

**MATERNAL NUTRITIONAL STATUS AND PREGNANCY  
SYMPTOMS AMONG HEALTHY PREGNANT AND  
GESTATIONAL DIABETIC WOMEN**

by

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**Thesis submitted in partial fulfilment  
of the requirements of the degree of  
Bachelor of Health Sciences (Nutrition)**

**JUNE 2012**

**Taraf Pemakanan dan Simptom Kehamilan dalam kalangan Ibu Mengandung yang Sihat  
dan Ibu Mengandung yang Menghidapi Penyakit Kencing Manis Kehamilan**

**ABSTRAK**

Tujuan kajian ini adalah untuk membanding dan mengaitkan hubungan antara tahap pemakanan ibu dan simptom kehamilan dalam kalangan ibu mangandung yang sihat dan ibu yang menghidapi penyakit kencing manis kehamilan. Sebanyak 108 orang ibu mengandung (77 orang ibu mengandung yang sihat dan 31 orang ibu yang menghidapi penyakit kencing manis kehamilan), umur di antara 19 hingga 40 tahun, berada dalam 32 hingga 40 minggu kehamilan telah diambil sebagai responden dari Klinik Obstetrik dan Ginekologi, Hospital Universiti Sains Malaysia. Penilaian atas simptom kehamilan dijalankan dengan *Pregnancy Symptoms Questionnaire* yang telah divalidasikan. Analisis secara statistik dijalankan dengan *Independent t-test*, *Mann-Whitney test*, *Pearson* dan *Spearman correlations*. Keputusan: Ibu mengandung yang menghidapi penyakit kencing manis kehamilan didapati mempunyai skor yang lebih tinggi dalam Index Jisim Badan sebelum mengandung ( $p=0.026$ ) dan jisim lemak badan pada hujung tempoh kehamilan ( $p=0.001$ ) serta mengalami kekerapan ( $p=0.044$ ) dan keterukan ( $p=0.026$ ) yang kurang dalam sakit kepala apabila berbanding dengan ibu mengundung yang sihat. Kadar pertambahan berat badan ibu adalah berkait dengan pelbagai jenis simptom kehamilan secara positif di kalangan ibu mengandung. Kajian ini mnunjukkan bahawa ibu mengandung yang sihat dan ibu mangandung yang menghidapi penyakit kencing manis kehamilan adalah berbeza dari segi tahap pemakanan dan simptom kehamilan umum. Selain itu, kadar pertambahan berat badan ibu adalah berhubung kait dengan simptom kehamilan dalam kalangan ibu mengandung.

# **Maternal Nutritional Status and Pregnancy Symptoms among Healthy Pregnant and Gestational Diabetic Women.**

## **ABSTRACT**

The aims of this study were to compare and correlate maternal nutritional status and pregnancy symptoms between healthy pregnant and gestational diabetic women. A total of 108 pregnant women (77 healthy and 31 gestational diabetic), aged between 19 to 34 year-old, within the gestational age of 32 to 40 weeks were recruited from Obstetric and Gynecology, Hospital Universiti Sains Malaysia. Pregnancy symptoms score were assessed with validated Pregnancy Symptoms Questionnaire. Independent t-test, Mann-Whitney test, Pearson and Spearman correlations were used for statistical analysis. Gestational diabetic women had significantly higher pre-pregnancy body mass index ( $p=0.026$ ), body fat mass at late trimester ( $p=0.001$ ), experienced lower frequency ( $p=0.044$ ) and higher severity ( $p=0.026$ ) of headache than healthy pregnant women. Maternal weight gain rate was correlated positively with various pregnancy symptoms among pregnant women. There is a significant difference on maternal nutritional status and general pregnancy symptoms between healthy pregnant and gestational diabetic women. There is also a significant correlation of maternal weight gain rate and pregnancy symptoms among all pregnant women.

## DECLARATION

I hereby declare that the thesis is my original work except for the quotations and citations which have been duly acknowledged. I also declare that it has not been previously, and is not concurrently submitted for any other degree or purposes in Universiti Sains Malaysia or at any other institutions.



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Teow Ying Liang

Date: 26/6/2012

I certify that Ms Teow Ying Liang has carried out her study entitled “Maternal Nutritional Status and Pregnancy Symptoms among Healthy Pregnant and Gestational Diabetic Women” as a final year research project in nutrition under my supervision. She has complied with the ethical standard and regulations in conducting her study and has completed writing her thesis. I am satisfied with her work and have no objection for the thesis to be examined by the appointed examiners by the School of Health Sciences, Universiti Sains Malaysia.

Thank you.



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## ACKNOWLEDGEMENT

First and foremost, I would like to thank the School of Health Sciences, USM for the support and trust given to me in preparing the “Guidelines to The Preparation of Dissertation” for the undergraduates in the School of Health Sciences, USM.

I would also like to offer my sincere gratitude to my supervisor, Dr Hamid Jan Jan Mohamed for giving me an opportunity to be their undergraduate student, for the continuous guidance and encouragement throughout my study, for the patience and knowledge that he shared to me in completing the thesis writing. Besides, I would also like to thank for the financial support for this study from USM for the sake to afford all the cost required in this study.

Furthermore, I wish to express my gratitude to my seniors who guides me a lot to in this study. Special thanks to Ms Loy See Ling and Ms Marhazlina Mohamad for assisting me to complete this study from initial to final draft. Countless appreciation I wish to send for them for the invaluable patience and knowledge they have shared to me. I have been grateful and blessed with kindly assistance from fellow postgraduate students.

Besides, I would also like to thank to pregnant women in Hospital Universiti Sains Malaysia (HUSM) who willing to be my respondents. Special thanks to Professor Dr. Nik Mohamed Zaki Nik Mahmood for his kindly guidance for us to collect data over Obstetric and Gynecology (O&G) Clinic. Not forgotten to thank all the staff in O&G Clinic, Antenatal Ward, School of Health Sciences and Nutrition Laboratory for providing me with the help throughout data collection and facilities for anthropometry tools.

Last but not least, very special thanks to my parents and lovely siblings, who provided me something greater in all these years, with care and loves.

## TABLE OF CONTENT

ABSTRAK .....	ii
ABSTRACT.....	iii
DECLARATION.....	iv
ACKNOWLEDGEMENT.....	v
TABLE OF CONTENT.....	vii
LIST OF TABLES AND FIGURES.....	viii
LIST OF ABBREVIATIONS.....	ix
DEFINITION OF KEY TERMS.....	x

### CHAPTER 1: INTRODUCTION

1.1	Introduction.....	1
1.2	Background of the study.....	3
1.3	Rationale of the study.....	4
1.4	Problem Statement.....	5
1.5	Purpose of the study.....	6
1.6	Aims of the study.....	6
	1.6.1 General Objectives.....	6
	1.6.2 Specific Objectives.....	7
1.7	Conceptual Framework.....	7
1.8	Research Questions.....	8
1.9	Research Hypothesis.....	8

### CHAPTER 2: LITERATURE REVIEW

2.1	Introduction.....	9
2.2	Definition of Gestational Diabetes Mellitus.....	9
2.3	Prevalence of Gestational Diabetes Mellitus.....	10
2.4	Pathophysiology of Gestational Diabetes.....	11
2.5	Maternal Nutritional Status.....	12
	2.5.1 Body Weight and Height.....	13
	2.5.2 Rate of Weight Gain.....	14
	2.5.3 Body Composition.....	15
	2.5.4 Skinfold Thickness.....	15
	2.5.5 Pre-Pregnancy Body Mass Index.....	17
	2.5.6 Body Circumference.....	17
2.6	Pregnancy Symptoms.....	18
	2.6.1 General Pregnancy Symptoms.....	18
	2.6.2 Constitutional Pregnancy Symptoms.....	20
	2.6.3 Somatic Pain Symptoms.....	22

### CHAPTER 3: METHODOLOGY

3.1	Study Design.....	24
	3.1.1 Population and Setting.....	24
	3.1.2 Sample Size.....	25
	3.1.3 Inclusion and Exclusion Criteria.....	26
3.2	Instrumentation.....	27
	3.2.1 Questionnaire.....	27
	3.2.2 Anthropometry Measurement Instruments.....	28

3.2.2.1	Body Weight.....	28
3.2.2.2	Body Height.....	29
3.2.2.3	Body Mass Index.....	30
3.2.2.4	Skinfold Measurement.....	31
3.2.2.5	Body Circumference.....	33
3.3	Data Collection.....	34
3.4	Validity and Reliability of the Data Collection Instrument.....	36
3.5	Ethical Consideration.....	36
3.6	Data Analysis.....	38
 CHAPTER 4: RESULTS		
4.1	Maternal Sociodemographic Data among Healthy Pregnant and GDM Women.....	39
4.2	Comparison of Maternal Anthropometry between Healthy Pregnant and GDM Women.....	40
4.3	Pregnancy Symptoms score among Healthy Pregnant and GDM Women.....	41
4.4	Association between Pregnancy Symptoms and Anthropometric Measurements.....	43
4.5	Association between Pregnancy Symptoms and Anthropometric Measurements in Healthy Pregnant Women.....	44
4.6	Association between Pregnancy Symptoms and Anthropometric Measurements in GDM Women.....	45
 CHAPTER 5 RESULT		
5.1	Socio-demographic Data.....	46
5.2	Comparison of Maternal Anthropometry between Healthy Pregnant and GDM Women.....	46
5.3	Comparison of Pregnancy Symptoms between Healthy Pregnant and GDM Women.....	49
5.4	Correlation of Pregnancy Symptoms with Anthropometry Measurements.....	50
 CHAPTER 6 CONCLUSION		
6.1	Summary of the study finding.....	51
6.2	Strength and Limitations.....	52
6.3	Implications and Recommendations	
6.3.1	Nutritionist Consultation.....	53
6.3.2	Nutrition Policies and Guidelines.....	54
6.3.3	Nutrition Research.....	54
REFERENCES.....		56
 APPENDICES		
Appendix 1:	Research Information for Participants.....	63
Lampiran 1:	Maklumat Kajian bagi Peserta.....	66
Appendix 2:	Patient Information and Consent Form.....	69
Lampiran 2:	Borang Keizinan Pesakit.....	70
Lampiran 3:	Maklumat Sociodemografik, Anthropometri dan Sejarah Kesihatan dalam kalangan Ibu Mengandung di Hospital Universiti Sains Malaysia.....	71
Lampiran 4:	Soal Selidik Symptom Semasa Mengandung.....	74
Appendix 5:	Ethical Approval Letter.....	76
Appendix 6:	Poster Award of The Study.....	77

## LIST OF TABLES AND FIGURES

Table 3.1	The international classification of adult underweight, overweight and obesity according to BMI	30
Table 4.1	Socio-demographic data among healthy pregnant and GDM women (n=108)	39
Table 4.2	Comparison of maternal anthropometry measurements at gestational weeks of 32 to 40 between healthy pregnant and GDM women (n=108)	40
Table 4.3	Comparison of Pregnancy Symptoms Score at gestational weeks of 32 to 40 between Healthy Pregnant and GDM women (n=108)	42
Table 4.4	Association between pregnancy symptoms and anthropometric measurements at gestational weeks of 32 to 40 among all the pregnant women (n=108)	43
Table 4.5	Association between pregnancy symptoms and anthropometry measurements at gestational weeks of 32 to 40 in healthy pregnant women (n=77)	44
Table 4.6	Association between pregnancy symptoms and anthropometric measurements in GDM women (n=31)	45
Figure 1.1	Conceptual Framework of the study	7
Figure 3.1	Flow chart of data collection	35



## ABBREVIATIONS

ACC/SCN	-	Administrative Committee on Coordination – Subcommittee on Nutrition
ADA	-	America Diabetic Association
ADH	-	Antidiuretic Hormone
BMI	-	Body mass index
BSP	-	Blood sugar profile
DM	-	Diabetes Mellitus
CDA	-	Canadian Diabetes Association
GDM	-	Gestational diabetes mellitus
hcG	-	human chorionic gonadotrophin
HPL	-	Human placental lactogen
IOM	-	Institute of Medicine
MUAC	-	Mid upper arm circumference
NIH	-	National Institutes of Health
O&G	-	Obstetric and Gynecology
OCP	-	Oral contraceptive prescription
OGTT	-	Oral Glucose Tolerance Test
PASW	-	Predictive Analytical Software
PSQ	-	Pregnancy Symptoms Questionnaire

## DEFINITION OF KEY TERMS

- Nutritional status** - Nutritional Status is known as a measurement of the extent to which an individual's physiological need for nutrients is being met.
- Gestational Diabetes Mellitus** - GDM is defined as glucose intolerance of various degrees that is first detected during pregnancy. Women with GDM are known to have exaggerated resistance to insulin's ability to stimulate glucose utilization and to suppress both glucose production and fatty acid level (Thomas AB, 2005). The exact physiology of this disease is uncertain but probably involves a combination of pronounced insulin resistance at peripheral tissue and inadequate  $\beta$ -cell insulin secretion in response to the metabolic stress of pregnancy (Belzer et al., 2010).
- Pregnancy** - Pregnancy is characterized by a progressive increase in nutrient-stimulated insulin response despite an only minor deterioration in glucose tolerance, consistent with progressive insulin resistance (Butte, 2000)
- Pregnancy Symptoms** - Prgnancy Symptoms is pregnancy-related physical symptoms which are unpleasant and cause profound effect to mother and infant. (Marhazlina et al., 2011)

# CHAPTER 1 INTRODUCTION

## 1.1 Introduction:

Pregnancy consists of a series of small, continuous physiologic adjustments that affect the metabolism of all nutrients that cause to alteration of maternal nutritional status. Studies on maternal nutritional status illustrate the potential of adjusting the use of macronutrients to conserve a fetal supply. Efforts are required to achieve good maternal nutritional status during preconception as well as throughout gestation best assure a good milieu for fetal growth and development (King *et al.*, 2000). The interactions among the physiology of pregnancy, nutrient metabolism, and maternal nutritional status are needed to be fully understood for future studies of nutrient metabolic adjustments in women consuming marginal to adequate diets.

In recent years there have been several studies demonstrating the role of gestational diabetes mellitus (GDM) on metabolism and in pregnancy. In normal pregnancy, progressive insulin resistance that begins near mid-pregnancy is attending and progresses through the third trimester to levels that approximate the insulin resistance seen in individuals with type 2 diabetes. GDM can exert its effect on maternal nutritional status through several mechanisms. Insulin requirements are high during late pregnancy consistently reveal reduced insulin responses to nutrients in women with GDM (Buchanan & Xiang, 2005).

Women with GDM altered resistance to insulin's ability to stimulate glucose utilization and to suppress both glucose production and fatty acid levels. (Buchanan & Xiang, 2005). Researcher has suggested that diabetes in pregnancy is associated with increased risk of adverse outcomes for both the mother and the infant such as hypertension, preeclampsia, preterm birth and caesarean delivery Saydah *et al.*, 2005). Therefore, the assessment of GDM women's health is rather important to minimise the obstetric risk.

It had been proven that effective interventions can be implemented among at risk pregnant women to promote maternal health and well-being (Crowther *et al.*, 2005). It is crucial to be aware the changes of nutritional status due to the consistent fluctuation of metabolic and physiologic profile throughout the gestation (Hass *et al.*, 2004). Previous study also suggested that the functional status of reproductive age women was lower during pregnancy than at other times (Haas *et al.*, 2004). Result from the similar study (Haas *et al.*, 2004) showed that women with gestational diabetes were more likely to have poor nutritional status than healthy pregnant. Health status measures are important and informative for pregnant women particularly in GDM women. This is because a higher proportion of GDM women tend to experience a decline in health status when compared to the unaffected women (Kim *et al.*, 2005).

Pregnancy symptom is one of the nutritional issues that relate to maternal health status (Perry, 2010). There is current interest in symptoms during pregnancy, but yet little is known about their prevalence and how the severity they are experienced across pregnancy (Rodriguez, 2001). Examples of pregnancy symptoms are nausea, vomiting, food craving, low back pain and heartburn (Ho *et al.*, 1998). Nausea and vomiting can develop into hyperemesis gravidarum which causes disturbed nutrition, electrolyte imbalance and extreme weight loss (Lub-Moss & Eurelings-Bontekoe, 1997). Maternal medical complications have been reported to be caused by dizziness, indigestion, shortness of breath and trouble sleeping (Haas *et al.*, 2004). The timing, frequency and intensity of each symptom may be differed individually (Lacroix *et al.*, 2000). From Belzer's study, the pregnancy symptoms among GDM women were more obvious during the third trimester if comparing with control group (Belzer *et al.*, 2010). Overconsumption of low-nutrients snacks might cause more nutritious food to be displaced by the diet (Perry, 2010). However, to what extend of pregnancy symptoms in affecting maternal nutritional status during pregnancy or vice versa remains unclear. Exploring the issue of pregnancy symptoms from the perspective of women may assist health care professionals in providing more appropriate care.

To our knowledge, the data on maternal nutritional status and pregnancy symptoms during the gestational are lacking in South East Asia population, particularly among the GDM women. Thus, this study aims to assess and compare the anthropometric measurements and pregnancy symptoms between GDM and healthy pregnant women, as well as to rule out the association of pregnancy symptoms in relation to nutrition status during pregnancy.

## **1.2 Background of the study**

Diabetes in pregnancy has long been recognized as a problem for both maternal and fetal concern. Although the outcome for pregnant women with diabetes has improved greatly over the last 50 years due to the advent of insulin, it is still found that GDM women have higher prevalence of stillbirth than healthy pregnancy (Wylie & Bryce, 2008).

The most comprehensive assessment of the historical publications on diabetes and pregnancy is done by Mestman, an endocrinologist and obstetrician who has initiated the study since 1960. He indicates the major change which followed was the introduction of insulin to allow women with GDM to carry a full-term pregnancy and deliver a healthy infant. Dramatic reduction of maternal mortality and improvement of perinatal mortality and morbidity is documented (McCance *et al.*, 2010).

On the other hand, previous basic animal and human research then showed that poor glycemic control at the time of conception and soon after was a major cause of both congenital abnormalities and spontaneous abortion (Eriksson, 1984). Unfortunately, the provision of this degree of detailed care for GDM women at a community level has been more difficult to achieve, and a number of national surveys have shown deficiencies in many aspects of this health care provision (McCance *et al.*, 2010).

Recent guidelines by the Canadian Diabetes Association (CDA) recommend that all pregnant women with GDM be followed and evaluated by a multidisciplinary team composed of diabetes nurse educators, endocrinologists, obstetrician and dietitians with the goal of minimizing GDM complications mainly by introducing self-glucose monitoring to reach adequate glycemic control. Dietitian is responsible to ensure that nutrition therapy will promote euglycemia and pregnant women with appropriate weight during their pregnancy period (Morrisset, 2011).

### **1.3 Rationale of the study**

Severe adverse effects of diabetes antedating pregnancy on fetal and neonatal outcome have been well established, and there is accumulating literatures support the notions of poor maternal health associated with negative fetal outcome (Lao *et al.*, 2001). Compared to neonatal health outcome, maternal nutritional status along gestation period has received considerably less attention.

The physiological changes of pregnancy is well-known by health care provider (Butte, 2000), but less is known about how these physiological changes affect on maternal nutritional status and pregnancy experiences which includes variety of symptoms and complaints. Majority of reproductive-age women usually are in good health status during gestational period. Nevertheless, small portion of women who are experiencing important declines in nutritional status should not be neglected and declines in health status may persists into the postpartum period of reproductive-age women (Haas *et al.*, 2004).

Previous study stated that excessive gestational weight gain was definitely a factor that promotes increased weight retention following pregnancy and the development of maternal obesity. While the changes in fat distribution with excessive gestational gains appearing associated with a disproportionately increased deposition of fat at central body sites in the index

postpartum compared with measured postpartum skinfold for the prior pregnancy (Hediger, 1997). Therefore, this study aims to investigate changes in body composition via subcutaneous body fat by measuring skinfold thickness. However, the findings on fat mass gain during pregnancy between healthy and GDM pregnant women were inconsistent (Ehrenberg *et al.*, 2003).

#### **1.4 Problem Statement**

According to the Pedersen hypothesis (1954), maternal hyperglycaemia results in excess transfer of glucose to the fetus resulting in fetal hyperinsulinaemia. The effects of fetal hyperinsulinaemia include an overgrowth of insulin-sensitive tissues such as adipose tissues which increases the risk of shoulder dystocia, perinatal death, birth trauma and the need for caesarean section, neonatal metabolic complications such as hypoglycaemia, a hypoxaemic state in utero which may increase the risk of intrauterine fetal death, fetal polycythaemia, hyperbilirubinaemia and renal vein thrombosis, an increased long-term risk of obesity and diabetes in the child (NIH, 2008).

The potential benefits of recognising and treating gestational diabetes include reductions in ill health in the woman or the baby during or immediately after pregnancy. Therefore, this is imperative for nutritionist or health care providers to acquire knowledge regarding maternal nutritional status in providing healthcare for childbearing women.

Because of gestational diabetes causes various complications on maternal health, this study can help in gaining the insight of healthcare provider's look into gestational diabetes, maternal nutritional status and pregnancy symptoms. The outcome of this study can help addressed the issue of providing essential information for pregnant women especially those with gestational diabetes while meeting the challenges associated with providing diet advise to these women.

## **1.5 Purpose of the study**

The ultimate purpose of this study is to examine the nutritional status of healthy and gestational diabetes women by studying their anthropometric changes during pregnancy and their relationship with pregnancy symptoms. The study is to improve maternal nutritional status and hence improve the quality of childbearing life period. This study will provide a vital baseline to guide the healthcare professionals, particularly the nutritionist or nurses who work in the maternity facilities to manage and provide care for pregnant women.

## **1.6 Aims of the study**

The researcher conducted a literature review which examined current research studies done in Malaysia and around the world into the nutrition status and pregnancy symptoms of pregnant women. Significantly, no study was found concerning local pregnant women regarding their nutritional status and pregnancy symptoms. Therefore, the nutritional status and pregnancy symptoms among Malaysian women cannot be accurately assessed. Information from this study can provide valuable input into assessing efficacy of current nutritional program for public health and development of relevant programs in near future.

### **1.6.1 General Objective**

The general aim of this study was to examine the maternal nutritional status and pregnancy symptoms among healthy and gestational diabetic women in Hospital Universiti Sains Malaysia (HUSM).



### 1.6.2 Specific Objectives

- i. To compare pregnancy symptoms and maternal nutritional status between healthy and gestational diabetic women.
- ii. To associate pregnancy symptoms with maternal nutritional status among healthy and gestational diabetic women.

### 1.7 Conceptual Framework

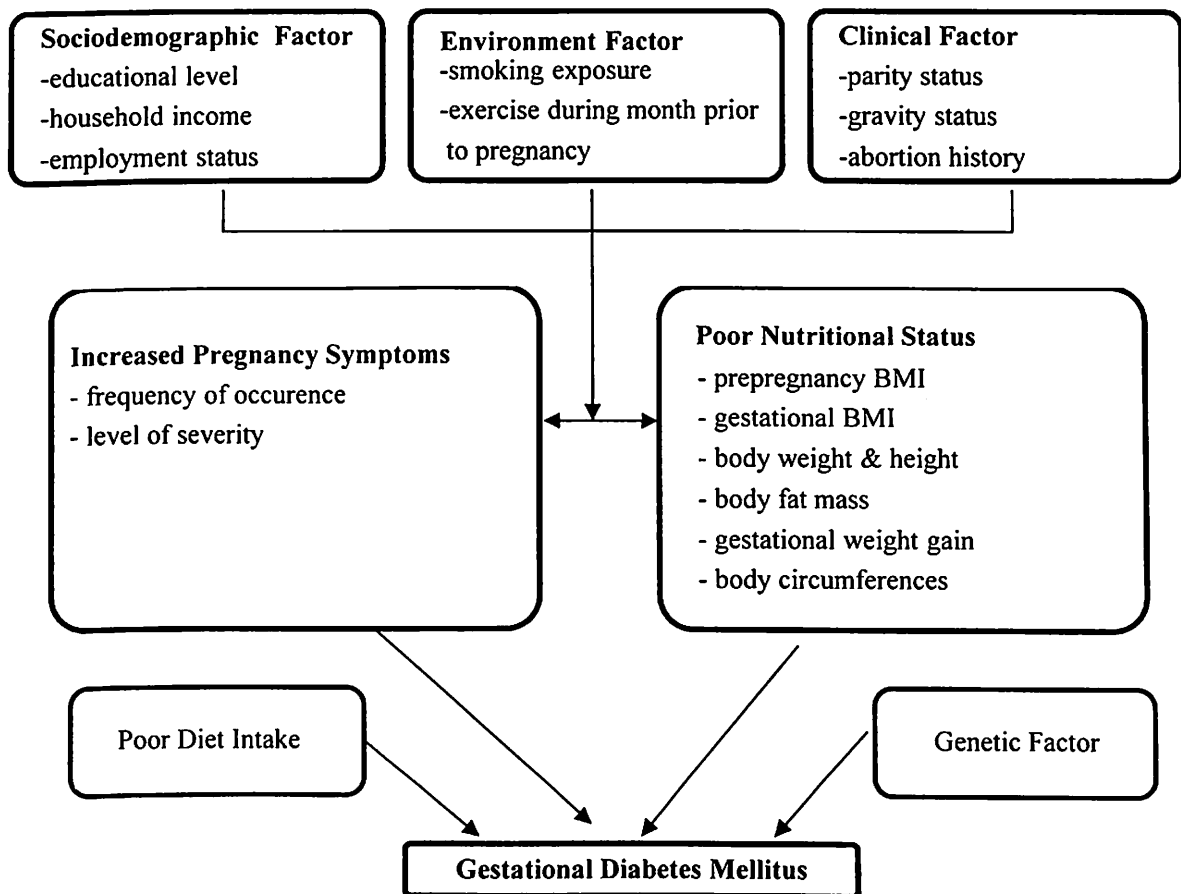


Figure 1.1: Conceptual Framework of the study

### **1.8 Research Questions:**

- i. What is the difference of nutritional status between healthy and gestational diabetic pregnant women?
- ii. What is the difference of pregnancy symptoms between healthy and gestational diabetic pregnant women?
- iii. What is the relationship of nutritional status and pregnancy symptoms experienced by pregnant women?

### **1.9 Research Hypothesis**

- i. There is a difference of maternal nutritional status and pregnancy symptoms between healthy and gestational diabetic women. ( $H_0 \neq H_A$ )
- ii. There is an association of pregnancy symptoms and maternal nutritional status among healthy and gestational diabetic women. ( $H_0 \neq H_A$ )

## **CHAPTER 2 LITERATURE REVIEW**

### **2.1 Introduction**

Pregnancy is associated with physiological changes that optimize the transfer of maternal nutrients to the fetus. Maternal and fetal adaptation occurs throughout pregnancy to ensure the energy requirements of the fetal placental unit and subsequent lactation are met from a combination of maternal energy intake, maternal adipose stores and energy conservation through decreased physical activity (Annita & Anne, 2010). Albeit the pregnancy outcome and research of effect on infants were well established, the nutritional status of mother of the infant is poorly understood. To conduct this study regarding nutritional status and pregnancy symptoms of pregnancy, it is necessary to review on previous literatures on the topics to allow for the researcher become familiar with the current update of knowledge of this topic. These reviews will be providing a comprehensive understanding of the topic as well as assist the researcher to be aware of what is known and what should be investigated.

### **2.2 Definition of Gestational Diabetes Mellitus**

The most controversial topic in the early days was the significance of the finding of sugars of various types in the urine and this finding contributes to the diagnosis of asymptomatic diabetes. Therefore a researcher, J.W. Williams came to a number of conclusions after review on literature up to 1909. His studies showed that more than 3g/L of sugar in urine was suggested as diabetes in early pregnancy. After some years, Lambie is the earliest report of glucose "intolerance" found glycosuria 2 hours after ingesting a 50g of glucose in 50% of pregnant women compared to 11% of non pregnant women in 1926. Ten years after the discovery of insulin, Eric Skipper drew an attention to high fetal mortality in women where the apparent onset of diabetes during the pregnancy almost high as that with the onset before pregnancy. Later, Priscillia White in 1949 has established a paper entitled White Classification

where White Class A indicate women with “a glucose tolerance test which deviates but slightly from the normal” either before or during the pregnancy (Hadden, 2010). In the late 1950’s high perinatal morbidity and mortality has stimulated the carbohydrate metabolism in pregnancy with the use of oral and intravenous glucose tolerance tests to detect hyperglycemia with the aim of improving maternal outcome. To date, American Diabetes Association defines gestational diabetes as “any degree of glucose intolerance with the onset or first recognition during pregnancy” but provides diagnostic threshold for fasting and post-glucose loading values in the table below (Carpenter, 2010).

### **2.3 Prevalence of Gestational Diabetes Mellitus**

The prevalence of GDM globally in 1998 was examined by King *et al.* (1998). Epidemiologic studies have facing various difficulties in comparing data in gestational diabetes mellitus with different approaches. In addition, screening too early (before 24 weeks) will result in fewer case of GDM being detected. Some women achieve criteria for GDM only later in pregnancy and will not be diagnosed with the conventional screening approach, which occurs between 24 and 28 weeks.

The prevalence rates vary within the same ethnic group in different locations, with migrant populations generally having a higher prevalence than those remaining in traditional rural areas, probably related to lifestyle change and greater adiposity. A Canada study indicated that 7% of pregnant women were detected with GDM (Buchanan *et al.*, 2005). However, a higher prevalence of GDM was found in the Chinese Australian women with the percentage of 13.9% (Lao *et al.*, 2001). Western population with the low to high-risk population has a prevalence rate of 1.4%-2.8% and 3.3%-6.1% (Idris, 2009). As showed in different studies, the prevalence of GDM varies from 1% to 14% across the population and studies (Hosseini-Nezhad *et al.*, 2007).

Apparently, Asian women have the highest risk for gestational diabetes mellitus among all racial or ethnic groups in the USA and Australia (Anna, 2008). Even though a China study found that 2.3% of pregnant women were diagnosed with GDM (Yang *et al.*, 2002), the prevalence is higher than what was reported in other Asian countries which range from 8.6 in Filipino population to in-excess of 16% in an Indian population (Idris, 2009). In addition, recent data show that gestational diabetes mellitus (GDM) prevalence has increased by 10–100% in several race or ethnicity groups during the past 20 years (Ferrara, 2007). A study conducted in Tianjin concluded the prevalence of gestational diabetes mellitus has markedly been increasing in a universally screened Chinese from 1999 to 2008 (Zhang, 2010). The prevalence of gestational diabetes mellitus in a population of Malaysian study was 11.4% by Tan *et al.* (2007) and 18.3% by Idris *et al.* (2009).

#### **2.4 Pathophysiology of Gestational Diabetes Mellitus**

The pathophysiology of GDM remains controversial. It may either reflect a predisposition of type 2 diabetes expressed under the metabolic conditions of pregnancy or represent the extreme manifestation of metabolic alterations that normally occur in pregnancy. It is not due to defective secretion of insulin or to disproportionate secretion of glucagon. Previous study only observed quantitative differences in insulin secretion between women with GDM and normal pregnant women (Butte, 2000). Evidence supports the view that GDM is related to a pronounced peripheral resistance to insulin. In normal pregnancy, insulin resistance and compensatory hyperinsulinemia is adapted to multifactor such as placental factor as well as body composition changes or nutrient in excess. Gestational diabetes result when pancreatic beta cell function fails to adequately compensate for the degree of insulin in pregnancy (Einstein, 2010). This is caused by an increased of insulin resistance due to pregnancy which resulting in alterations in glucose metabolism which burden the pancreas to produce more insulin (Stables & Rankin, 2010). At the same time, human placental lactogen (HPL), estrogen and cortisol increase insulin resistance and alter carbohydrate tolerance to increase the

availability of glucose and amino acid transfer to the fetus. GDM is a risk factor for both future pregnancies pre-diabetes and type 2 diabetes in later life. Besides, infants of diabetic mother with either macrosomia or microsomia also have an increased diabetogenic tendency (Coad & Dunstall, 2005).

## **2.5 Maternal Nutritional Status**

Maternal nutritional status plays an important role in women and children's health. The importance of adequate maternal nutritional status on milk production and maternal health is documented including amount and concentration of breast milk energy and fat (Gewa *et al.*, 2011). Maternal malnutrition remains a burden in many communities which is low socioeconomic based (Lartey, 2008). This issue has received considerable attention since 1990s, especially in the international community. In western literature, there were several studies on maternal nutritional status in term of closely space of pregnancies (King *et al.*, 2003) and rate of weight gain in GDM women (Morrisset *et al.*, 2011). However in Asia setting, the main focus researches on maternal health were targeted to micronutrient deficiencies (Haniff *et al.*, 2007; Seshadri, 2001).

The assessment of the nutritional status of pregnant women is important for the prognosis of the course of pregnancy and possible gestational complications experienced by mother. (Zekan *et al.*, 1998 & Lopez *et al.*, 2011). Anthropometry assessment has many advantages for nutritional evaluation: it is relatively simple, non-invasive, and cause minimal discomfort to the respondent (Lopez *et al.*, 2011). In term of pregnancy, continued weight gain through the third trimester along with the absence of decreases in skinfold thicknesses indicates the women accommodated their pregnancies without using their own energy stores (Piperata *et al.*, 2002).

### 2.5.1 Body Weight and Height

The ability to reproduce is closely correlated with physical growth and development. Frisch (1994) suggested that the onset and the maintenance of menstrual cycles are associated with the attainment of a minimum weight-for-height to representing a critical fat store. Maternal height at puberty results from the combined influences of genetic inheritance, pre- and postnatal environment including nutrition. Besides, maternal stature influences birth weight with taller women giving birth to heavier infants in Asian, Black and Whites (Piperata *et al.*, 2002). Height is a measure of past nutritional status and reflects in part the cumulative effect of social and economic outcomes on access to nutritional foods during childhood and adolescence. Women less than 145 centimeters in height are considered too short or stunted; this has been determined to be a useful cut-off point in several studies (ACC/SCN, 1992). This indicator was also used to assess the relationship between maternal and child nutrition.

Women's weight is another indicator of nutritional status to some degree. It has been suggested nearly 80% of women attending infertility clinics can be classified as underweight, and a BMI of greater than 30kg/m<sup>2</sup> in a pregnant women is considered a risk factor in the obstetric management (Coad & Dunstall, 2005). Gestational weight gain for the index pregnancy was defined as the difference between recalled pregravid weight and weight within two weeks at delivery, adjusted for duration of gestation. The definition of excessive total weight gain (for gestations of more than 39 weeks) in the index pregnancy was derived based on the Institute of Medicine cut-off is 18.1kg or more (Hediger, 1997). Result from similar study suggested that excessive gestational weight gain was a factor that promotes increased weight retention following pregnancy, the development of maternal obesity and the changes in fat distribution (Hediger, 1997). However, a study demonstrated by Zekan (1998) found that women on the average weight gain of more than 12kg causes excessive accumulation of body fat. In the contrary, women who gain weight under the 10<sup>th</sup> percentile have significantly greater risk of pre-term delivery (Zekan, 1998). Recent data show there is an increasing number of

women gain excessive weight during pregnancy and excessive gestational weight gain early in pregnancy has been suggested to increase the risk of GDM (Morisset *et al.*, 2009). The recommendation for gestational weight gain which is established by the Institute of Medicine (IOM) in 1990 was revised in 2009. In the latest recommendations, IOM has proposed a gestational weight gain of 7-11.5kg for overweight women and 5-9kg for obese women.

### **2.5.2 Rate of Weight Gain**

Pregnancy weight gain measurements are part of antenatal care and surveillance of pregnant women where abnormal rate of weight gain has negative influence on the course of pregnancy (Zekan, 1998). Previously, Hytten (1991) has investigated the weight gain in pregnancy and provided the basic of clinical recommendations for decades. His studies is generally sigmoid in shape correspond to a maximum rate of gain before midgestation. Generally, the rate of weight gain is least during the first trimester (about 1 kg/month), and levels off at about 0.45 kg/week in the second and third trimesters (Hediger, 1997). Weight gain during pregnancy is associated with the growing fetus, development of maternal reproductive tissues and energy stores (Piperata *et al.*, 2002). Zekan's study (1998) demonstrated that body weight has increased significantly with the weeks of pregnancy before entering 39<sup>th</sup> week. Apparently, excessive rate of weight gain during pregnancy might not enhance fetal growth, but merely contributed to post-partum weight retention and obesity (To & Wong, 2009).

A gestational weight gain of 0.5 to 2kg is recommended for all pregnant women in the first trimester with a weight gain rate of 0.22 to 0.28 kg/week respectively (IOM, 2009). Mean range for rate of weight gain in the second and third trimester should vary between 0.22 and 0.51kg/week according to pre-pregnancy BMI. The pregnancy weight gain targets for women with GDM should be the same as for women without GDM. However, this may be difficult to achieve for women on insulin due to their greater dependency on frequent snacks to avoid hypoglycaemia (Anita & Anne, 2010).



### 2.5.3 Body Composition

It has been recognized that there may be an optimal maternal weight gain or fat gain that reduces of maternal obesity while optimizing fetal growth (Paxton *et al.*, 1998). Estimation of body composition is important for assessing nutrition and metabolism of pregnant women. By knowing a respondent's body composition, it allows an investigator to be more accurate classify the nutritional status if compared to weight or body mass index alone. Estimating body fat allows for more precise classification of individuals for issues related to assessment and comparison of nutritional status among healthy and GDM pregnant women. Basically, the body can be divided theoretically into two-compartments, fat mass and fat-free mass. Generally, water constitutes approximately 72% of fat-free mass in non-pregnant women, whereas fat mass is considered essentially devoid of water (Catalano *et al.*, 2000). Fat distribution is not uniform and mostly accumulates in abdominal, subscapular and upper thigh area (Forsum *et al.*, 1998). Because of the increases in total body water during pregnancy, estimating body composition is best done by using multi-compartment modelling because measure of density tend to overestimate fat mass by lowering body density closer to that of fat.

### 2.5.4 Skinfold Thickness

The dominant way in determining nutritional status is the assessment of fat component and especially its distribution (Zekan., 1998). It is done by skinfold thickness as a reliable and convenient indicator of nutritional status (Lopez *et al.*, 2011). In fact, skinfold thickness reflect subcutaneous fat stores that are used to meet the energy needs of the mother and the fetus during pregnancy, and thus change in these measurements is an indicator of maternal nutritional status (Lopez *et al.*, 2011). The majority of previous anthropometric study has focused on weight gain and been conducted in developed countries (Adair and Bisgrove, 1991; Brown *et al.*, 1986; Hytten, 1991). Less is known about changes in skinfold thickness and circumferences during pregnancy especially is Asia setting.

In late gestation, abnormal body weight can be due to clinical edema, therefore skinfold thickness is an alternative parameter to be used for nutritional assessment as they are not influenced by leg edema (Reynold., 2003). Previous studies demonstrated that body fat has increased in a range of 1.3kg to 5.8kg throughout gestational period (Zekan, 1998). However, through the third trimester and into the immediate postpartum period, skinfold thicknesses at all sites tend to decrease (Hediger *et al.*, 1994). Decrease in some skinfold thickness in the latter stages of pregnancy support the idea that maternal energy stores laid down earlier are used during latter stages when energy demands are higher (Taggart *et al.*, 1967).

Biceps and triceps skinfolds are the indicator of peripheral subcutaneous fat, whereas subscapular and suprailiac skinfolds are the indicator of central subcutaneous fat. Changes in fat are neither associated with each other nor simultaneous during pregnancy, which confirms the existence of two components of subcutaneous tissue: peripheral and central with different structures morphologies and receptor of adipocytes (Zekan, 1998). Furthermore, increased in the number of adipocytes in subcutaneous tissue and the peripheral distribution of fat is caused by estrogen which is observed in the last trimester of pregnancy when the decrease in internal fat occurs (Zekan, 1998). Piperata *et al.* (2002) found that women were significant higher in skinfold thickness at centralised part of subscapular, suprailiac and mid-thigh between the second and the third trimester. Throughout the gestational period, subscapular skinfold has the most obvious increase if compared to biceps and triceps support the idea central skinfold thickness increases more than those in peripheral sites during pregnancy (Lopez *et al.*, 2011).

After reviewing on different articles, it is known that research on skinfold change during pregnancy estimating the accretion and utilization of body fat during gestation, reflects the concept of optimal maternal nutrient reserves associated with better pregnancy outcome (Pipe, 1979).

### **2.5.5 Pre-pregnancy Body Mass Index**

One of the anthropometric indices that represent nutritional status is Body Mass Index (BMI). It is known as Quetelet's index which is the ratio of weight to square of height. When evaluated in studies of body composition and skinfold thickness, BMI showed high correlation with body fat and degree of obesity (Garrow, 1985). Therefore, BMI is recommended to be used in the clinical setting by the Nation of Academy of Sciences (1990).

Furthermore, pre-pregnancy BMI is one of the most used anthropometric indicators because it is closely related to neonatal birth weight correspond to charts that identify low or excessive weight gain (Lopez *et al.*, 2011). Overweight and obesity prior to pregnancy and excessive gestational weight gain are common nutritional problem due to a notable shift in demographic and epidemiologic profiles over the last few years (Lopez *et al.*, 2011). In addition, obesity is one of the risk factor of GDM (Xiong *et al.*, 2001). Therefore, concern should be provided by health care provider on the women with higher pre-pregnancy BMI.

### **2.5.6 Body Circumferences**

In some developing countries, pre-pregnancy weight may be frequently unknown and thus total weight gain cannot be calculated. MUAC is recognized as an effective tool for screening purpose because of strong correlation with body weight (Lopez *et al.*, 2011). A study conducted by Khadivzadeh (2002) to Iranian women in reproductive age also found a strong correlation of MUAC with maternal weight and BMI. However, there is no consensus about the cut-off point that can be associated with insufficient of maternal weight gain. In Mazambian pregnant women, MUAC below 25 cm has been proposed as a warning of malnutrition and below 23 cm as a strong indicator of malnutrition (Lopez *et al.*, 2011). A study found that hip circumference showed a significant increase from the second to third trimesters, which paralleled skinfold thickness at thigh circumferences (Piperata *et al.*, 2002).

## 2.6 Pregnancy Symptoms

To support the development of fetus and to prepare for labour and lactation, maternal physiology has changed remarkably throughout the pregnancy period (Coad & Dunstall, 2005). Even though those pregnancy symptoms were not life-threatening, but women who suffer these minor disorders might suddenly become a serious illness. These symptoms occur because of physiological adaptation of the women's body to pregnancy, in particularly the effect of progesterone and other hormones on the smooth muscles and connective tissue (Kamysheva *et al.*, 2009). From previous study, it is found that pregnant women even without pregnancy symptoms do not meet the requirements for energy and several minerals (Lee *et al.*, 2004). Therefore, this research is going to investigate whether there is effect of pregnancy symptoms on maternal nutritional status.

Generally, early physiological changes in pregnancy are regulated by hormonal changes, whereas later changes might be structural effects of the enlarging fetus (Coad & Dunstall, 2005). Undoubtedly, these symptoms are unpleasant and have negative effect on a women's life (Kamysheva *et al.*, 2009). Based on the validated Pregnancy Symptoms Questionnaire developed by Marhazlina *et al.* (2011), the 22 common symptoms were found to be loaded in the three domains which were named as 'General', 'Constitutional' and 'Somatic pain'. General domain consisted of 9 items, Constitutional domain consisted of 5 items and Somatic pain domain included 8 items. To have a better understanding, literature reviews of occurrence and severity on these particular symptoms were done for the findings and significance.

### 2.6.1 General pregnancy symptoms

General pregnancy symptoms include headache, dizziness, food cravings, shortness of breath, hot flushes, insomnia, heartburn, bloating and constipation (Marhazlina *et al.*, 2011).

Headache was reported as one of the symptoms that cause most discomfort to pregnant women in a study of investigating the relationship between symptoms and psychological well-being (Kamysheva *et al.*, 2009). Previous population-based studies indicate that the prevalence of headache in diabetes patients has been shown to be lower, similar, and higher compared with controls without diabetes (Aamodt *et al.*, 2007). Dizziness of pregnant women is due to the effect of progesterone on smooth muscle. Decreased in vascular resistance is then altering the blood pressure and venous return, permitting the pooling of blood in the lower extremities. Therefore, pregnant women who erect for long periods having increased vasodilation may feel dizziness (Stables & Rankin, 2010).

The studies on the prevalence of food cravings found the occurrence rate was up to a range of 50% to 90% of pregnant women (Bayley *et al.*, 2002). The most craved items were fruit, fruit juices and sweet foods which are low in nutrient density. Research indicates that those who craved sweets consumed more sugar and energy than those without sweet cravings (Pope *et al.*, 1992). Women with moderate to severe vomiting report more craving both before and during their pregnancy (Crystal *et al.*, 1999). Food cravings typically arise late in the first trimester peak during the second trimester then diminish when near to delivery (Belzer *et al.*, 2010). The frequency of food cravings was reported twice higher in GDM group during late gestational period (Belzer *et al.*, 2010). As for heartburn, the prevalence was reported in 30-70% in pregnant women (Blackburn, 2007). Asian women seem to have lower prevalence of heartburn with 17% in a study conducted among Singaporean (Ho *et al.*, 1998). Another study found that troublesome of heartburn was more prevalent among diabetic women (Bytzer *et al.*, 2001). Heartburn was a burning sensation or discomfort felt behind the breastbone or throat. It occurs in pregnant women is due to the relaxing effect of progesterone on the smooth muscle of the cardiac sphincter between stomach and esophagus (Stables & Rankin, 2010). Women in heartburn were reported have a higher score on nausea and vomiting as well as the well-being scores (Gill *et al.*, 2009).

It is common for pregnant women to complain of being hot. Pregnancy women experienced hot flushes due to increased body temperature because pregnancy mimics hyperthyroidism. Progesterone as a hormone of pregnancy also has released to increase body temperature (Coad & Dunstall, 2005). Oestrogen and progesterone increased the blood flow to the lungs and hence increases the circulating blood volume and cardiac output. Distribution of blood to the skin is greatly increased expediting heat loss. Blood flow to the hands increases about seven-fold giving a very marked increases in skin temperature. Insomnia of pregnant women is more likely disturbed by urinary frequency, leg cramps breathing problems and vomiting (Stable & Rankin, 2010). This condition usually occurs during second half of pregnancy with increasing disturbances (Coad & Dunstall, 2005).

The constipation prevalence rates were 24, 26%, and 16% in the first, second, and third trimesters of pregnancy. The increased production of progesterone in pregnancy causes relaxation and reduced peristalsis in the transit time of food through the gut and greater time for water to be absorbed in the large intestine (Stables & Rankin, 2010). It may be due to the side effect of iron supplement prescribed by health practitioner (Bradley *et al.*, 2007). Even the prevalence of those general symptoms were rather higher, the effect of general pregnancy symptoms on maternal nutritional status has never been studied.

### **2.6.2 Constitutional Pregnancy symptoms**

The symptoms categorized under this domain were nausea, vomiting, loss of appetite, food hypersensitivity and non food hypersensitivity (Marhazlina *et al.*, 2011). Symptoms of nausea and vomiting of pregnancy were experienced by 80% of pregnant women (Nguyen & Einarson, 2006). Crystal *et al.* (1999) found that over 16% of pregnant women reported to have moderate to severe symptoms of vomiting. Women with lower pre-pregnancy BMI experience less severe symptoms of nausea and vomiting (Huxley, 2000). Common name for these symptoms is morning sickness, even though only less than one-third of women experience it

solely in morning. Pike (1999) claimed that women who experience nausea and vomiting do encounter nutritional consequences in the later stages of pregnancy and more likely to have poor pregnancy outcome. The hypothesis of “Maternal and Embryo Protection” propose that nausea and vomiting shield both mother and baby from infections by food microorganism and poisoning (Flaxman & Sherman, 2000).

With regards to appetite, the secretion of human chorionic gonadotrophin (hcG) affecting appetite and fat deposition together with thirst sensation with alteration of Antidiuretic Hormone (ADH) and other osmoregulation during pregnancy (Coad & Dunstall, 2005). From previous study, we know that women with severe pregnancy symptoms seek to avoid strong flavors because such food may exacerbate their symptoms (Crystal *et al.*, 1999). Morning sickness which correlated with protein food aversion has been reported significantly lower diverse diet and calcium intake (Lee *et al.*, 2003). In the same study, it is found that maternal weight gain was reduced gradually when high pregnancy symptoms during first trimester of pregnancy (Lee *et al.*, 2003). Likewise, research study in Turkana found that women who experienced nausea and vomiting had significantly lower summed skinfold and body mass index (BMI) during mid and late gestation (Pike, 1999).

On the other hand, Huxley (2000) suggested that the nausea and vomiting stimulated placental growth by dividing nutrient factors from the mother to the benefit of growing embryo. If compared to healthy women, poor diabetic control increases the severity of nausea and vomiting during the first trimester (Wylie & Bryce, 2008). In the perspective of GDM as case, nausea and vomiting in early pregnancy may upset diabetic control and lead to either hypo or hyperglycemia (Taylor & Davison, 2007).

### 2.6.3 Somatic Pain Pregnancy symptoms

Wide range of somatic pain included in pregnancy symptoms which are carpal tunnel, pelvic pressure, Braxton Hicks, Groin pain, backache, leg cramps and leg edema and fatigue (Marhazlina *et al.*, 2011). Previous study indicates that women who experienced the most frequent and uncomfortable physical symptoms were most likely to report higher depressive symptoms (Kamysheva *et al.*, 2008).

About 50% of pregnant women experience backache and it is more likely reported in very young women. The effect of strained back muscles and relaxin on pelvic ligaments may contribute to backache (Stables & Rankin, 2010). The incidence of backache increases particularly after the 5<sup>th</sup> month of pregnancy. Some women experience severe back pain often with peak at night (Coad & Dunstall, 2005). Few mechanisms of back pain were proposed such includes mechanical, traumatic, hormonal, metabolic and degenerative factors (Vermani *et al.*, 2009).

Women who develop Carpal tunnel syndrome complain of numbness and tingling in their fingers and hands. The prevalence of this symptom was about 62% of pregnant women in a study conducted in Italy (Padua *et al.*, 2001). This syndrome together with Braxton Hicks occurs mostly during third trimester (American Pregnancy Association). This is due to fluid retention of pregnancy and swelling of connective tissue which compresses the median nerve as it runs through the carpal tunnel in the wrist. Carpal tunnel and backache were the symptoms that having significant effect on life (Kamysheva *et al.*, 2009).

Braxton Hicks contractions are painless contractions that are measurable from the first trimester of the pregnancy. The contractions do not dilate the cervix but assist the circulation of blood to placenta. In spite of that, pelvic pressure during pregnancy is mainly affected by breast change, stretching of the round ligament and decreased tone of abdominal muscles.



About 45% of pregnant women suffering from pelvic pressure in a study conducted in United Kingdom (Vermani, 2009). A higher prevalence was reported in Swedish research with 72% of pregnant women (Mogren & Pohjanen, 2005). In late pregnancy, the symphysis pubis which supports the pelvic may separate and cause the pregnant women great discomfort when walking. On the other hand, pressure of the uterus stretching nerves and blood vessels result in numbness and tingling of extremities (Coad & Dunstall, 2005). Women with higher pre-pregnancy and gestational weight and BMI tend to have low back pain (Mogren & Pohjanen, 2005).

Leg cramps are not uncommon in the second half of pregnancy especially of the calf and thigh muscles (Coad & Dunstall, 2005). It is caused by an imbalance between electrolytes calcium and phosphorus or decreased circulation to lower extremities produced by the pressure of the uterus (Littleton, 2005). In late pregnancy, most women also experience leg edema owing to the combined effects of progesterone relaxing the vascular tone, the impeding of the venous return by the gravid uterus and gravitational forces. The incidence tends to increase with increased maternal age. Fluid drunk by the pregnant women appears as increased leg volume and the expected diuresis is delayed until she lies down, resulting in increased nocturia (Coad & Dunstall, 2005). Moreover, up to 97% of pregnant women experience fatigue in the first trimester of pregnancy (Stable & Rankin, 2010).

Provided that the studies regarding physical symptoms only focus on number of frequency (Kamysheva *et al.*, 2009) but not related to nutritional status. Effects of symptoms on quality of life have been shown in cancer research to enhance the understanding of subjective experiences of physical symptoms (Okamura *et al.*, 2005) and therefore it is potentially for the researcher to investigate the effects of symptoms on maternal nutritional status.

## **CHAPTER 3 METHODOLOGY**

### **3.1 Study Design**

The research design applied for this study was a comparative study whereby the target population was the Malay pregnant women in Malaysia. The source population selected was Malay pregnant women living in Kelantan state. Therefore, the respondents selected, represent the source population was those who lived in Kota Bahru. A comparative study was done by the researcher by using validated questionnaire conducted among healthy and gestational diabetic pregnant women in Obstetric and Gynecology (O&G) Clinic in Hospital Universiti Sains Malaysia to examine maternal nutritional status and pregnancy symptoms among healthy and gestational diabetic women in Hospital Universiti Sains Malaysia (HUSM).

#### **3.1.1 Population and Setting**

The study aims to examine pregnancy symptoms and maternal nutritional status among healthy and gestational diabetic women in Hospital Universiti Sains Malaysia (HUSM). This hospital practiced selective screening with the Oral Glucose Tolerance Test (OGTT) tests being performed on patients with indications such as than 25 years old, history of gestational diabetes mellitus, a family history of diabetes (in first-degree relatives), history of macrosomic baby or Body Mass Index more than 30kg/m<sup>2</sup>.

The management of abnormal OGTT at HUSM depended on the period of gestation and the severity of the hyperglycemia at the time of diagnosis. If the patient present risky in first visit, test was done at once. For those patients with normal glycemic result, test will be done again after 6-8 weeks later. For those patients with slightly hyperglycemia, diet control was done by referring to Diet Clinic. Review was done after 2 weeks by using blood sugar profiles

(BSP), which consisted of the results of pre-meal and 10.00pm testing of blood sugar levels were assessed. In patients with normal BSP (5-7 mmol/L), diet therapy would be advised. In mild GDM, diet was the initial therapy. However, if hyperglycemia not controlled, insulin therapy would be started at 4-6 unit. Review would be done after 2 weeks therapy and BSP testing is repeated.

Pregnant women were defined as a female having a child or young developing in the uterus. Pregnant women in third trimester were defined as women in pregnancy's time period extending from the 28th week of gestation until delivery. Women with gestational diabetes had a positive result in glucose screening test before recruitment. Healthy pregnant was defined as pregnant women without GDM or any other pre-existing chronic diseases. Meanwhile, GDM women were defined as pregnant women diagnosed with GDM during antenatal check-up.

### **3.1.2 Sample Size**

Sample size calculation is performed by using PS software (Dupont & Plummer, 1990).

Type 1 error probability ( $\alpha$ ) = 0.05

Power = 90%

A difference in population means= 1.7 (Patrick M. Catalano, 1998)

Standard Deviation = 2.83

Ratio (m) = 1

Output =  $59 \times 2 = 118$

Drop outs compensation of 10% = 11

Sample Size = 129

By using 95 % power of the study and the significance level of 5 %, the sample size calculated was rounded to 118. With the addition of 10 % drop-outs, the sample size proposed was 129. During recruitment period, a total of 150 pregnant women were approached by the researcher. However, only 125 pregnant women agreed to participate in the study. After eliminating the respondent who was dropout from the study, 108 respondents were recruited in this study. Therefore, there were 77 healthy pregnant and 31 GDM women involved in this research.

### **3.1.3 Inclusion and Exclusion Criteria**

Upon the approval from the Universiti Sains Malaysia Human Research Ethics Committee (USMKK/PPP/JEPeM [245.4(2.16)]) (Appendix 5), the study has recruited respondents based on the following criteria:

The inclusion criteria were:

1. Malaysian citizen.
2. Aged 19 to 40 year-old at the time of recruitment.
3. Within the gestational age of 32-40 weeks based on the last menstrual period and ultrasound scan.
4. Returned signed consent.

The exclusion criteria were:

1. Respondents with pre-existing chronic diseases such as heart disease, diabetes or hypertension.
2. Respondents with multiple pregnancies.

## **3.2 Instrumentation**

In this study research perspective, the nutritional status and pregnancy symptoms survey was conducted using self-administered questionnaires filled out by the researchers (Appendix 3). This questionnaire consists of five sections.

### **3.2.1 Questionnaire**

#### **Section A Socio-demographic background**

This section consisted of demographic and socioeconomic information of the respondents. Data such as age, education level, employment status and household income were furnished by the respondents.

#### **Section B Obstetric and Gynecology History**

This section consisted of obstetric and gynecology data of respondents such as number of gravidity, parity, gestational week, gestational diabetes mellitus status, history of gestational diseases, frequency of miscarriage and use of oral contraceptive.

#### **Section C Family Medical History and Systemic Diseases**

This section includes family medical history and systemic diseases that had been diagnosed among respondents such as diabetes, hypertension and stroke. Respondents were required to answer whether their first degree relative have any of these illnesses (genetic factors).

#### **Section D Physical Activity Status**

For women with gestational diabetes, respondent were required to answer whether she had done any physical activity in a month prior to pregnancy. If the answer was “yes”, respondents were required to proceed to the next questions which asked about duration of physical activity per day.

## **Section E      Pregnancy Symptoms Questionnaire, PSQ**

This validated questionnaire (Appendix 4) was developed by experts in nutrition, obstetrics and statistics (Marhazlina *et al.*, 2011). The 22 items were categorised into 3 domains of symptoms which are general, constitutional and somatic pain. During the interview session, respondents were to answer the frequency and severity of each pregnancy symptoms based on their experience throughout the gestational period. For the frequency of occurrence, rate ranging from 1 to 5 was used to indicate never, rarely, sometimes, often and very often. Whereas for the severity score, there is rating from 1 to 5 as well indicates for slightly, moderate, severe, very severe and extremely severe.

### **3.2.2    Anthropometric Measurement Instruments**

Anthropometry is the measurement of body size, weight and proportions. Measures obtained from anthropometry can be sensitive indicators of health, development and growth in infants and children. Anthropometric measures can be used to evaluate nutritional status. They are valuable in monitoring the effects of nutritional intervention of disease or malnutrition. It is a method of choice for estimating body composition in a clinical setting (Lee & Niemen, 2010). All anthropometric measurements followed the procedures described in Lohman *et al.* (1988).

#### **3.2.2.1    Body Weight**

All the current weight of respondents was measured by electronic weighing scale. Electronic scales tend to be lighter in weight, somewhat more portable, faster, easier to use and provides easy-to-read digital output in metric units (Lee & Niemen, 2010). The scale was placed on a flat, hard surface that allows them to sit securely without rocking or tipping. The zero on the scale's digital reading was checked every time before weighing.