EFFECT OF MATERNAL FOOD CHOICES AND PREGNANCY SYMPTOMS ON BIRTH OUTCOMES

by

AINOR FARAHIN BINTI AZIZ

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Kesan Pemilihan Makanan Ibu dan Simptom Kehamilan kepada Hasil Kelahiran Bayi

ABSTRAK

Pemakanan ibu dan simptom kehamilan telah menunjukkan impak kepada anak yang dilahirkan. Kajian keratan rentas ini bertujuan untuk menyiasat perkaitan antara pengambilan makanan ibu dan simptom semasa kehamilan dengan hasil kelahiran bayi. Seramai 99 wanita hamil yang berada di trimester ketiga (32 hingga 40 minggu kehamilan) telah diambil dari Klinik Obstetrik dan Ginekologi dan dua antenatal wad iaitu 2 Baiduri dan 2 Akik, Hospital Universiti Sains Malaysia. Ibu-ibu telah ditemubual dan disoal selidik bagi melengkapkan borang kekerapan pengambilan makanan dan borang simptom semasa kehamilan yang telah disahkan. Berat, panjang dan lilitan kepala bayi diukur dalam masa 72 jam selepas bersalin. Data dianalisis dengan menggunakan regresi pelbagai yang telah diselaraskan untuk ketinggian ibu, indeks jisim tubuh sebelum hamil, pariti, usia kandungan semasa kelahiran dan jantina bayi. Antara kumpulan makanan yang dianalisis, kumpulan makanan jenis kuih-muih dikaitkan dengan berat lahir bayi yang kurang (β = -100.36, P = 0.028), lilitan kepala yang kecil (β = -0.47, P = 0.025) dan indeks ponderal yang rendah (β = -0.84, P = 0.024). Begitu juga dengan kumpulan makanan jenis perasa yang menunjukkan perkaitan negatif dengan berat lahir bayi (β = -106.25, P = 0.021) dan lilitan kepala (β = -0.47, P = 0.026). Manakala, pengambilan teh dan kopi dikaitkan dengan nisbah lilitan kepala kepada berat lahir bayi yang lebih tinggi (β = 0.28, P = 0.036). Antara tiga kategori bagi simptom kehamilan yang dianalisis, hanya kekerapan bagi kategori simptom umum menunjukkan hubungan yang positif dengan indeks ponderal (β = 0.17, P = 0.003). Manakala, keterukan bagi kategori simptom alahan semasa mengandung menunjukkan perkaitan negatif dengan panjang kelahiran bayi (β = -0.10, P = 0.027). Perbandingan pengambilan kumpulan makanan ke atas status pra-kehamilan IJT (kurang berat, normal, berat badan berlebihan) yang berbeza telah dianalisis dengan menggunakan ujian Kruskal-Wallis. Antara 11 kumpulan makanan, minuman kumpulan makanan menunjukkan perbezaan yang signifikan dengan P<0.01. Dari penemuan ini, dapat disimpulkan bahawa pengambilan diet ibu dan simptom yang dialami semasa kehamilan memberi kesan yang bermanfaat dan juga kesan buruk kepada pertumbuhan janin. Oleh itu, pemilihan makanan dan pengurusan simptom semasa kehamilan mungkin penting bagi kesihatan bayi pada jangka masa panjang.

Effect of Maternal Food Choices and Pregnancy Symptoms on Birth Outcome

ABSTRACT

Maternal nutrition and pregnancy symptoms were shown to exert impacts on birth outcome. This cross-sectional study aimed to investigate the association of maternal food groups intake and pregnancy symptoms with birth outcome. A total of 99 pregnant women who were at their third trimester (32 to 40 gestational weeks) of gestation were recruited from Obstetrics and Gynaecology Clinic, two antenatal wards which were 2 Baiduri and 2 Akik of Hospital Universiti Sains Malaysia. Mothers were interviewed to complete the validated Food Frequency Questionnaire and Pregnancy Symptoms Questionnaire. Birth weight, birth length and head circumference were measured within 72 hours after delivery. Data were analysed using multiple linear regression adjusted for maternal height, prepregnancy body mass index, parity, gestational age at birth and neonatal gender. Among food groups, confectioneries was associated with lower birth weight (β=-100.36, P=0.028), head circumference (β=-0.47, P=0.025) and ponderal index (β=-0.84, P=0.024). Similarly, condiments showed a negative association with birth weight (β=-106.25, P=0.021) and head circumference (β=-0.47, P=0.026) while tea and coffee intake was associated with higher head circumference to birth weight ratio (β=0.28, P=0.036). Among pregnancy symptoms categories, frequency of general symptoms showed a positive association with ponderal index (β=0.17, P=0.003) and severity of constitutional symptoms showed a negative association with birth length (β=-0.10, P=0.027). Comparison of food group intake across different pre-pregnancy BMI status (underweight, normal, overweight) was analysed using Kruskal-Wallis test. Among 11 food groups, beverage food group showed significant difference with P<0.01. These findings suggest that maternal dietary intake and pregnancy symptoms exert beneficial and adverse effects on foetal growth. Food selection and pregnancy symptoms management during pregnancy therefore will be important for long term health consequences of the child.

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LIST OF ABBREVIATIONS

BMI	Body mass index
IJT	Indeks Jisim Tubuh
NBW	Normal birth weight
LBW	Low birth weight
VLBW	Very low birth weight
PRNV	Pregnancy-related nausea vomiting
IUGR	Intrauterine growth restriction
SGA	Small for gestational age
WHO	World Health Organization
FIGO	International Federation of Gynaecology and Obstetrics
IOM	International of Medicine
RDA	Recommended Daily Allowance
RNI	Recommended Nutrient Intake
PUFA	Polyunsaturated fatty acids
UNIMMAP	United Nations International Multiple Micronutrient Preparation
MMS	Multiple-micronutrient supplementation
CRP	C-reactive protein
PM	Particulate matter
NO_2	Nitrogen dioxide
SHS	Second hand smoke
PTB	Preterm birth
PAH	Polycyclic aromatic hydrocarbons
HG	Hyperemesis gravidarum
PI	Ponderal index
SES	Socio-economic status
LMP	Last menstrual period
FFQ	Food frequency questionnaire
PSQ	Pregnancy symptoms questionnaire
SCM	Sweetened condensed milk
EFA	Essential fatty acids

CHAPTER 1: INTRODUCTION

1.1 Background of study

Maternal nutrition can determine the outcome of pregnancy. Maternal nutrition has significant associations with birth outcomes. Maternal nutrition comprises anthropometric characteristics such as pre-pregnancy weight-for-height (i.e., body mass index [BMI]) and gestational weight gain (which partly reflects the balance between energy intake and energy expenditure, but also includes increases in body water), as well as intake of protein and micronutrients (vitamins and minerals). Pregnancy is a crucial period during which good maternal nutrition is a key factor influencing the health of both child and mother (American Dietetic Association, 2002). Of the pregnancy outcomes that might be affected by maternal nutrition, the one encountered most often in the research literature is low birth weight, that is, a birth weight less than 2500 g. There is a lot of research literature associate the effect of pregnancy symptoms on neonatal birth outcomes but mostly it mentioned about pregnancy symptoms such as hyperemesis gravidarum, nausea and vomiting (Behrman *et al.*, 1990; Pike, 2000; Veenendaal *et al.*, 2011; Forbes, 2002).

In Malaysia, from the year 2000 until 2009 the percentage of newborn for low birth weight is 11% (WHO Statistic, 2011). The neonatal mortality rate is 3 per 1000 live birth reported in 2009 (WHO Statistic, 2011). For Asian countries like Malaysia, the survival rate of neonatal for very low birth weight (VLBW) which is less than 1500 g is quite high which was 81% in 2003 compared to other countries like Iran and Thailand which were 66.6% and 78.4% in 1998 respectively (Ballot *et al.*, 2010). Even

though the survival rate of VLBW neonatal is higher than other countries, the most important thing is to avoid such things from happened. As we know, baby born in their inappropriate weight reflected the maternal nutrition intake during pregnancy. The weight of the infant at birth is a powerful predictor of infant growth and survival, and is dependent on maternal health and nutrition during pregnancy (Muthayya , 2009). From the cohort study reported in 1991 and 2003, stated that lower birth weight was also associated with increased rates of glucose intolerance, hypertension, and hyperlipidemia (Hales *et al.*, 1991 and Hales, 2003).

Apart from the studies conducted previously about the relationship between maternal nutrition and its effects on birth outcomes, there is a growing need to determine whether both nutrition factor and pregnancy symptoms factor or either one could directly be associated with birth outcomes. Furthermore, the study about pregnancy symptoms usually mention on hyperemesis gravidarum, nausea and vomiting to investigate their association on maternal nutrient intake and the birth outcomes. Findings from this study could be used for other related study due to lack of research mentioning about other pregnancy symptoms which might also affect maternal nutrition and birth outcomes.

1.2 Problem Statement

According to Barker (1994 & 1995), the "foetal origins" hypothesis stated alterations in foetal nutrition or an adverse environment in utero can lead to a permanent physiological change in the foetus and predispose to chronic disease in later life. Inadequate nutrition secondary to poor maternal protein intake or inadequate micronutrients can lead to foetal growth restriction. This in turn can increase a neonate's risk of hypertension, diabetes, and stroke (Kunz *et al.*, 2007). Maternal

distress during pregnancy was significantly associated with delivery of a low-birth weight infant in a Brazilian study, which 865 women were included (Rondo *et al.*, 2003). Other qualitative research findings indicate that prenatal stress occurs with nausea and vomiting (Chou *et al.*, 2008; Kuo *et al.*, 2007; O'Brien *et al.*, 2002).

Pregnancy is arguably one of the most normal of physiological processes. Pregnancy is usually perceived as a joyful experience of expectation socially and individually. Being pregnant, however, has its stressors, especially for women who experience uncomfortable symptoms such as nausea and vomiting (Chou and Chen, 2000; O'Brien *et al.*, 2002). Nausea and vomiting in pregnancy is the most common pregnancy complication, affecting more than half of all women during the first trimester of pregnancy (Arsenault *et al.*, 2002). These symptoms impact the foetal outcomes such as birth weight (Zhou *et al.*, 1999).

1.3 Objective

1.3.1 General objective

1. To determine the effect of maternal dietary pattern and pregnancy symptoms on birth outcomes.

1.3.2 Specific objectives

1. To examine the distribution of maternal dietary pattern and pregnancy symptoms during late trimester.
2. To investigate the association of maternal food intake during late trimester with birth outcomes.
3. To investigate the association of pregnancy symptoms throughout pregnancy with birth outcomes.

1.4 Research questions

1. What is the maternal dietary pattern and pregnancy symptom during late trimester?
2. Is there any association between maternal food intakes during late trimester with birth outcomes?
3. Is there any association between pregnancy symptoms throughout pregnancy with birth outcomes?

1.5 Research Hypothesis

1.5.1 Null hypothesis, Ho:

1. There is no association between maternal food intake and birth outcomes.
2. There is no association between pregnancy symptoms and birth outcomes.

1.5.2 Alternatives hypothesis, H_A:

1. Maternal food intake during pregnancy is associated with birth outcomes.
2. Pregnancy symptom is associated with birth outcomes.

1.6 Definition of terms

1.6.1 Preterm birth

Preterm birth, defined as childbirth occurring at less than 37 completed weeks or 259 days of gestation. It has long-term adverse consequences for health and a major determinant of neonatal mortality and morbidity (WHO, 1992). It contributes substantially to the incidence of low birth weight and is the heading underlying cause of

infant mortality among infants with nonlethal congenital anomalies (Scholl *et al.*, 2000).

1.6.2 Birth weight

Infant birth weight is currently used as an indicator of a successful pregnancy (Kramer, 2003). The first weight of the foetus or newborn obtained after birth is the birth weight. For live births, birth weight should if at all possible be measured within the first hour of life, before significant postnatal weight loss has occurred. Birth weight is affected to a great extent by the mother's own foetal growth and her diet from birth to pregnancy, and thus, her body composition at conception. Mothers in deprived socio-economic conditions commonly have low birth weight infants. In those settings, the infant's low birth weight stems primarily from the mother's poor nutrition and health over a long period of time, including during pregnancy, the high prevalence of specific and non-specific infections, or from pregnancy complications, because of poverty. Physically demanding work during pregnancy also contributes to poor foetal growth (WHO, 2004).

1.6.3 Low birth weight (LBW)

Low birth weight has been defined by the World Health Organization (WHO) as weight at birth of less than 2,500 grams (5.5 pounds).

Table 1.1: Classification of low birth weight

Category	Weight (g)
Low birthweight	less than 2,500 g (up to and including 2,499 g)
Very low birthweight	less than 1,500 g (up to and including 1,499 g)
Extremely low birthweight	less than 1,000 g (up to and including 999 g)

(Source: WHO, 1992)

The definitions of 'low', 'very low', and 'extremely low' birth weight do not represent mutually exclusive categories. Below the set limits they are all inclusive and therefore overlap (i.e., 'low' includes 'very low' and 'extremely low', while 'very low' includes 'extremely low') (WHO, 1992).

1.6.4 Intrauterine growth restriction (IUGR)

There is no internationally accepted clinical definition for IUGR. Classically, it defined as an estimated foetal weight less than the 10th percentile. Many other studies define IUGR as an infant falling below the 10th, 5th or 3rd centile for gestational age; i.e. babies that are small for gestational age (SGA). Others consider IUGR to be present only when alterations of umbilical blood flows are already in place (Cetin *et al.*, 2001).

1.6.5 Gestational weight gain

Gestational weight gain, defined as how much weight a woman should gain during pregnancy. Infants born to women with inadequate gestational weight gain had odds of infant death that were 2.23 times the odds for infants born to women with normal weight gain. Inadequate gestational weight gain is associated with poor outcomes for infants (Regina *et al.*, 2012).

Table 1.2: Recommendations for total and rate of weight gain during pregnancy, by prepregnancy BMI

Pre-pregnancy BMI	BMI+(kg/m^2) (WHO)	Total weight gain lbs (kg)	Rates of weight gain 2^{nd} and 3^{rd} trimester (mean range in lbs/wk)
Underweight	<18.5	28-40 (12.5-18)	1 (1-1.3)
Normal weight	18.5-24.9	25-35 (11.5-16)	1 (0.8-1)
Overweight	25.0-29.9	15-25 (7.0-11.5)	0.6 (0.5-0.7)
Obesity (include all classes)	≥30.0	11-20 (5.0-9.0)	0.5 (0.4-0.6)

(Source: IOM,2009

1.6.6 Gestational age

Gestational age can be defined as length of pregnancy, determined by counting the number of weeks between the first day of a woman's last normal menstrual and birth (McGuire *et al.*, 2007). Babies born with gestational ages between 37 and 42 weeks are considered full-term infants, whereas those born with gestational ages less than 37 weeks are called preterm infants. The earlier a baby is born, the greater the risk for complications that can affect survival and long term-health due to the fact that organs may not be fully developed and may therefore be unable to sustain life outside the womb.

1.6.7 Pregnancy

Pregnancy is the state of carrying a developing embryo or foetus within the female body. This condition can be indicated by positive results on an over-the-counter urine test, and confirmed through a blood test, ultrasound, detection of foetal heartbeat, or an X-ray (Webster's New World™ Medical Dictionary, 2008). WHO and FIGO (International Federation of Gynaecology and Obstetrics) have defined pregnancy as the stage of the reproductive process during which the body of the woman and the developing new individual interlace with each other, which starts at implantation and ends when an abortion or a birth takes place (Anibal *et al.*, 2006).

1.6.8 Pregnancy trimesters

The first trimester was considered from conception until the 13th week; second trimester, from the 14th until the 27th week; third trimester, from the 28th week until delivery; puerperium, 8 weeks post-delivery or post-abortion (Branch, 1994).

1.6.9 Pregnancy symptoms

Pregnancy-related physical symptoms which are unpleasant and cause profound effect to mother and infant (Marhazlina *et al.*, 2011). A study done by Kamysheva *et al.*, 2009 reported that, for women who experienced symptoms, frequency totalled for all symptoms correlated highly with both the total discomfort (severity) and total effect scores. There are three categories for pregnancy symptoms included general symptoms, constitutional symptoms and somatic pain symptoms. General symptom is a symptom that affects the entire body rather than a specific organ or location. For example, headache, dizziness, food cravings, insomnia, shortness of breath, hot flushes, heartburn, bloating, and constipation (Marhazlina *et al.*, 2011). Constitutional symptoms can be defined as a symptom that affects the general well-being or general status of a patient (Mosby's Medical Dictionary, 2009). For example, nausea, vomiting, loss appetite, food hypersensitive and non food hypersensitive (Marhazlina *et al.*, 2011). For somatic pain symptoms, it is pain emanating from muscles, skeleton, skin or pain in the parts of the body other than the viscera (Saunders Comprehensive Veterinary Dictionary, 2007). Example of somatic pain includes carpal tunnel, pelvic pressure or discomfort, backache, groin pain, Braxton Hicks, leg cramps, leg edema and fatigue (Marhazlina *et al.*, 2011).

1.7 Rationale of the study

Several researches has been done to associate maternal nutrition with pregnancy outcomes but the findings of studies in human are much less consistent due to some extent like secondary factors that differ from one study to another study (e.g., socio-economic status (SES), methods and timing of accessing or manipulating maternal nutritional variables) (Abu-Saad and Fraser, 2010). A number of research on pregnancy symptoms majorly in nausea and vomiting also been studied over the past decades in the correlation of birth outcomes.

As there are lacking data on other pregnancy symptoms which include general symptoms (i.e. headache, abdominal flatulence), constitutional symptoms (i.e. nausea, loss of appetite) and somatic pain (i.e. back pain, swollen feet) which is not well researched, the effect of these factors might be overlooked. There might be other factors correlates with the outcomes of neonatal. In view of the important role of maternal nutrition and pregnancy symptoms on foetal growth, this study also aims to investigate the distributions of maternal dietary intake with birth outcomes by focusing on the late trimester of gestation. Foetal demand for nutrients occurs primarily during the last half of gestation when more than 90 % of the foetal growth occurs (King, 2000).

Nutrition at third trimesters shows significant changes for the birth outcomes especially birth weight. In particular, the data of maternal nutrition and pregnancy symptoms is limited in Asia setting. Hence, this cross sectional study will be done to centre the important of role in both maternal nutrition and pregnancy symptoms on the effects of neonatal outcomes.

1.8 Conceptual Framework

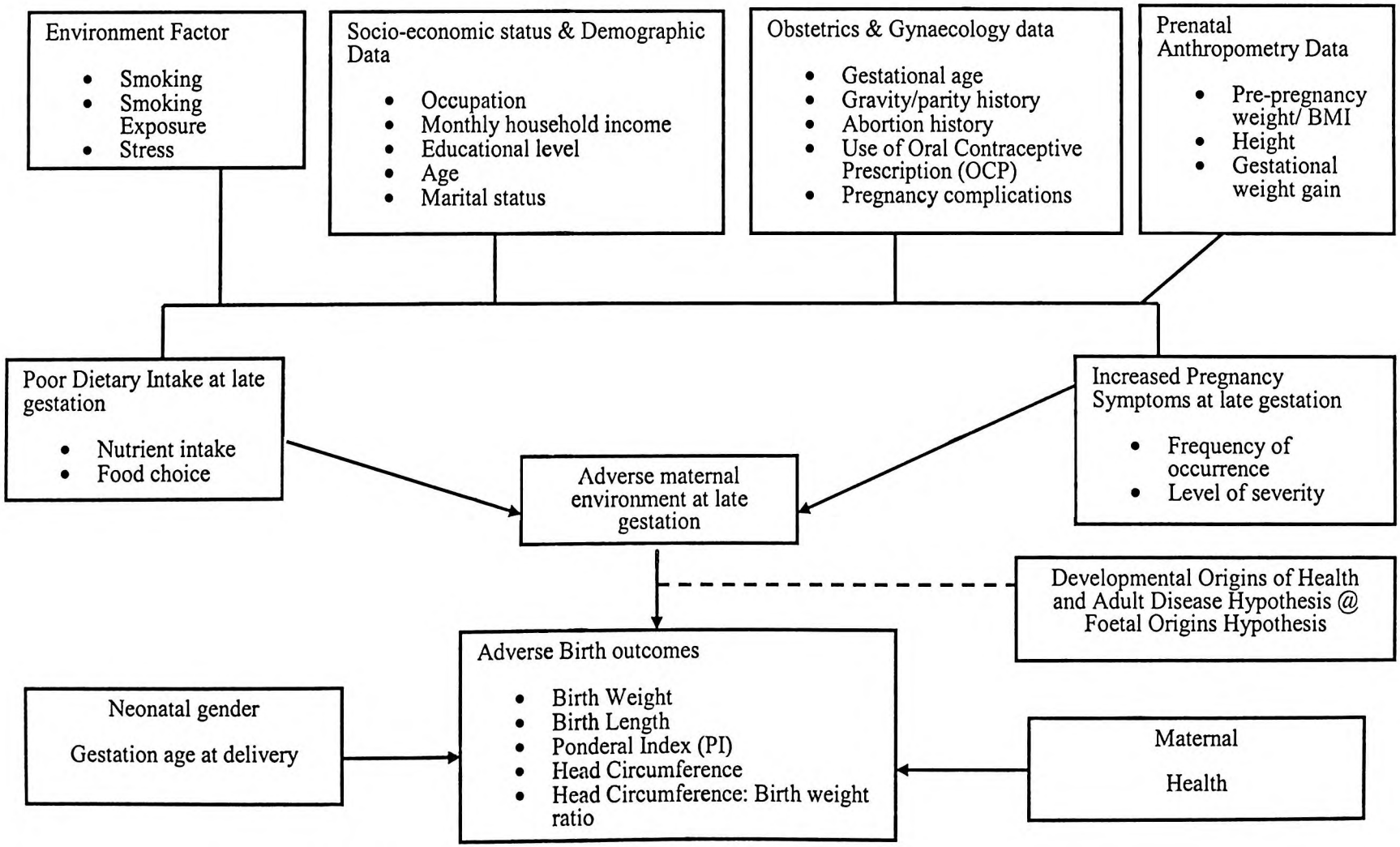

Figure 1.1: Conceptual framework of the study

CHAPTER 2: LITERATURE REVIEW

2.1 Maternal nutritional status

2.1.1 Nutrient

Pregnant women experience a variety of physiological changes, mostly affect by nutrient requirements. Nutrient supply to the foetus will be influenced by a number of adaptive physiological changes that occur during pregnancy, including alterations in maternal absorption, utero–placental blood flow, placental transfer mechanisms and foetal uptake (Hytten, 1983). Adequate weight gain during pregnancy depends on adequate energy intake. During pregnancy, the growth of the foetus and placenta, as well as other maternal tissues is supported by additional energy requirement. Other nutrient requirements also increase during pregnancy, but it is mainly recognised that the increase in energy intake will bring with it an increase in many of the vitamins and minerals required. One must remember that when considering the impact of maternal nutrition on pregnancy outcomes such as gestation length and birth weight, it is vital to appreciate that maternal nutrition is not the same as foetal nutrition. The foetus lies at the end of a nutritional supply line, with maternal nutritional intake at one end and foetal tissue uptake at the other (Bloomfield *et al.*, 2006).

2.1.1.1 Energy requirement

Energy is the chief nutritional determinant of gestational weight gain. However, the strength of this relation is confounded by a number of intervening factors including deficiencies of other specific nutrients which may limit or restrict gestational and foetal weight gain (IOM, 1990a). During pregnancy, additional energy is required for the

growth and continuance of the foetus, the placenta, and maternal tissues. The response of women who seem to enter pregnancy in similar nutritional states varies widely due to the fact that energy metabolism may be adjusted in more than one way (King, 2000). Maternal basal metabolism increases because of the increased mass of metabolically active tissues such as maternal cardiovascular, renal, and respiratory work and new tissue synthesis. The available evidence suggests that the efficiency of energy metabolism may increase during pregnancy, but the mechanisms involved are not well understood (Abu-Saad *et al.*, 2010). The generic energy intake recommendation of the American Dietetic Association is 2,200–2,900 kcal/day (Kaiser *et al.*, 2008). On the basis of theoretical calculations, the Food and Agriculture Organization/World Health Organization/United Nations University recommended that during pregnancy women increase their energy intake by 85 kcal/day in the first trimester, 285 kcal/day in the second trimester, and 475 kcal/day in the third trimester (FAO/WHO/UN, 1985).

During World War II, studies of well-nourished pregnant women who were exposed to the Dutch Famine showed that severe calorie restriction in certain stages of pregnancy, led to low maternal weight gain or weight loss in the third trimester. This was associated with reduced birth weight (Stein *et al.*, 1995). Improvement in infant outcome is less clear; some studies showed a reduction in low birth weight and preterm birth, whereas others did not (IOM, 1990b). Bhutta *et al.* (2005) concluded that administration of energy supplementation to chronically undernourished populations in sufficient quantity and/or duration did lead to significant increases in birth weight and decreases in rates of LBW and small-for-gestational-age birth.

Energy and nutrient requirements increase during pregnancy to insure proper maternal adaptation to pregnancy and optimal foetal growth. In singleton pregnancies,

the daily caloric requirement is approximately 27–30 kcal/kg maternal pre-pregnancy weight during the first trimester, and 30kcal/kg maternal pre-pregnancy weight plus 200–300 kcal during the second and third trimesters. In underweight women, these caloric prescriptions would need to be adjusted upward because they were required to sustain for both mother's nutrition as well as foetal nutrition. The recommended caloric distribution of macronutrients during pregnancy is the same as for all healthy adults with 20% of kcal from protein, 30–35% of kcal from fat, and the remainder (45–50% of kcal) from carbohydrates (Luke , 2007).

2.1.1.2 Macronutrient intake

a) Protein

The relationship between maternal intake of specific macronutrients, such as proteins, carbohydrates, and fats, and foetal outcomes is not as clear as the relationship between maternal weight gain and infant birth weight. Kramer (2001a, 2001b) noted that restricting protein or energy intake in overweight women may be harmful to the developing foetus and that protein supplementation improves foetal growth and may reduce foetal death. Likewise, Godfrey *et al.* (1996) found a direct relationship between babies who were large for gestational age with the increased meat intake late in pregnancy. In addition, they reported that that the positive association between maternal protein intake in late pregnancy and placental weight reflected by dairy consumption whereas birth weight was more closely related to meat protein consumption. An adequate nutrient supply to the foetus is a crucial area of research while investigating interventions to enhance birth weight. Protein deficiency during pregnancy usually occurs with limited intake of energy. Comparisons providing the mother with additional

energy versus additional energy and protein show similar effects on pregnancy outcome (Hamaoui et al, 2003).

The RDA for protein for the average adult is 0.8 g/kg/d. During pregnancy, additional protein is required for deposition in foetal, placental, and expanding maternal tissues. The mother and foetus accumulate a total of approximately 1 kg of protein during pregnancy, although the rate of increase is not constant. The requirement for additional protein is 1.3, 6.1, and 10.7 g/d for each of the three trimesters of the pregnancy, respectively. The RDA for pregnancy is an additional 10 g/d throughout the pregnancy (Food and Nutrition Board, 1989). Maternal protein intake was found to be associated with increased of birth weight (Rao *et al.*, 2001; Moore *et al.*, 2004; Cuco′ *et al.*, 2006; Olsen *et al.*, 2007). In particularly, those studies had assessed maternal intake periconceptionally and in very early pregnancy, in both developed (Moore *et al.*, 2004; Cuco′ *et al.*, 2006; Olsen *et al.*, 2007) and developing/low-income populations (Rao *et al.*, 2001; Sloan *et al.*, 2001).

b) Fat

Fat intake during pregnancy is also as important as any macronutrient which involve in maternal's metabolism during pregnancy. Additional requirement for dietary fat is needed to provide for maternal fat storage during the early trimester, and subsequent uterine growth, preparative development of the mammary glands, the expansion of blood volume, placental and foetal growth in the second and third trimesters. Recommended Nutrient Intake (RNI) for pregnancy during second trimesters and third trimester are (54-82 g/d) and (57-85 g/d) respectively (NCCFN, 2005). From an energy point of view, fatty acids seem less important at the beginning of pregnancy and instead become of greater importance near delivery when they represent energy

storage in adipose tissue. By studying pregnancies at the time of in utero foetal blood sampling, Cetin *et al.*, (2001) found that saturated fatty acids proportionally increase during pregnancy in foetal plasma.

Fatty acids represent a very good model of the relationship between maternal diet, foetal growth and wellness. Certain polyunsaturated fatty acids, omega-6 and omega- 3 fatty acids, are essential for human growth and health but cannot be synthesized by the human body, so they must be obtained through the diet. The foetus needs mostly essential fatty acid and their derivatives such as arachidonic (n-6) and docosahexaenoic (n-3) acid. Intrauterine requirements for essential fatty acids (derivatives of n-6 and n-3) during the last trimester of pregnancy through to the early weeks of life have been estimated to be 400 mg/kg/d for n-6 and 50 mg/kg/d for n-3. Some research has focused on other nutritional agents that might be able to counter the negative effects. Some research suggests that one mediating factor might be the presence or absence of essential fatty acids in either the maternal or the neonatal diet (i.e. breast milk).

In IUGR, the ratio of n-6/n-3 polyunsaturated fatty acids (PUFAs) has been concerned in affecting the inducible changes in the immune system in response to immunogenic antigen (i.e. immune tolerance) (Hanson *et al.*, 2006). Moreover, cross-fostering of rat offspring with diets high in n-3 PUFAs seems to lessen the postnatal hyperleptinemia and hypertension found in rats programmed to the outcomes by protein restriction in utero (Wyrwoll *et al.*, 2006). Being important structural elements of cell membranes, these fatty acids are essential to the formation of new tissues, which occurs at an elevated rate during pregnancy and foetal development (Hornstra *et al.*, 2000 and McGregor *et al.*, 2001). The diet and body stores of essential polyunsaturated fatty acids