first trimester mothers are still physically strong, almost like unpregnant women, and thus accidents do not hurt them. Similarly, in the case of the third trimesters, the mother does not feel hurt because by almost 9 months of carrying babies, they are used to taking care of themselves.

Feeling sad during pregnancy . The data from our study again show that feeling sad during pregnancy is a risk factor for the mother to have LBW. The reason would be in the same as above that is, mind and body are closely related. When feeling sad for whatever reasons (generally caused by closely related persons, e.g. husbands, parents, brothers, sisters and friends), their physical state is weak and thus become risky of bearing LBW.

Other psychological factors . Husband's abuse and feeling frightened during pregnancy are other two variables studied by this research. The data disprove the hypothesis that the two variables are risk factors for mothers to have LBW. It could be added that the variables are vital but not to the degree of risk to produce negative effects.

Environmental Medical factors

Interpregnancy interval

Victor Eisner et al had studied the risk of LBW and concluded that a short interpregnancy interval was associated with an increased percent of LBW babies. The lowest proportions of LBW babies occurred to mothers who waited at least 12 months after the previous delivery before again becoming pregnant.[18]

The M - H procedure in the present study indicated that there is an increase risk of LBW with interpregnancy interval of less than six months : The odds ratio was 1.47 time than that of > 25 months interval (Table 16). It seems reasonable to conclude that the interval between successive pregnancies should be no less than two years, in order to permit recuperation of the mother's reproductive organs, as well as other organs and systems. In addition, this allows her nutritional status to return its prepregnancy state.[12]

Maternal nutritional factors

Nutrition before and during pregnancy, and possibly the nutritional status of mother may influence foetal growth. In experimental animals Zamenhof demonstrated that malnutrition prior to mating and through gestation of an F_0 generation of rats could lead to foetal malnutrition in the F_2 generation.[22] The time of nutritional insults and the ability of mother and foetus to adapt to sub-optional nutrition intake are also important attention has already been drawn to the effect that malnutrition during growth and development may have on maternal stature, and the bearing that this, in turn, has on foetal growth.[12] The present study showed that the quetelet's index before pregnancy of below 24 had higher risk of LBW than that of more than 25 while the quetelet's index decreases the relative risk will be increased (Table 17). This maternal status would certainly affect foetal growth during pregnancy. Data from the British Perinatal Survey indicated that foetal weight at birth was influenced by maternal size.[14] The Quetelet's index is estimated by maternal weight(kg)/ height(metre) square and it does represent maternal stature or size. Nutrition during pregnancy can be adversely affected in several ways : reduced intake due to low

socioeconomic status or severe vomiting in pregnancy, anorexia, restrict intake secondary to another illness including associated infection.[12]

Aaron Lechtig et al concluded that maternal malnutrition has been implicated as one of several environmental factors contributing to LBW. He has found an association between supplemented calories during pregnancy and birth weight and also somewhat surprising result that both the protein-calorie and the calorie supplements had a similar effect on birth weight.[23]

Naismith DJ. reported that the effects on birth weight of inadequate intake of energy or protein in rats and explained that there is improved utilization of protein during pregnancy as a result of reduced amino acid catabolism. He concluded that the biphasic character of protein metabolism in pregnancy may thus play a major role in modulating the effects of chronic malnutrition on foetal growth and development. [24]

Also the type of nutritional limitation may influence foetal growth, e.g. protein, fat, minerals. The present study result showed that women who had same or decreased amount of food intake during pregnancy revealed higher risk of LBW, when compared with women who had more amount of food intake during pregnancy (Table 18).

The extra amount of food intake during pregnancy such as protein plus others and carbohydrate plus others has a highly significant beneficial result in decreasing the risk of LBW. (Table 18) Moreover, some women prefer to consume unnatural food such as unusual animal protein, including raw food.

From this study, 18 of the cases and 32 of the controls who had the history of unnatural consumption during pregnancy and avoiding the prohibited food according to the villagers' belief are more risky to have LBW outcome compared to those who consume natural food (Table 19). However, there is no statistical difference between the two groups

In conclusion, women during pregnancy should consume extra amount of food because they need to consume enough food for their baby as well. The extra food intake should include protein, carbohydrate and minerals which help in decreasing the risk or protect mothers of LBW

outcome. The intake of unnatural food and avoidance of prohibited food should, therefore, not be advised.

Hytten had studied on maternal weight gain during pregnancy and concluded that most of the weight gain occurs prior to 30 weeks, at which time maternal stores account for 44 percent and foetal weight for 18 percent. Most of the weight gain between 30 and 40 weeks represents foetal growth and increases in extracellular water.[26] The impact of pregnancy weight gain on birth weight increases as prepregnancy weight decreases so that the maximum effect is seen in women who are underweight at the start of pregnancy.[27]

Edozein JC et al noted that in the rural Yoruba community of Osegere, W. Nigeria, women gain less weight during pregnancy have smaller babies than "elite" Nigerian women from Ibadan.[28]

Significant foetal growth retardation occurs when underweight women gain less than 6 kgs at term, independent of foetal weight.[29] Annette Gormican et al have concluded that increases in maternal weight gain were accompanied by statistically significant increases in infant birth weight. The study gives added support to those investigators advocating weight gain of from 20 to 27 lbs during pregnancy in healthy women, regardless of pre-pregnancy weight status. [30] Richard L. et al has done a study on weight gain and the outcome of pregnancy concluded that weight gain had its greatest correlation with the outcome of pregnancy when the offspring were male and had blood group B and the mother had 1+ or greater acetonuria a recorded in one or more urine samples tested during pregnancy.[31] Mean weight gain for healthy Caucasian primigravida eating without restriction is 12.5 kgs, where as that of multiparous women is approximately 1 kg less.[32]

The study revealed that pregnant women with total weight gain of 5 — 10 kgs were more risky to have LBW newborns than those of more than 10 kgs. And the lesser the weight which was less than 5 kgs, the more risky it would be (Table 20). It's known that total weight gain during normal pregnancy ranger from 10 — 12 kgs were classified as referent group. If more than 12 kgs, other cause should also be considered eg. edema.

Kaltreider, D. et. al had concluded that patients under 19 years of age and those with hemoglobin less than 9.0 gm% were found to have significant by higher incidence of LBW.[17] Also Jean Fedrick had shown that women not delivered by 37 weeks and having a low hematocrit (under 30%) were 30 percent more likely to have a LBW infant than those women whose lowest recorded hematocrit was over 30 percent.[13] The study revealed similar results to the previous ones. Patients with hematocrit less than 30% had 1.56 times the risk of LBW newborns than normal patients. This has statistical significance and can also help in identifying what kind of food should be taking during pregnancy; protein will increase hematocrit level. The other factor considered to be associated with the decrease of hematocrit level are diseases that patients had during pregnancy eg. malaria, hook worm infection, or other diseases. The study revealed that patients had very few diseases during pregnancy and the disease that had most frequency was respiratory diseases. Other important diseases that had impact upon newbornes were syphilis and German measles. It can therefore, be concluded that patients with the above mentioned diseases were more risk to have LBW than those without diseases. But there was no statistical significance which might be due to lack of information on those diseases

However viral infection before or during early pregnancy and the influence of serious acute disease during childhood and adolescence upon the course of pregnancy and the development of the foetus have not been quantified.[33]

Maternal obstetric factors

Placentas of growth retarded foetuses have been reported as "small" placenta[34, 35, 36] Leichtig et al in a study of poorly nourished population noted that moderate energy protein malnutrition was associated with 15 percent reduction in placental weight. These authors suggested that such reduction in placental size secondary to gestational undernutrition and malnutrition may be one mechanism by which foetal growth retardation is produced in undernourished population.[37] Metcoff J. et al concluded that the placentas of growth retarded infants are significantly smaller than normal by size and weight.[33] The study revealed that patients with anomalies of placenta are 3 times more at risk of LBW newborns than those with normal

ones. Considering placenta weight, it was confirmed that women with placentas which weighed less than 400 grams were 10 times more at risk of LBW newborns than those with normal weight (400 — 700 grams) Naeye reported that in foetal and neonatal death associated with small-sized placentas, the foetuses were undergrown and the placentas shows signs of reduced perfusion from the uterus.[38] Also from WHO Report had supported that anomalies of the placenta may be related to many factors : maternal uterine vasculature, quality of the uterine bed, site of implantation, malformations of the placenta itself, separation of the placental vasculature, placental infection, placental size. Many of these factors have a direct influence on placental of foetal distress, and the incidence of premature delivery, spontaneous or induced.[12]

Abnormalities of placentas by various factors can be observed by vaginal bleeding during pregnancy. The study showed that vaginal bleeding was a risk factor and had a statistical significance to LBW newborns. (Table 23)

Shapiro S. et al found that one out of four pregnancies ended in loss or disability (including minor ones), there is a strong relationship between prior pregnancy history and outcome of current pregnancy; and, early antepartum bleeding is associated with a high foetal loss rate, as well as with risk of LBW, congenital anomalies and neonatal mortality among surviving infants.[39] Also Eisner V. , et al had studied the risk of LBW and multivariate analysis was used to determine the correlates of LBW. When other factors were held constant, the following factors lack increased the risk of having a LBW infant : previous reproductive loss, short interpregnancy interval, no prenatal care, out-of-wedlock birth, and mother aged under 19 years or over 35 years.[18] Ross and Schneider suggested that previous spontaneous abortion predispose to subsequent premature delivery.[40] Also Fedrick J. et al had done the study on the factors associated with spontaneous preterm birth and concluded that threatened abortion is one of the risk of spontaneous preterm birth.[13] The study revealed that mothers with history of 2 induced abortions or more were likely to have LBW newborns(Table 23). Other variables contributing to LBW newborns was premature rupture of the membrane which has the relative risk of 3.18 and has statistical significance. (Table 23)

The WHO Report concluded that premature rupture of the membrane is also a major factor in spontaneous premature labour and is commonly associated with cervical incompetence. Chronic oligohydramnios due to prolonged leakage of amniotic fluid is associated with foetal growth retardation[12] and this WHO Report supports the present study. Naeye, R.L. et al concluded that rupture of membranes obviously increases foetal exposure to bacteria in vagina, but such premature rupture may be due to weakness in foetal membranes secondary to chorioamnionitis. In such instances, foetal bacterial infections may antedate the rupture of membranes.[41, 42]

Mothers with high blood pressure (systolic >140 mm Hg., diastolic > 90 mm Hg) were 3.48 and 1.97 times more at risk of LBW newborns than those who had normal systolic and diastolic blood pressure respectively. (Table 24) The present study result is supported by the WHO Report that maternal hypertension, pre-existing or arising during pregnancy, is a major cause of placental insufficiency and foetal growth retardation. Premature delivery may occur spontaneously or be produced electively because of foetal distress.[12]

There are several maternal behavioural risk factors associated with LBW. The relationship between smoking and foetal growth retardation is well established.[13,43-53] The study revealed that there were many risk factors to LBW. Generally, very few Thai women smoke comparing to western women. However, it was found that there were regularly smoking during pregnancy in 76 cases of mothers with LBW newborns and 78 cases of mothers with normal newborns. The odds ratio showed that mothers who smoked regularly during pregnancy were 2.04 more at risk of having LBW newborns than those who did not smoke and this was statistically significant. The WHO Report concluded that cigarette smoking has definitely been established that cigarette smoking retards foetal weight gain, the reduction in potential birth weight being indirect proportion to the number of cigarettes smoked. The difference in birth weight between infants born at term to smoking versus non-smoking mothers is in the order of 150 grams or more.[12] The effect of smoking on LBW can be explained that smoking reduces placental perfusion and has a separate hypoxic effect through accumulation on of carbon monoxide in maternal blood.[47, 48]

Also Miller & Hassanein have shown by multivariate analysis that smoking during pregnancy is associated with decreased baby weight and length at birth.[54]

However, The WHO Report explained that drug addicts have a high incidence of LBW infants. It is not yet known this is an effect of the drug involved, or of the many interrelated socioeconomic and nutritional factors.[12] The study showed that drug addiction is a statistically significant risk factor for LBW but there were very few cases of drug addicts both in the cases and controls (5 and 2 cases, respectively). Therefore, more studies should be made before making any conclusions.

Other factor of maternal behaviour during pregnancy is drinking of coffee or tea (Table 26). The study revealed that mothers who drank coffee or tea during pregnancy were 1.78 times more at risk than those who did not drink and this was statistically significant. The researchers thought that more studies and information on the drinking of coffee and tea as risk factors to LBW newborns should be done because it will be widely useful since these beverages are preferable to Thai people.

Lack of antenatal care was considered to be a risk factor to LBW newborns. Eisner V. et al had analyzed the result by using multivariate analysis to examine the relationship between antenatal care and LBW newborns. From the M-H procedure showed highly significantly increased risks of birth weight below 1501 grams and below 2501 grams for primigravida. He also found that the odds ratios from MLR were similar to those from M-H for primigravida. Odds ratios by MLR for multigravida with no prenatal medicare were statistically significant, ranging from 2.09 to 5.88.[18]

Gortmaker s. results indicated that a significant relationship between lack of Antenatal care and infant mortality could be established, mainly via LBW. However, the author noted that as a variety of behavioural characteristics of the mother were not controlled, causal differences concerning the impact of antenatal care could not be drawn.[55]

From the study, the history of antenatal care had been collected and the information on primigravida and multigravida had also been collected. It is revealed that mother who lacked ANC were 2.26 times more at risk of LBW

newborns than those who came for ANC 4 times and over and this was statistically significant. Going for ANC 4 times has been a standard of the Ministry of Public Health. Furthermore, going for ANC less than 4 times was also a risk factor to LBW newborns. (Table 27)

A problem usually found in antenatal care especially in rural areas of Thailand was going for antenatal care in late trimesters. The study revealed that mothers going to antenatal care less than 4 times either in the 1st, 2nd, or 3rd trimester were statistically significant more at risk of LBW newborns. It can, therefore, be concluded that no antenatal care and going for antenatal care less than 4 times were risk factors to LBW newborns.

The WHO Report had concluded that infants with congenital malformations whether due to either genetic or early intrauterine environmental influences, are frequently small-for-dates at birth. An increased proportion are born preterm.[12] Also Van der Berg, B.J. et al had concluded that growth-retarded infants have a higher frequency of major congenital malformations.[56] The present study revealed that there were 44 mothers whose babies had congenital malformation problems in the group of mothers with LBW newborns and 28 mothers in the group of mothers with normal weight newborns. Considering the odds ratio or relative risk, it was found that mothers whose babies had congenital malformation problem were statistically significant 3.27 times more at risk of LBW newborns than those whose newborns were normal. That is, mothers with LBW newborns had 3.27 times more chances to have congenital malformation newborns. Also Sharpiro et al had studied on the relationship between low birth weight and the diagnosis of a significant congenital anomaly. The result showed the likelihood that children with birth weight of 2500 grams or less will be found to have such an anomaly more than twice the rate for other children.[39]

Procedure II : Multiple Regression Analysis

Discussion and recommendation

The results from Table 31-33 show that mothers who have 10 factors have a high opportunity to deliver low birth weight newborns when a value of likelihood ratio statistics with 10 degree of freedom equal 403.203 which indicate that there is an association between low birth weight and factors with high level of statistically significant ($p < .0001$). Model I which consists of 10 factors can predict probability of LBW as high as 98.85 percent (see equation of probability in page 13). The results from MLR Analysis can recommend a Model for prediction of LBW outcome as follows :

1. Model I — Consists of 10 factors (the results from Table 38) can be used in health centres or community hospitals to predict the outcome of LBW newborns from pregnant woman by considering some criteria when a pregnant woman comes to have ANC at health centre or community hospital, data on 10 factors (if possible) will be collected by physical examination and historical interviews. Then these data are compared with Table 38 to see the probability value which can state the risk for the mother to deliver a low birth weight newborns. The prediction will reach an ultimate benefit if pregnant women have ANC within the first trimester.

For calculating a probability of LBW, the equation will be

$$P(Y = 1 \mid X_1, \ldots\ldots, X_p) = 1/\{1 + \exp(-a - b_1X_1 - \ldots\ldots - b_pX_p)\}$$

when a = constant value in Table 31
$b_1 — b_p$ = from coefficient value of each variable
$X_1 — X_p$ = value of characteristics

The result from the above equation was if pregnant women who have ANC within the first trimester and have all 10 factors the value of probability will be .9885 or 99%. When using this model to predict LBW newborn in health centre level, it is necessary to be concerned about the data which are not covered by all 10 factors but the probability of LBW can still be derived.

Example for calculating probability

The accurate and valid collected data of pregnant women who come to have ANC at health centre or community hospital will be Height (X_2), Systolic B.P. (X_3). Parity (X_6), Bleeding (X_7) which can predict LBW by replacing *a* and b_x from Table 31 in the equation :

$$P(Y = 1 \mid X_2, X_3, X_6, X_7) = 1/\{1 + \exp(- a - b_2X_2 - b_3X_3 - b_6X_6 - b_7X_7)\}$$

$$= 1/\{1+ [- (- 1.6743) - .3354\ X_2 - 1.3703\ X_3 - .5113\ X_6 - 1.2030\ X_7]\}$$

$$= .8514$$

Then the constant value, coefficient value and X value of each variable associated with LBW be used to calculate probability value in predicting LBW in Table 38

Philippa, Adelstein and Jean Fedrick had studied the model to predict LBW outcome similar to this study by study factors associated with low birth weight of newborns delivered at term.[14] The risk factors from that study will be changed to a score by divided into 2 groups ; parous and non-parous woman. If pregnant women who had ANC, had any qualification which was the risk factors of LBW, the score of each factors will be gathered and can predict the chance whether that pregnant woman will deliver low birth weight newborns or not.[57] For this study, the methodology is the same as the study of Jean Fedrick et al[14] that is to study maternal risk factors for LBW newborns then bring these risk factors in MLR Analysis. The result which is different from the scoring system in predicting LBW is that the result from MLR analysis can show the association between variables and LBW when controlling for other variables and can predict the probability of LBW outcome from qualifications which were statistically significant factors for LBW as shown in Table 38.

Table 38, if pregnant women who had ANC had qualifications of 10 factors in Model I, we can predict that these women had a high opportunity to deliver a low birth weight newborn at 99% or if these qualifications become less, it can read the probability value of LBW as in Table 38. It is due to the accuracy and completeness of the collected data.

Table 38 Model I : Prediction probability of LBW outcome (MLR analysis)

Probability	Factors									
	X1 M.Wt <45 kgs	X2 M.Ht <150 cm	X3 Sys BP >140mmHg	X4 M. age <19,≥35	X5 F. Occ: Labour	X6 Parity (1,≥4)	X7 Bleeding: Yes	X8 Same or less food intake	X9 Coffee/ tea : yes	X10 Smoking : yes
.9885										
.9039										
.8979										
.8964										
.8920										
.8826										
.8779										
.8763										
.8686										
.8514										
.8495										
.8405										
.8320										
.8272										
.8250										
.8149										
.8125										
.8118										
.8029										
.7746										

Model II consists of five variables ; Maternal height, Maternal age, Systolic Blood Pressure, Parity and Bleeding. Model II will be extremely useful when accurate and valid data for five variables are completely collected. It can predict the probability value of pregnant women who have an ANC with five variables up to 92 percent (Table 39). The following recommendation is to examine the accuracy of two predictive models.

Table 39 Model II : Prediction probability of LBW outcome (MLR analysis)

Probability	Factors				
	X1 Maternal Ht <150 cms	X2 Syst B.P > 140 mmHg	X3 Maternal .age <19. ≥35	X4 Parity (1, ≥4)	X5 Bleeding : Yes
.9228					
.8876					
.8811					
.8391					
.8304					
.8303					
.7843					
.7669					
.7636					
.7061					
.7059					

CONCLUSION AND RECOMMENDATION

The present study applies the risk approach for maternal risk factors for LBW newborns in Thailand. This study can be considered as a managerial tool for developing local strategies and is particularly useful in maternal and child health care. The objectives of the study are to identify and to assess the relative importance of the various maternal risk factors for LBW newborns and to make policy recommendations aiming at reducing the maternal risk factors through future public health intervention programs as following :—

1. From a conclusion of maternal risk factors for Low Birth Weight newborns by M-H procedure as in Table 30, data can be used as a health educational tool for pregnant women. It also can be used to inform the public about the risk factors for LBW newborn which will be extremely useful for Thai women of reproductive age in reducing the risk for LBW newborns.

2. From a conclusion of the study by using MLR Analysis, Model I and Model II (Table 38 & 39) can be used in predicting which pregnant women will deliver LBW newborn as, especially from the first trimester. If the prediction has been proved and shows its accuracy, the two models will be extremely useful for Thai people. For the usage, the investigators think that the Model I will be appropriate for applying at the level of provincial and district hospitals while the Madel II should be used at the health centre level which is at the periphery of the health delivery system and regularly gives the service of ANC. If any pregnant woman is at risk of LBW by either model, she will be advised about caring for herself or by referring her to other appropriate services.

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ANNEX

ANNEX 1 — TRAINING PROGRAMME

ANNEX 2 — QUESTIONNAIRES INSTRUCTION

ANNEX 3 — QUESTIONNAIRES

ANNEX 4 — RESEARCH PERSONNEL

ANNEX 1

TRAINING PROGRAMME

MATERNAL RISK FACTORS
FOR LOW BIRTHWEIGHT NEWBORNS IN THAILAND

DURING 17 — 19 MARCH 1986

AT THE INSTITUTE OF HEALTH RESEARCH
CHULALONGKORN UNIVERSITY

MARCH 17, 1986

9.00 — 9.30 A.M	REGISTRATION
9.30 — 10.00 A.M	OPENING CEREMONY
10.00 — 12.00 A.M	INTRODUCTION TO THE RESEARCH PROJECT THE QUESTIONNAIRE FORM AND THE DEFINITION
12.00 — 1.30 P.M	LUNCH
1.30 — 4.00 P.M	OPEN DISCUSSION

MARCH 18, 1986

8.30 — 10.30 A.M	OPEN DISCUSSION AND TRAINING THE METHOD OF INTERVIEWING
10.30 — 10.45 A.M	BREAK AND COFFEE
10.45 — 12.00 A.M	TRAINING (CONT.)
12.00 — 1.30 P.M	LUNCH
1.30 — 4.00 P.M	TRAINING AND DISCUSSION (CONT.)

MARCH 19, 1986

8.30 — 10.15 A.M	THE STEP OF DATA COLLECTION
10.15 — 10.30 A.M	BREAK AND COFFEE
10.30 — 12.00 A.M	OPEN DISCUSSION ON STEP OF DATA COLLECTION
12.00 — 1.30 P.M	LUNCH
1.30 — 4.00 P.M	REVISE THE QUESTIONNAIRE FORM

CLOSE THE SEMINAR

INSTRUCTION FOR DATA COLLECTION

1. DEFINITION

1.1 **Cases** : Pregnant women who delivered a single low birth weight newborn (weight under 2500 grams) during the recruitment period.

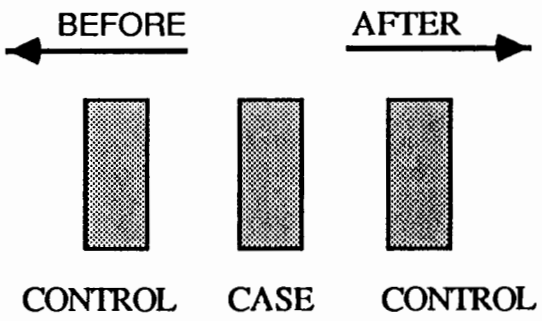
1.2 **Controls** : Pregnant women who delivered normal weight newborns (single birth) weight 2500 — 4000 grams, from the same study areas :

The proportion of cases to controls is 1 : 2 Cases and Controls will be interviewed by using the same structured questionnaires.

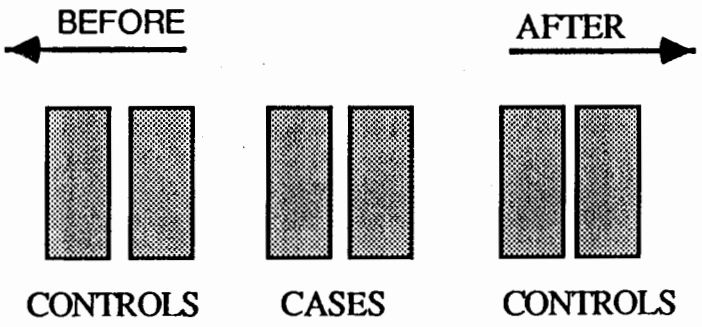
2. SELECTION OF CASES & CONTROLS

2.1 Potential cases are found by systematic daily review of lists of delivery women.

2.2 Select 2 Controls for each case by choosing two fullterms, born alive precedingly and subsequently to each case.



OR



Live Birth : Live birth is the complete expulsion or extraction from its mother of a product of conception, irrespective of duration of pregnancy, which after such separation, shows some evidence of life eg. breathing, beating of the heart, movement of voluntary muscles.

Foetal Death : Foetal death is death prior to the complete expulsion or extraction from its mother of product of conception, irrespective of duration of pregnancy, the death is indicated that after such separation the foetus does not breath or show any evidence of life.

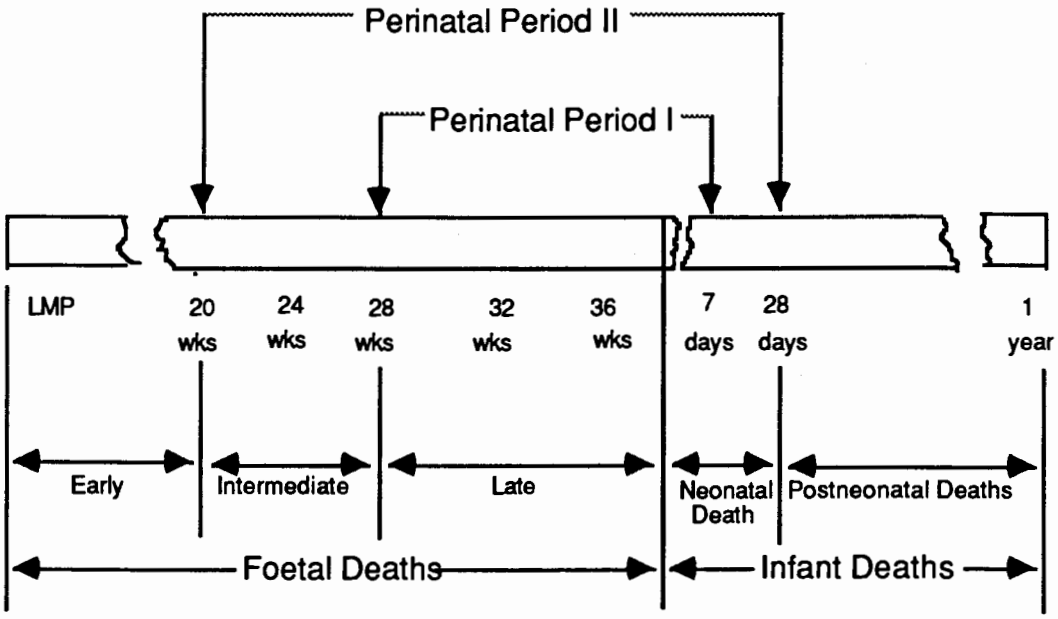
Low Birth Weight Infants : Infants weighing less than 2500 grams. This definition encompasses both type of small infants

— Preterm infants : Infants delivered before 37 completed weeks (due to short gestational period)

— Small-for-dates infants : Infants whose birth weight is less than expected for gestational age (due to intrauterine growth retardation and foetal malnutrition)

Infant and Neonatal mortality

Neonatal mortality	:	Infant's death under 28 days of age.
Postneonatal mortality	:	Infant's death between 28 days and one year.
Infant mortality	:	Infant's death after birth to one year.
Perinatal mortality I	:	Deaths between 28 weeks of gestation and 7 days after birth.
Perinatal mortality II	:	Deaths between 20 weeks of gestation and 28 days after birth.



Measures of mortality in early life. Foetal death registration varies in different jurisdictions. (LMP - First day of last menstrual period)

Reference :

Mausner JS, Bahn AK. Infant and Neonatal Mortality. In : EPIDEMIOLOGY- An Introductory Text. Philadelphia : W.B. Saunders, 1974. 189

ANNEX 2

Estimation of gestational age of the newborn

Sites	Gestational age 32 weeks or less	34 — 37 weeks	37 weeks or more
1. Scalp hair	Fine and fuzzy	Fine and fuzzy	Silky
2. Ear lobe	Pliable, no cartilage	Some cartilage	Stiffened by thick cartilage
3. Nipple	2 mm.	4 mm.	> 7 mm.
4. Genitalia			
Male :			
Scrotum	Small , empty	Intermediate	Full
Rugae	Few	Intermediate	Extensive
Testis	In lower canal	Intermediate	Pendulous
Female :			
Labia minora	Prominently seen	Seen at same level with L.majora	Covered by L.majora
5. Sole creases	Anterior transverse crease, only anterior 1/3	Creases anterior two thirds	Sole covered with creases

Reference :

Behrman RE, Fisher D, Paton JB, and Keller J. In Utero Disease and Newborn Infant. In : Schulman I (ed). Advances in Pediatrics. Chicago: Year book medical publishers, 1970. vol 17.

ANNEX 3

QUESTIONNAIRE FORM

MATERNAL RISK FACTORS FOR LOW BIRTH WEIGHT NEWBORNS IN THAILAND

FACULTY OF MEDICINE, CHULALONGKORN UNIVERSITY
DEPARTMENT OF PREVENTIVE & SOCIAL MEDICINE
DEPARTMENT OF PEDIATRICS
DEPARTMENT OF OBSTETRICS & GYNECOLOGY

INSTITUTE OF HEALTH RESEARCH,
CHULALONGKORN UNIVERSITY
BANGKOK, THAILAND

MINISTRY OF PUBLIC HEALTH
DIVISION OF FAMILY HEALTH, DEPARTMENT OF HEALTH
KHONKAEN MCH CENTRE
CHIANGMAI MCH CENTRE
NAKORNSAWANN MCH CENTRE
RATCHBURI MCH CENTRE
YALA MCH CENTRE
MAHARAJ NAKORNSRITHAMMARAJ HOSPITAL

MATERNAL RISK FACTORS FOR LOW BIRTH WEIGHT NEWBORNS IN THAILAND

Filing Date _____ Running No. _____

code

Study Areas :

_ 1. CHULALONGKORN HOSPITAL
_ 2. CHIENGMAI MCH CENTER
_ 3. NAKORNSAWANN MCH CENTRE
_ 4. KHONKAEN MCH CENTRE
_ 5. RATCHBURI MCH CENTRE
_ 6. YALA MCH CENTRE
_ 7. MAHARAJ NAKORNSRITHAMMARAJ HOSPITAL

Mother's name _____ Last name _____

Father's name _____ Last name _____

Present Address : Number _____ Street _____

District _____ City _____ Zip code _____

Telephone Number _____

How long have you been living at present address ? _____ year / month (s)

Previous Address : Number _____ Street _____

District _____ City _____ Zip code _____

How long have you been living at previous address ? _____ year / month (s)

The infant's registered number H.N _____ Building _____

The infant's I.D Number _____ Building _____

Interviewee's Status

__ CASE __ CONTROL

Mother's name _____ HN _____

code

Section A : Data of newborn and mother in delivery room
(Obtained from the delivery's room record)

1. Birth's date _____ Time at birth _____
2. Sex _1. Male _2.Female
3. Birth weight _____ grams
4. Birth length _____ centimetres
5. Head circumference _____ centimetres
6. Chest circumference _____ centimetres
7. Left mid-arm circumference _____ centimetres
8. Delivered by :
   - _ 1. Physician
   - _ 2. Nurse R.N / G.N
   - _ 3. Midwifery nurse
   - _ 4. Assistant nurse
   - _ 5. Medical student
   - _ 6. Nurse student / Midwifery student
   - _ 7. Other (Specify) _____
9. Type of delivery :
   - _ 1. Normal labour
   - _ 2. Forceps extraction
   - _ 3. Vacuum extraction
   - _ 4. Breech extraction
   - _ 5. Breech assisting
   - _ 6. Cesarean section
   - _ 7. Other (Specify) _____
10. If Cesarean section, specify the indication :
   - _ 1. Old aged primigravida (> 35 years)
   - _ 2. Previous Cesarean section
   - _ 3. Foetal distress
   - _ 4. Foetus in transverse position
   - _ 5. Cephalo-Pelvic disproportion
   - _ 6. Placenta previa
   - _ 7. Premature rupture of membrane
   - _ 8. Other (Specify) _____

Mother's name _____ HN _____

code

11. Maternal complication during labour

_ 1. None _ 2. Yes (Specify) _____

_____

12. Gestational age (Estimated from last menstrual period)

_ 1. Term (37 — 42 weeks)

_ 2. Pre-term (Less than 37 weeks)

_ 3. Post-term (More than 42 weeks)

13. Congenital Anomalies (Birth defects)

_ 1. No _ 2. Yes (Specify) _____

_____

14. Was an infant having a normal breathing at birth ?

_ 1. Normal

_ 2. No, having used resuscitator

about _____ minutes

_ 2.1 Baby alive _ 2.2 The baby died

15. Placental weight _____ grams

16. Placental appearance _____

Mother's name _____ HN _____

code

Section B : Mother's data at time of admission or in the delivery room

Some information can be obtained from mother's ANC records

17. Mother's weight (before labour) _____ Kgs.
18. Mother's height _____ Centimetres
19. Mother's left arm circumference _____ Centimetres
20. Blood pressure before labour _____ mmHg.
21. Urinalysis

    Protein: _ Positive _ Negative

    Sugar : _ Positive _ Negative

    Result obtained from

    _ ANC _ Delivery room

    _ Not done

22. Blood test :

    Haemogobin (Hgb) _____ Gm %

    Haematocrit (Hct) _____ %

    Result obtained from

    _ ANC _ Delivery room

    _ Not done

    VDRL _ Negative _ Positive : Titer _____

    TPHA_ _ Negative _ Positive

    Result obtained from

    _ ANC At _____ months of gestation

    _ Delivery room

    _ After labour

    _ Not done

    If having positive serology, treatment (Specify)_____

    R_x given at _ ANC At _____ months of gestation

    _ Delivery room

    _ After labour

    _ Not done

Mother's name _____ HN _____

code

Section C : The newborn's data

Collect all the following information (No.23 — No.31)from the newborns' record on the day of discharge or 1 — 2 days before discharge.

23. The gestational age assessed by Pediatrician _____ weeks
    _ No record
24. Does the baby have any fever while staying in the hospital ?
    _ 1. Yes (Specify) Age at starting of fever _____ days
    Duration of fever _____ days
    _ 2. No
25. Is the baby jaundice ?
    _ 1. No (Skip to answer Q.27)
    _ 2. Yes (Specify) Total Bililubin _____ mg %
    Highest level _____ mg %
    At the age of _____ days
26. If Jaundice noted, specify the treatment the baby received
    _ 1. Photo therapy
    _ 2. Exchange transfusion
    _ 3. Other treatment (Specify) _____
    _ 4. No treatment , (Specify) _____
27. Does the baby have any other diseases detected ?
    _ 1. No _ 2. Yes (Specify) _____
    _____
28. Baby's condition while staying in the hospital
    _ 1. Baby's crib in the nursery
    _ 2. Incubator (Almost)
    _ 3. With mother, occasionally (breast-feeding)
    _ 4. With mother all the time
    _ 5. Other (Specify) _____

code

29. Type of baby's feeding while staying in the hospital

_ 1. Breast-feeding only

_ 2. Bottle-feeding only

_ 3. Mixed (1 + 2)

_ 4. Other (Specify) _____

30. How many days does the baby stay in the hospital ?

_____ days Date at discharge _____

31. Does the baby return home with mother ?

_ 1. Yes, the baby returns home with mother

_ 2. No, after mother has returned home for _____ days

_ 3. No, the baby died (at the age of _____ days

_ 4. Other (Specify) _____

Mother's name _____ HN _____

code

Section D : Data concerning baby's parents by interviewing

32. The mother's age _____ years
    Date of birth _____ (Thai Zodiac year)
    The father's age _____ years
    Date of birth _____ (Thai Zodiac year)

33. The parents' religions
    _ 1. Both are Buddhists
    _ 2. Both are Christians
    _ 3. Both are Muslims
    _ 4. Different religions
    (Specify) Mother's religions _____
    Father's religions _____

34. Marital status
    _ 1. Married, living together (with marriage license)
    _ 2. Married, living together (without marriage license)
    _ 3. Divorced
    _ 4. Separated (could not get along)
    _ 5. Job separation
    _ 6. Widow
    _ 7. Other (Specify) _____

35. Education (specify highest level of education)

	Mother	Father
	_____	_____

36. Occupation

	Mother	Father
Principal occupation	_____	_____
Other occupation	_____	_____

code

37.Working status :

	Principal occupation	
	Mother	Father
1. An employer	___	___
2. Civil servant	___	___
3. Private employee	___	___
4. Private business	___	___
5. Family business (Without salary)	___	___
6. House-wife	___	___
7. Unemployed	___	___
8. Student	___	___

38. How far is it from your house to your work place _____ Kms.

How long does it take for travelling _____ minutes/ hours

___ Work at home

How do you go to your work place ?

_ On foot _ By transportation

(Specify) _____

How was about the road condition from your residence to your work place ?

_ 1. Smooth road _ 2. Pot hole road

_ 3. Fair-sidewalk _ 4. Unsmooth sidewalk

_ 5. Other (Specify) _____

39. How many children are under your responsibility now ? (Including the present one) _____ person (s)

40. How much family's income do you have ? (per month)

(Specify total _____ Bahts)

41. Check your residence's surrounding area :

_ 1. Residential area

_ 2. Farming area

_ 3. Commercial area

_ 4. Industrial area

(Specify the type of factory) _____

_ 5. Slum area

_ 6. Other (Specify) _____

Mother's name _____ HN _____

code

Section E : Mother's medical and reproductive history

42. Age at menarche _____ years

43. Number of gestation _____ (Including the present one)

If twin, specify _____

44. Did you ever have a still-born ?

_ 1. No _ 2. Yes (How many _____)

45. Number of abortion _____ times,

Non-criminal abortion _____ times

Criminal abortion _____ times

46. Number of alive premature birth _____

(Not including this gestation)

_ Don't know

47. Number of living children at present. (Including the present one)

(Specify) _____

48. Number of dead children. (Not including the present one)

(Specify) _____

49. How long was your last pregnancy interval ?

About _____ year(s) / month(s)

50. Have you ever had any complications during your previous pregnancies ?

_ 1. No

_ 2. Yes (specify) _____

_ 3. Could not remember

Mother's name _____ HN _____

code

Section F : Mother's current pregnancy history

51. Have you ever had Tetanus Toxiod injection during your pregnancy ?
    - _ 1. No
    - _ 2. Yes, 1 injection
    - _ 3. Yes, 2 injections
    - _ 4 Not sure or don't know

52. Have you ever had Tetanus Toxiod injection before ?
    - _ 1. Never
    - _ 2. Yes, in the year of 19 ___ or _____ year(s) ago
    - _ 3. Not sure or don't know

53. How much did your weight before starting this pregnancy ?
    - _ 1. Weight _____ (Kgs) at _____ months before pregnancy
    - _ 2. Don't know or never weighted

54. Have you used contraception within a year before your pregnancy ?
    - _ 1. Yes
    - _ 2. No, (skip to answer Q.57)

    If yes, please specify your last contraceptive method
    - _ 1. IUD
    - _ 2. Oral pills
    - _ 3 Injection
    - _ 4. Other (specify) _____

55. How long have you been using the last contraceptive method ?
    _____ year / months

56. How long did you stop using contraceptive before starting this pregnancy ?
    - _ 1. Right away
    - _ 2. Pregnancy while still using contraception
    - _ 3. Had completely stopped for _____ years / months before became pregnancy

57. Did you have antenatal check up for this pregnancy ?
    - _ 1. Yes
    - _ 2. No (skip to answer Q.61)

code

58.Where did you often go for antenatal check up ?

_ 1. Maternal and Child Health Centre
_ 2. Community Hospital (District Hospital)
_ 3. General Hospital (Provincial Hospital)
_ 4. Health Centre
_ 5. Private Clinic
_ 6. Private Hospital
_ 7. Municipal Health Centre, Bangkok Metropolis
_ 8. Government Hospital / Chulalongkorn Hospital

59. When did you have first antenatal check up ?
Specify gestational age _____ month(s)

60. How many times did you have antenatal check up during your pregnant period ? _____ time (s)

61. Mother's weight gain (during this pregnancy) _____ kgs.

_ 1. Don't know

Please specify mother's weight during pregnancy
(From ANC record)

Gestational age	Weight (Kgs)
_____	_____
_____	_____
_____	_____

62. Were there any complication during your pregnancy ? (If yes, please specify the gestational age when first had that symptom)

_ 1. Edema : Specify gestational age _____ month (s)
_ 2. High blood pressure (> 140/90 mmHg) :
Specify gestational age _____ month (s)
_ 3. Convulsion :
Specify gestational age _____ month (s)
_ 4. Vaginal Breeding :
Specify gestational age _____ month (s)
_ 5. Leakage of amniotic fluid more than twelve hours before delivery
_ 6. Other (Specify) _____

code

63. Did you take more amount of food during your pregnancy (than previous pregnancy)

_ 1. No, as usual

_ 2. Yes, more than usual

_ 3. Less than usual (Please specify reasons) _____

_____

_ 4. Other (specify) _____

64. During this pregnancy, did you have any kind of extra-food ?

_ 1. No

_ 2. Yes (specify the kind of food) _____

_____

65. During this pregnancy, did you take any unnatural food ?

_ 1. No

_ 2. Yes (specify the kind of food) _____

_____

66. Which food do you consider as prohibited food for pregnant women ?

(Write down every word) _____

67. Did you avoid eating prohibited food during pregnancy ?

_ 1. No

_ 2. Yes (specify the kind of food) _____

_____

(Specify gestational age when start to avoid eating prohibited food _____ months)

68. Did you drink drug containing alcohol during this pregnancy ?

_ 1. No

_ 2. Yes

	ALCOHOLIC DRUG	ALCOHOLIC SPIRIT
_ Drink (everyday)		
Specify quantity	_____	_____
_ Drink (seldomly)		
Specify quantity	_____	_____
_ Other(Specify)	_____	_____

69. Did you drink coffee or tea during this pregnancy ?

_ 1. No, not at all

_ 2. Drink (everyday) specify number(s) of cup/day _____

_ 3. Drink (seldomly)

_ 4. Other (specify) _____

code

70. Did you drink tonic ?

_ 1. No

_ 2. Yes, specify the name of tonic _____

quantity / day _____

71. Did you smoke cigarettes during this pregnancy ?

_ 1. No

_ 2. Yes, specify quantity / day_____

72. Did you smoke any hashish or other addictive drug during this pregnancy ?

_ 1. No

_ 2. Yes, specify quantity / day_____

73. Have you ever had any quarrel with your husband during this pregnancy ?

_ 1. No (skip to answer Q.75)

_ 2. Yes, because

_ 2.1 Your husband drank

_ 2.2 Your husband had other girl friends / second wife

_ 2.3 Other (specify) _____

_____

74. Has your husband ever hurt you during this pregnancy ?

_ 1. Yes, specify how often _____

The first time you were hurt, it was _____

month (s) of gestation.

_ 2. No

75. Did you have any accident during this pregnancy ?

_ 1. No

_ 2. Yes, specify what was the accident _____

_____

76. Did you have problems which made you sad during this pregnancy ?

_ 1. No

_ 2. Yes, specify the preblem _____

and specify gestational age _____ month (s)

77. Did you have any problems which frightened you during this pregnancy ?

_ 1. No

_ 2. Yes, specify the preblem _____

and specify gestational age _____ month (s)

code

78.Have you ever used any drug to terminate your pregnancy (at the beginning of this pregnancy) ?

_ 1. Yes, _ 2. No, (skip to answer Q.81)

If yes, by which route

_ 1. Ingestion _ 2. Injection (skip to answer Q.80)

79. If you have ever used such drug, please specify the gestational age you first had if _____ month (s)

Dosage : _____ tablets each time

No. of ingestion daily _____

No. of days used _____

80. If you have ever had injection, please specify the gestational age you first had it _____ month (s)

No of injection _____

81. Have you used other medication during your pregnancy ?

_ 1. Yes _ 2. No

If yes, please specify

Name of drugs	Used for	Duration of usage	Gestational age (months)

82. Have you ever been sick during this pregnancy ?

_ 1. Yes _ 2. No (skip to answer Q.85)

83. If yes and you had to be on medication during pregnancy, please specify names of medicine that you used .

Disease/Symptoms	Age of gestation	Prescription issued from	Name of drugs (Specify)

code

84. Have you ever heard of German Measles ?

_ 1. Yes _ 2. No (skip to answer Q.90)

85. Have you ever got ill with German Measles ?

_ 1. Yes _ 2. No

_ 3. Don't know _ 4. Not sure

86. If you have ever heard, do you know about its sympton ?

_ 1. Yes _ 2. No

If yes, please specify the symptoms

_ 1. Having fever

_ 2. Rashes all over body

_ 3. Enlarged lymph glands over body

_ 4. Other (specify) _____

87. During your pregnancy, were you exposed to anybody who were ill of German Measles ?

_ 1. No

_ 2. Yes, specify who was he/ she _____

88. Have you had German Measles during your pregnancy ?

_ 1. Yes

_ 2. No.....skip to answer Q90

_ 3. Don't know.....skip to answer Q90

89. If yes, what kind of treatment did you get ?

_ 1. Medicine prescribed by physician

_ 2. Self treatment

_ 3. Do nothing

_ 4. Other (speicify) _____

90. Diseases or symptoms you usually have

Yourself _ No _ Yes, (specify the disease)

_____

Your husband _ No _ Yes, (specify the disease)

_____

91. Total number sof day in the hospital after labour _____day(s)

Date of mother's discharge from hospital _____

ANNEX 4

RESEARCH PERSONNEL

1. **Principal Investigator**

Termsri Chumnijarakij, M.D.
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Head, Department of Preventive & Social Medicine,
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2. **Co-Investigators**

1) *Thassanee Nuchprayoon*, M.D.
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2) *Saree Chitinand*, M.D.
Associate Professor in Pediatrics
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3) *Yupha Onthuam*, MS. (Statistics)
Head, Data Processing Unit,
Institute of Health Research
Chulalongkorn University, Bangkok.

4) *Nanta Ouamkul*, M.D.
Senior Staff Physician
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5) *Ong-arj Viputsiri*, M.D.
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7) *Sompop Limpongsanurak*, M.D.
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8) *Sanya Sunyavivat*, Ph.D. (Sociology)
Associate Professor in Sociology
Faculty of Political Sciences,
Chulalongkorn University

9) *Suchart Vongkietkajorn*, M.D.
Former Director, Chiangmai MCH Centre (North)

10) *Mongkol Jittawatanakorn*, M.D.
Director, Khonkaen MCH Centre (Northeast)

11) *Sopon Chalapati*, M.D.
Director, Chiangmai MCH Centre (North)

12) *Vallop Thaineau*, M.D.
Director,Nutrition Division,
Department of Health, Ministry of Public Health

13) *Siripon Kanshana*, M.D.
Pediatrician, Nakornsawann MCH Centre (North)

14) *Pradit Sukomol*, M.D.
Director, Ratchburi MCH Centre (Central)

15) *Kamin Punprasong*, M.D.
OBGYN, Ratchburi MCH Centre (Central)

16) *Aroon Ratanaparikorn*, M.D.
Head, Department of Obsteric & Gynaecology,
Nakornsrithammaraj Maharaj Hospital

17) *Anan Sulaimand*, M.D.
Director, Yala MCH Centre (South)

RESPONSIBILITIES OF RESEARCH PERSONNEL

Principal investigator

The principal investigator will be responsible for research design and research planning. All administrative and organization work will be the responsibility of the principal investigator with the cooperation of the co-investigators and the research assistants. She will be responsible for on-going or process evaluation of the project. Finally, the report writing will be the responsibility of the principal investigator.

Research assistants

The research assistants (social scientist or Biostatistician) will be responsible for the coordination of each phase of the study. They will have to handle all administrative work and timetable. All of the following jobs will be the responsibility of research assistants with close supervision of the project investigators : recruitment of interviewers, preparation of questionnaires, pretest and revision of the questionnaires, extraction and collection of the data. One research assistant will be responsible for the Northern and North-Eastern study areas. The another research assistant will take responsibility for the Central, Western and Southern study areas. Also they will insure data processing, analysis and programming with close supervision of the Statistician.

Research secretary

The secretary will be responsible for all clerical work. She will also assist the research assistants all administrative work; data extraction, data collection and data analysis.

Interviewers

The interviewers will be responsible for collection of data from all of 6 study areas. One interviewer will be responsible for each study area. They will be trained by the investigators before starting the project. All questionnaires will be completed and checked by the interviewers. These

interviewers will work with close supervision of the research assistants and the investigators.

Research Statistician

The statistician will be responsible for design and formulation of questionnaires pretest and revision of questionnaires. All data processing, data analysis and programming work be done by the statistician.

Co-investigators and support-staff

The co-investigators and the support-staff will take responsibility for administrative and organization work for each study site. Also they will be responsible for the coordination of each phase of study including process evaluation of the project.