GESTATIONAL WEIGHT GAIN AMONG MALAY WOMEN WITH HIGH RISK PREGNANCY IN KELANTAN TERTIARY HOSPITALS: A MIXED METHOD STUDY

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LIST OF ABBREVIATIONS

ACOG	American College of Obstetricians and Gynaecologist
AOR	Adjusted odds ratio
BMI	Body mass index
CI	Confidence interval
GDM	Gestational diabetes mellitus
GWG	Gestational weight gain
HDP	Hypertensive disorder in pregnancy
IDI	In-depth interview
IOM	Institute of Medicine
IQR	Interquartile range
LBW	Low birth weight
LGA	Large for gestational age
LSCS	Lower segment caesarean section
METs	Metabolic equivalents
PIH	Pregnancy induced hypertension
PPAQ	Pregnancy Physical Activity Questionnaire
RNI	Recommended Nutrient Intake
SGA	Small for gestational age
SD	Standard deviation
WHO	World Health Organization
SEM	Socio Ecological Model

LIST OF SYMBOLS

>	More than
<	Less than
=	Equal to
≥	More than and equal to
≤	Less than and equal to
α	Alpha
ß	Beta
%	Percentage
Δ	Precision

ABSTRAK

KENAIKAN BERAT BADAN SEMASA HAMIL DI KALANGAN IBU-IBU HAMIL BERISIKO TINGGI DI HOSPITAL RUJUKAN BERPAKAR KELANTAN: KAJIAN KAEDAH CAMPURAN

Kenaikan berat badan semasa hamil adalah peramal penting dalam menentukan kesan jangka pendek dan panjang kepada kesihatan ibu dan anak. Hanya sedikit maklumat yang tersedia ada berkenaan dengan faktor-faktor yang boleh diubahsuai yang boleh menyumbang kepada peningkatan berat badan yang tidak optimum semasa hamil di kalangan wanita Melayu. Tujuan kajian ini dijalankan adalah untuk menentukan perkadaran dan faktor-faktor yang mempengaruhi kenaikan berat badan semasa hamil di kalangan wanita Melayu hamil berisiko tinggi. Ia juga untuk meneroka persepsi dan pengalaman wanita berkaitan dengan peningkatan berat badan yang berlebihan. Kajian kaedah campuran penumpuan selari yang terdiri daripada kajian kuantitatif dan kualitatif telah dijalankan dalam kalangan wanita Melayu hamil berisiko tinggi semasa trimester ketiga yang menghadiri klinik antenatal di hospital rujukan berpakar di Kelantan. Terdapat 399 orang wanita Melayu hamil yang memenuhi kriteria untuk kajian kuantitatif. Sebanyak 23 orang wanita Melayu hamil dengan berat badan berlebihan ditemuramah secara individu yang terdiri dari pelbagai indeks jisim badan pra-kehamilan, nombor kehamilan, tahap pendidikan dan status pekerjaan. Analisis regresi logistik multinomial digunakan untuk menganalisis hubungan antara kenaikan berat badan dan faktor -faktor penyumbang. Analisis tematik telah digunakan untuk mengenal pasti tema berulang. Analisa data awal kuantitatif dan kualitatif dilakukan secara berasingan, kemudian kedua-dua data tersebut dikumpulkan dan ditriangulasi untuk menjawab persoalan kajian. Perkadaran kenaikan berat badan semasa hamil

bagi kategori berlebihan, mencukupi, dan tidak mencukupi adalah 39.8% (95% CI; 35.0, 44.8), 34.8% (95% CI; 30.2, 39.7) and 25.4% (95% CI; 21.1, 29.9). Indeks jisim badan pra-kehamilan berat badan berlebihan dan obes (AOR 1.75; 95% CI: 1.07, 2.86; *p*-value = 0.026) adalah faktor yang berkait rapat dengan peningkatan berat badan yang berlebihan. Terdapat tiga tema utama yang terbit dari temuduga (23 IDI) iaitu; keutamaan kepada bayi mereka yang belum lahir; perasaan negatif tentang berat badan; kepercayaan mengenai penyumbang utama kepada peningkatan berta badan yang berlebihan. Indeks jisim badan pra-kehamilan merupakan peramal yang kuat terhadap peningkatan berat badan yang berlebihan semasa hamil. Ia berkaitan dengan amalan kebudayaan, penambahan berat badan daripada kehamilan sebelum ini, masalah gaya hidup seperti yang telah dikenalpasti dalam kajian kualitatif. Penemuan kami boleh menjadi mesej dan strategi intervensi pada masa depan untuk menyediakan penjagaan antenatal yang terbaik untuk mengelakkan kenaikan berat badan yang berlebihan.

Kata kunci: *Kenaikan berat badan semasa hamil, kehamilan berisiko tinggi, indeks jisim badan pra-kehamilan*

ABSTRACT

GESTATIONAL WEIGHT GAIN AMONG MALAY WOMEN WITH HIGH RISK PREGNANCY IN KELANTAN TERTIARY HOSPITALS: A MIXED METHOD STUDY

Gestational weight gain is an important predictor of short and long-term pregnancy outcomes for both mother and her offspring. Little information is available regarding modifiable factors contributing to suboptimal weight gain among Malay women. The aim of this study was to determine the proportion and factors associated with gestational weight gain among Malay women with high risk pregnancy; and to explore women's perceptions and experience in relation to excess weight gain. A convergence parallel mixed method study comprising of quantitative and qualitative study was conducted among Malay women with high risk pregnancy in third trimester who attended antenatal clinic in tertiary hospitals, Kelantan. There were 399 Malay pregnant women who met the study criteria for the survey. Systematic sampling was applied. A subsample of 23 women with excessive weight gain were interviewed individually representing different range of pre-pregnancy body mass index (BMI), gravidity, education level and employment status. Multinomial logistic regression was used to analyse the association between gestational weight gain and contributing factors. Thematic analysis was used to identify recurring themes. Initial data analysis of quantitative and qualitative were done separately, then both data derived were converged and triangulated to address the research question. The proportion of excessive, adequate and inadequate gestational weight gain was 39.8% (95% CI; 35.0, 44.8), 34.8% (95% CI; 30.2, 39.7) and 25.4% (95% CI; 21.1, 29.9), respectively. Pre-pregnancy BMI overweight and obese (AOR 1.75; 95% CI: 1.07, 2.86; *p*-value =

0.026) was the only factor significantly associated with excessive gestational weight gain. There were three major themes emerged from the interviews (23 IDIs) which were; prioritised the needs of their unborn baby; negative feelings about pregnancy weight gain and belief regarding main contributors to excess weight gain. Pre-pregnancy BMI was a strong predictor of excessive GWG. It was related to the cultural practices, weight gain from previous pregnancy and lifestyle issues as identified in the qualitative study. Our findings can serve as future intervention messages and strategies to provide best antenatal care in avoiding excessive weight gain.

Keywords: *Gestational weight gain, high risk pregnancy, pre-pregnancy body mass index*

CHAPTER ONE

INTRODUCTION

1.1 Background of Study

Obesity is increasing at an alarming rate worldwide and has tripled since 1975, with a dramatic increase now seen in low and middle-income countries, particularly in urban settings (WHO, 2016). Economic and technology advancement, and lifestyle changes have created an abundance of cheap, high-calorie food coupled with decreased required physical activity. The population is eating more and moving less. In 2016, 39% of adult women aged 18 years and older were overweight and 13% were obese globally (Devlieger *et al.*, 2016). The prevalence of obesity continues to rise in the general population and particularly among reproductive age women (Siega-Riz *et al.*, 2004).

Malaysia also is facing the escalating prevalence of overweight and obesity parallel with developed country. The National Health Morbidity Survey 2015 reported 47.7% of the general population as either overweight (BMI 25 kg/m^2, 30%) or obese (BMI 30 kg/m^2, 17.7%), with a 3% increase in the prevalence of obesity since 2011. Currently, the prevalence of obesity in Malaysia is also higher than the world prevalence of 13.0% in 2014 (Ministry of Health, 2015). Not surprisingly, women of reproductive age are also affected. Almost half of female adult more than 18 years old were overweight and obese based on the World Health Organization (WHO), 2008 classification (Ministry of Health, 2015).

As prevalence of obesity is increasing, majority of reproductive age women will enter pregnancy with higher BMI. Currently, maternal obesity is well known as one of the greatest challenge for maternity services in developed and developing countries (Hemminki, 2009). Obesity in pregnancy increases the risk of maternal and perinatal complications; and also affect health in the later life (Krishnamoorthy *et al.*, 2006; Catalano, 2007). Prevalence of maternal obesity in 2015 in Malaysia was 14.6% (Ministry of Health, 2016) which was parallel with figure from developed countries (Heslehurst *et al.*, 2010). Pregnancy has been proposed as a critical period for development of overweight and obesity both for the mother and her offspring. For women, these risks include heart disease and hypertension while for children it will increase risk of future obesity and heart disease (Gunderson and Abrams, 1999; Siega-Riz *et al.*, 2004).

Based on the Confidential Enquiries into Maternal Death (CEMD) in Malaysia, leading causes of maternal death in 2015 were pulmonary embolism and associated medical condition. This accounted for 60% of all maternal death cases. The data also showed that five top causes of maternal death in Malaysia between 2008 and 2015 were associated medical condition, obstetric embolism, postpartum haemorrhage, hypertensive disorder in pregnancy and obstetric trauma. Following the finding, obesity remains the main risk factors contributing to pregnancy related deaths, representing a disproportionate number of deaths associated with obesity in childbearing women (Majdah, 2016).

Pre-pregnancy obesity is associated with increased risk of pregnancy complications such as gestational hypertension, preeclampsia, gestational diabetes mellitus,

thromboembolic diseases, intrapartum outcomes (e.g. caesarean delivery), and foetal outcomes (e.g. foetal macrosomia, late foetal death, birth defects, early neonatal death) (Siega-Riz and King, 2009). The health risks associated with obesity are further compounded during pregnancy when excessive gestational weight gain contribute to additional risks to the mother and their offspring (Restall *et al.*, 2014).

1.2 Gestational Weight Gain

Gestational weight gain (GWG) is defined as the amount of weight gained between conception and just before the birth of the infant. It is a unique biological phenomenon which includes three important components. These components includes product of conception (fetus, placenta and amniotic fluid), maternal tissues (uterus, mammary and blood) and maternal fat stores (Rasmussen and Yaktine, 2009). The total weight gain comprise about 30 percent of fat reserves, 65 percent of water and remaining five percent of protein (Butte *et al.*, 2003).

The GWG guidelines have evolved and adapted to the changing health concerns and needs of the pregnant women. Weight gain recommendations for pregnant women were first developed in 1970 to mitigate low maternal weight gain, prevent premature birth and low birth weight which resulting in a high infant mortality rate (National Research Council, 1970). Twenty years later, in 1990, The Institute of Medicine (IOM) released more specific weight gain targets, based on pre-pregnancy BMI but did not take into account an upper limit for obese women (Institute of Medicine, 1990). In 2009, the guidelines were reexamined and updated in response to concerns of the increased number of women entering pregnancy with high pre-pregnancy BMI and gaining excess gestational weight gain. The IOM highlights that the new

recommendations differ from the previous ones in that they are based on the WHO BMI categories and include a more restrictive range of weight gain for obese women (Institute of Medicine, 2009). These guidelines are currently the primary source of GWG information used by healthcare providers worldwide.

There are three classifications of gestational weight gain according to the IOM guidelines which are inadequate, adequate and excessive. Literatures reported only one third of pregnant women in developed and developing countries achieved optimal weight gain (Cedergren, 2007). Because pregnancy is the only common clinical situation in which the care provider has at least two patients which are the mother and the foetus, thus the appropriate weight gain and balancing the amount of weight gain are needed to optimize the growth of babies without jeopardizing the health of mothers in either the short or the long term (Institute of Medicine, 2009).

Women with excessive gestational weight gain may experience various adverse maternal outcomes, which include increased risk for pregnancy-associated hypertension, gestational diabetes mellitus, intrapartum complications, postpartum weight retention, subsequent maternal obesity and also increased risk for unsuccessful breastfeeding (Chen *et al.*, 2010; Restall *et al.*, 2014). While, low body mass index and suboptimal weight gain during pregnancy are long-recognized risk factors for the small for gestational age infants and increased risk for prematurity (Krasovec and Anderson, 1991).

1.3 Maternal Health Services in Malaysia

In Malaysia, health services are delivered through a network of tax-funded public healthcare organisations and private providers. Antenatal care services are provided at all health clinics, community health clinics and public hospitals for free of charge (Safurah *et al.*, 2013). Maternal health services in Malaysia were established as far back as 1923 with the introduction of midwifery legislation and the training of midwives in the straits settlements. Since 1957, various strategies have been implemented at all levels of health care to improve maternal health in Malaysia. There has been significant decline in maternal mortality ratio from 540 per 100 000 livebirths in 1957 to just 22.3 in 2014 (Ministry of Health, 2017a). This is one of the successful story of maternal health services in Malaysia.

The 1980s marked the Global Safe Motherhood Initiative designed to improve antenatal care and counselling throughout the world. Risk approach system is one of the strategies implemented in Safe Motherhood to reduce maternal mortality ratio. Risk approach studies were initially done in the Krian District of Perak, which at the time had the highest maternal mortality rates in the country. The findings resulted in a risk approach strategy, which was designed to improve antenatal and postnatal care, especially in the management of complications and hospital referrals. After the study in Krian District, Perak (Karim, 1987), which identified the nature and prevalence of local risk factors, a national risk approach system which used four-tiered colour coding system was institutionalised in September, 1989 (Somboonsook *et al.*, 1995).

In this system, antenatal mothers are colour coded as one of four colour categories which are white, green, yellow or red. This system grades all antenatal mothers

according to the level of risk factors. The checklist is made into a format and attached to the antenatal card. A self-adhesive colour tag is placed on the mother's antenatal card (Ravindran *et al.*, 2003). This system function as managerial tools to determine care providers, locations of antenatal care and delivery. The public sector primary health clinics in Malaysia adopted a dual-record system whereby the women carry their own case notes and the clinics keep a duplicate set (Ministry of Health, 2013). According to Perinatal Care Manual 2013, pregnancy with no risk labelled as white code; pregnancy with low risk factors as green code; pregnancy with high risk factors as yellow code and pregnancy with extreme high risk factors as red code (Ministry of Health, 2013).

All antenatal mothers should be weighed at every antenatal visit. There should be a progressive increase in weight of approximately 10 – 12.5 kg which were 25% of non-pregnant weight throughout the pregnancy. Generally, the weight gain should be about 0.5 – 0.75 kg/month for the first 20 weeks and 0.5 – 0.75 kg/week from 20 weeks onwards (Ministry of Health, 2013). However, this recommendation is applied to women in general and does not consider the different categories of pre-pregnancy BMI as compared to IOM guidelines. During antenatal visit if pregnant women were noted to have inadequate or excessive weight gain, they will be referred to medical professionals for thorough assessment of foetal growth and any underlying causes. All pregnant women who did not gain weight within recommended range have to see dietician for dietary counselling (Ministry of Health, 2013).

1.4 Research Gap

Although optimal GWG is necessary for better maternal and foetal outcomes, the precise optimal GWG among Malaysian women is still controversial, and there is still a lack of data on prevalence and modifiable risk factors of GWG among the Malay population.

The social ecological model provides a framework for understanding why so few women gain weight within the IOM guidelines. The model emphasizes that health outcomes are not solely due to individual characteristics and behaviors, but also the various environments in which people work, live, play, and develop (Davison and Birch, 2001). The model has been employed widely and successfully in obesity prevention and health promotion research, yet individual and community level determinants of gestational weight gain are still not well understood.

The current literatures have focused on sociodemographic predictors (Drehmer *et al.*, 2010; Samura *et al.*, 2016), but few studies have examined relationship between individual and community determinants such as socio-cultural norms and psychosocial factors in relation to dietary nutrient intake and physical activity behaviours during pregnancy (Lindberg *et al.*, 2016). Little attention has been given to environmental contexts that promote or inhibit healthy gestational weight gain. This study addresses this gap by identifying predictors of gestational weight gain across multiple levels of the social ecological model.

1.5 Justification of the Study

Due to lacking of systematic database on maternal health data such as pre-pregnancy weight, height, and weight at delivery in Malaysia, thus there is no comprehensive representative picture of the epidemic burden of maternal obesity was available. Most published figures are derived from cross-sectional and national cohorts. The findings from this study can add to the intellectual value to fill the voids in the database. It also can be used as references in future study in the same field.

Malay ethnicity was found to have higher risk for inadequate and excessive gestational weight gain as reported by Koh *et al.* (2013). Such variation may be accounted for by differences in dietary intake, physical activity, psychosocial factors or sociocultural norms. Furthermore, women's experiences of gestational weight gain are also influenced by positive and negative interactions with external and societal factors. These include cultural norms and the support from partners, family, friends, and health care providers. Due to the broad internal and external influences, it is important to gain a broad and in depth understanding of the sociocultural, personal, and environmental factors that influence gestational weight gain in Malay women, in order to develop the best care.

Despite the important contribution of maternal nutritional status and dietary factors to weight gain during pregnancy, only few studies have determined the influences of these factors on maternal weight gain. Most published studies have focused on the relationship between gestational weight gain and birth outcomes. To the author's knowledge, at present data on socio-demographics, medical history, dietary nutrient intakes and physical activity associated with gestational weight gain are still

insufficient, particularly in many developing countries including Malaysia. Recognizing that information on these modifiable risk factors is important in developing appropriate strategies to encourage adequate weight gain and plan for better pregnancy outcomes, the present study aims to determine factors associated with gestational weight gain among high risk group of pregnant Malay women.

Previous literatures were limited to quantitative assessments of predictors of pregnancy weight gain. Mechanisms that resulted in behaviour change are not very clear in the Malay culture context, and quantitative studies may not able to capture these factors due to close-ended nature of assessment tools thus having qualitative in-depth information on individual's perception and socio-cultural factors which influence lifestyle behavior is much needed and meaningful. This study used a mixed method design to converge quantitative and qualitative data, an approach ideally suited to addressing complex questions from a number of perspectives thus perhaps, it will enhance validity of the study. The findings from qualitative part can support substantially to the body of literatures pertinent to the exploration of perception and experience of excess weight gain among Malay pregnant women in Kelantan. Results from this study will contribute to the body of evidence to inform and guide appropriate recommendation for weight gain during pregnancy to Malaysian women.

1.6 Research Question

1. What is the proportion of inadequate, adequate and excessive gestational weight gain among Malay women with high risk pregnancy who attended antenatal care in tertiary hospitals in Kelantan?
2. Are there associations between sociodemographic factors, clinical factors, dietary nutrient intake and level of physical activity with gestational weight gain of Malay women with high risk pregnancy who attended antenatal care in tertiary hospitals in Kelantan?
3. What are the perceptions and experiences in relation to excessive weight gain among Malay women with high risk pregnancy in Kelantan?

1.7 Objectives of Study

1.7.1 General Objective

To study the proportion, associated factors and explore the perceptions and experiences regarding gestational weight gain among Malay women with high risk pregnancy who sought antenatal care in government tertiary hospitals, Kelantan.

1.7.2 Specific Objectives

1. To determine the proportion of gestational weight gain categories among Malay women with high risk pregnancy who attended antenatal care in tertiary hospitals in Kelantan.

2. To determine factors associated with gestational weight gain among Malay women with high risk pregnancy who attended antenatal care in tertiary hospitals in Kelantan.
3. To explore the perceptions and experiences of excessive weight gain among Malay women with high risk pregnancy who attended antenatal care in tertiary hospitals in Kelantan.

1.8 Research Hypothesis

There are significant associations between sociodemographic factors, clinical factors, dietary nutrient intake and level of physical activity with gestational weight gain during pregnancy.

CHAPTER TWO

LITERATURE REVIEW

2.1 Gestational Weight Gain

Nutritional concerns in pregnancy are gaining importance as problems with obesity, poor nutrition, and suboptimal gestational weight gain have been shown to result in maternal and perinatal morbidity. Weight gain during pregnancy is an important anthropometric indicator and is widely used to evaluate the effect of weight gain as it cause direct influence on pregnancy outcomes (Cox and Phelan, 2008). Pregnancy is a unique period during a woman's life and is characterized by complex biological phenomenon of a pregnant women which requires adequate nutrients intake for the development of foetus. As the foetus is fully dependent on the pregnant mother to provide the necessary nutrients for a healthy growth and development, adequate and well-balanced diet is important to ensure sufficient energy intake with adequate weight gain to support nutritional needs of foetus. Optimal weight gain is basic indicator in evaluating maternal and neonatal health during the perinatal period (Zhou and Olsen, 1997). Hence, gestational weight gain recommendation were revised and published by the Institute of Medicine, U.S in 2009 to strike a balance between the known risks and benefits of weight gain during pregnancy (Institute of Medicine, 2009).

Excessive gestational weight gain is defined as gaining above the Institute of Medicine's (IOM) (2009) recommendations and inadequate gestational weight gain defined as gaining below IOM recommendation according to each pre-pregnancy BMI (Institute of Medicine, 2009). It is associated with risks for both the mother and her offspring during pregnancy, delivery, and postpartum. This study aims to determine

proportion of gestational weight gain categories among Malay women with high risk pregnancy and explored their perception and experiences in relation to excessive GWG. The literature review begins with an overview of the IOM pregnancy weight gain guidelines, prevalence rates of gestational weight gain categories and determinants of GWG.

2.1.1 Weight Gain Recommendation According to IOM Guidelines

The 1990 IOM committee recommended rate of gestational weight gain during pregnancy to facilitate the clinical monitoring of weight changes in pregnant women. In 2009, the U.S Institute of Medicine published revised gestational weight gain guidelines based on pre-pregnancy body mass index (BMI) ranges for underweight, normal weight, overweight and obese women recommended by the World Health Organization regardless of age, parity, smoking history, race and ethnic background (Rasmussen and Yaktine, 2009) as shown in Table 2.1. The revised guideline also include weight gain recommendation for women with twin pregnancy (ACOG, 2013). All pregnant women have been advised to gain weight within recommendation as to have a safe pregnancy and healthy infants without any complications (Ochsenbein-Kölble *et al.*, 2007). From observational data showed that women who gained within IOM range experienced better pregnancy outcomes (Rasmussen and Yaktine, 2009).

Table 2.1 : U.S IOM recommendations for total and rate of weight gain during pregnancy, by pre-pregnancy body mass index.

Pre –pregnancy BMI	BMI (kg/m^2)	Total weight gain range (kg)	Rates of weight gain 2nd and 3rd trimester (mean range in kg/week)
Underweight	<18.5	12.5 – 18 kg	0.51 (0.44-0.58)
Normal weight	18.5 – 24.9	11.5 – 16kg	0.42 (0.35-0.50)
Overweight	25.0 – 29.9	7.0 – 11.5kg	0.28 (0.23-0.33)
Obese (all classes)	≥30	5.0 – 9.0kg	0.22 (0.17-0.27)

Institute of Medicine (2009)

2.1.2 Adverse Health Outcomes of Suboptimal GWG

A broad spectrum of adverse pregnancy outcomes have been linked to suboptimal GWG. It is associated with a series of maternal and neonatal complications and even life-threatening diseases (Tsai *et al.*, 2012). Excessive GWG increases the likelihood of hypertensive disorder in pregnancy, Gestational Diabetes Mellitus, caeserean delivery, instrumental delivery, large for gestational age (LGA) infants independent of maternal pre-pregnancy BMI (Cedergren, 2007; Restall *et al.*, 2014). In addition, GWG exceeded recommendation is the strongest predictor for postpartum weight retention and this may contribute to obesity epidemic among reproductive age women due to the legacy effect of weight gain (Crealey and Prosser, 2015). One in five women experienced substantial postpartum weight retention and significantly retained more than 5kg above pre-pregnancy weight at 6 months and one year after delivery (Althuizen *et al.*, 2011).

Excessive GWG has also been associated with the development of childhood adiposity and obesity, thereby contributing to obesity in both mothers and their offspring (Mamun *et al.*, 2009). Women who had excessive GWG may expose the developing fetus to persistently raised concentrations of glucose, insulin, amino acids, and lipids as well as inflammatory cytokines derived from maternal adipose tissue (Fraser *et al.*, 2010). During developmental periods, it is hypothesised that fetal pathways of energy balance may be permanently "reset" by this adverse environment, leading to a metabolic predisposition to obesity (Wrotniak *et al.*, 2008). Instead, heritable predisposition to gain weight or common lifestyle factors which promote weight gain (such as low levels of physical activity and high energy diet) may contribute to the shared risk of obesity between mother and child (Fraser *et al.*, 2010). On the other hand, study reported inadequate GWG also poses risk for maternal and neonatal complications. Women with inadequate GWG was associated with increased risk of preterm delivery and low birth weight as compared to women with adequate GWG (Rodrigues *et al.*, 2010).

2.1.3 Prevalence of Gestational Weight Gain in Other Countries and Malaysia

Published literatures found that prevalence of excessive gestational weight gain was markedly high as compared to prevalence of inadequate weight gain about 45 to 75% in western countries (Brawarsky *et al.*, 2005; Chasan-Taber *et al.*, 2008; Nohr *et al.*, 2008; Chu *et al.*, 2010; Fraga and Theme Filha, 2014; Restall *et al.*, 2014). Women who had excessive gestational weight gain were associated with poor maternal and fetal outcomes. Based on observational data, women who had excessive weight gain in pregnancy is associated with large-for-gestational age infants or infants with birth

weight more than 4000g, complicated with prolonged labour, birth trauma, caesarean delivery and increased risk of perinatal (Brawarsky *et al.*, 2005; Zhang *et al.*, 2015).

Irrespective of the overall increasing trend of excessive GWG worldwide, inadequate GWG remains a major public concern in both developed and developing countries (Liu *et al.*, 2012). In the developing countries, women generally have a lower GWG than women in the developed countries (Ota *et al.*, 2011; Ebrahimi *et al.*, 2015). A vast literature reported only one third of pregnant women in both developed and developing countries achieved optimal weight gain (Cedergren, 2007).

There is limited study conducted in Malaysia regarding GWG. A cross-sectional study conducted in Kuala Lumpur Maternity Hospital revealed prevalence of excessive weight gain is higher than inadequate weight gain. They also found that inadequate GWG among normal BMI women was significantly associated with having premature birth and low birth weight (Rozlan *et al.*, 2012). Another cross-sectional study by Yong *et al.* (2016) conducted among pregnant women attending three urban maternal and health clinics in Selangor and Negeri Sembilan, found that mean gestational weight gain rate for all pre-pregnancy BMI categories in the second and third trimester were exceeded the IOM recommendation and prevalence of excessive GWG was the highest. On a contrary, prevalence of inadequate weight gain was highest (54.5%) among rural pregnant women in Kelantan (Farhana *et al.*, 2015). Table 2.2 shows the summary of prevalence of gestational weight gain in other countries and Malaysia.

Table 2.2: Summary of prevalence of gestational weight gain (GWG) in other countries and Malaysia

References	Study design/setting	GWG categories	Prevalence (%)
(Restall *et al.*, 2014)	Prospective cohort study (2004 – 2011) Multicentre western countries	Inadequate Adequate Excessive	8.5% 17.2% 74.3%
(Chasan-Taber *et al.*, 2008)	Prospective cohort study (2000-2003) U.S.A	Inadequate Adequate Excessive	22.0% 33.0% 45.0%
(Fraga and Theme Filha, 2014)	Cross-sectional study (2008) Brazil	Inadequate Adequate Excessive	21.5% 28.5% 50.0%
(Brawarsky *et al.*, 2005)	Prospective cohort study, U.S.A	Inadequate Adequate Excessive	15.0% 32.0% 53.0%
(Nohr *et al.*, 2008)	Prospective cohort study (1996 – 2002) Denmark	Inadequate Adequate Excessive	8.0% 46.0% 46.0%
(Ebrahimi *et al.*, 2015)	Cross-sectional study, Iran	Inadequate Adequate Excessive	19.2% 45.7% 35.1%
(Rodrigues *et al.*, 2010)	Prospective cohort study, Brazil	Inadequate Adequate Excessive	41.0% 37.0% 22.0%
(Koh *et al.*, 2013)	Cross-sectional study, Singapore	Inadequate Adequate Excessive	27.7% 36.1% 36.2%
(Norfazlin *et al.*, 2012)	Cross-sectional study HKL, Malaysia	Inadequate Adequate Excessive	29.4% 27.7% 42.9%
(Farhana *et al.*, 2015)	Cross-sectional study Rural district, Kelantan	Inadequate Adequate Excessive	54.5% 32.5% 13.0%
(Yong *et al.*, 2016)	Cross-sectional study in Selangor and Negeri Sembilan	Inadequate Adequate Excessive	25.5% 30.2% 44.3%

2.2 Determinants of gestational weight gain

The total amount of weight gain during pregnancy is determined by many factors. Aside from physiological factors, psychological, behavioural, family, social, cultural and environmental factors can also have impact on GWG. This can be explained by the Socio Ecological Model (SEM) which recognized health behaviour such as GWG was influenced by multiple levels of factors from personal, interpersonal, community and society levels (Paul *et al.*, 2013) as shown in Figure 2.1. This model have been used commonly in research assessing multilevel factors influencing GWG (Anderson *et al.*, 2015; Criss *et al.*, 2016). Understanding these factors as determinants of GWG is an important component to encourage successful promotion of healthy GWG and optimal pregnancy outcomes in the future.

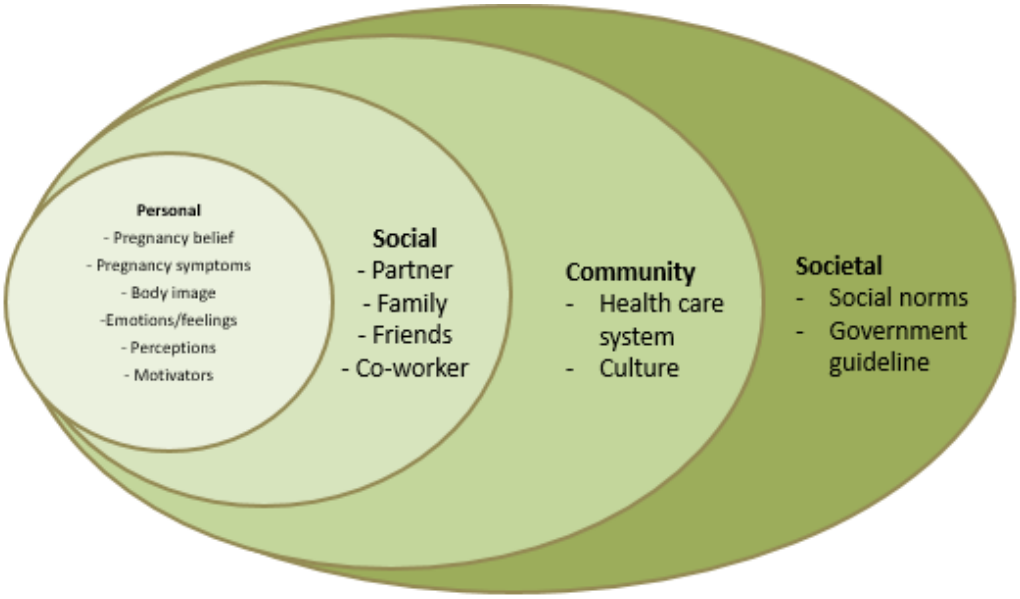

Figure 2.1 : Socio Ecological Model (Paul *et al.*, 2013)

2.2.1 Maternal Determinants

Earlier study by Hickey (2000) have examined relationship between socioeconomic status (SES) and gestational weight gain, documented previously low-income women have been regarded as at risk for inadequate gestational weight gain. However, the proportion of women in this group gaining above IOM recommendations has also increased by years. Olson and Strawderman (2003a) reported that women with lower income were about 2.6 times more likely to have excessive weight gains during pregnancy than women with higher incomes. Similar finding was reported by Lederman *et al.* (2002) that stated 30 of 47 low-income African-American women in New York City gained excessive gestational weight gain.

A qualitative study by Paul *et al.* (2011) had documented diet and physical activity behaviour reported by low income women were more likely to promote positive energy balance than women in high income group. Its explained why low-income women had higher risk for excessive GWG. They reported women described eating energy dense foods (fast foods, fried foods, soda, high fat toppings on vegetables, etc.), overeating (binge eating and eating large portions), eating few fruits and vegetables (only eating fruits and just eating one or two types of vegetables), and walking only in association with daily living. High income women mentioned soothing cravings and nausea with healthy foods, choosing less energy dense foods to satisfy increased appetites, eating small, frequent meals to prevent hunger, bringing lunch from home to avoid overeating at work, and maintaining exercise frequency.

Food insecurity is closely related to socioeconomic status and education level. Frongillo *et al.* (1997) have shown a higher prevalence of overweight and obesity

among women living in food-insecure households compared to women living in food secure households. Poverty was a significant predictor of hunger and food insecurity whereby women living in low income families were more likely to be overweight than other women. The relationship between hunger and obesity in the United States suggested by food choices or physiologic adaptations in response to episodic food shortages could cause increased body fat. Among the food insecure household, food intake may be involuntarily restricted due to insufficient resources to access food and it cause higher prevalence of overweight (Townsend *et al.*, 2001). However, Wells *et al.* (2006) documented no association between socioeconomic status and the risk of either insufficient or excessive gain during pregnancy.

Published literatures documented that prevalence of GWG categories varied based on ethnicity and pre-pregnancy BMI (Lederman *et al.*, 2002). Asian women consistently had percentages of excessive GWG less than other ethnicities (Schieve *et al.*, 1998). A study by Koh *et al.* (2013) evaluating predictors and adverse outcomes of inadequate and excessive GWG among Asian population in Singapore, found that ethnic differences significantly influence gestational weight gain. They reported that Malay ethnicity significantly increased the odds of inadequate (AOR: 1.92 ; 95% CI : 1.28, 2.89) and excessive weight gain (AOR: 2.00 ; 95% CI : 1.39, 2.88) as compared to Chinese ethnicity. The author postulated such variation might be due to differences in diet and/or other unmeasured psychosocial factors. It also due to cultural differences among ethnic group with regard to risk factors (Koh *et al.*, 2013). However, very few studies have explored these associations among Asian women. Another recent study among Malaysian women in Selangor and Negeri Sembilan with majority of respondents were Malay pregnant women had identified mean GWG rate in second

and third trimester were exceeding IOM recommendation with prevalence of excessive GWG was the highest about 44.3%. followed by adequate GWG and inadequate GWG, respectively (Yong *et al.,* 2016). The researcher explained cultural factors influenced GWG such as belief regarding "eating for two" to ensure healthy infants is still exists in community.

Literatures have well documented that women who have deviation of weight gain from IOM recommendation were significantly associated with their educational level. As reported by Hickey (2000), inadequate gestational weight gain was nearly three times more prevalent among women with low education compared to those who have high education. A consistent finding also noted from a study done by Chu *et al.* (2010) who found that women with less than 12 years duration of education were more likely to gain inadequate gestational weight gain. Low education indirectly reflects limited purchasing power and less access to nutritious food. Having a college degree or beyond was also associated with increased risk of excessive GWG for women in low and medium socioeconomic neighbourhoods; however there was no significant association for women in high socioeconomic neighbourhoods (Huynh *et al.*, 2014).

On the other hand, a prospective pre-birth cohort study reported a significant association between lower educational level with excessive gestational weight gain (Jedrychowski *et al.*, 2011). Study by Holowko *et al.* (2014) also reported lower education women with normal pre-pregnancy BMI were at higher risk of excessive GWG. This might be explained by association between educational level and nutritional knowledge of pregnant women and subsequently affects their dietary habits and resulted in excessive GWG. A study by Manaf *et al.* (2014) conducted among

Malay pregnant women to determine the nutritional knowledge and nutritional status have found that educational level was significantly associated with nutritional knowledge score. Pregnant women with higher education were more knowledgeable and had better understanding when provided with nutrition information. This subsequently leads to better nutritional status during pregnancy and had been shown to be associated with good dietary and physical activity behaviour (Alemayehu and Tesema, 2015).

Previous studies have reported conflicting findings on the relationship between age and gestational weight gain. In a retrospective study of older (≥35 years old) and younger (25-29 years old) pregnant women, Prysak *et al.* (1995) found that older women had significantly lower mean gestational weight gain compared to younger women. Similarly, Olafsdottir *et al.* (2006) reported that women gaining excessive gestational weight were significantly younger than women gaining inadequate weight gain. The possible explanations include advanced maternal age associated with poor anabolic response to pregnancy or older women may be more disciplined regarding lifestyle choices (Restall *et al.*, 2014).

Other studies have shown that older women tend to gain more weight during pregnancy (Chasan-Taber *et al.*, 2008). A prospective cohort study by Rodrigues *et al.* (2008) have shown that, for each increase of one year in the maternal age, there was an increase of 0.631 kg in gestational weight. A study by Ebrahimi *et al.* (2015) in Iran also found that women's age was positively associated with GWG but this relationship was confined to older women (30 − 35 years) who were more likely to have adequate than inadequate weight gain. This postulated by older women in their study were more

aware of adequate weight gain during pregnancy through improved dietary intake compared to younger women. A cohort study by Chasan-Taber *et al.* (2008) reported gestational weight gain varied across age categories whereby the youngest (<20years) and oldest age groups (30 − 39years) were most likely to exceed IOM guideline. This finding differs from study by Fraga and Theme Filha (2014) and Walker *et al.* (2009) who found that there was no association between maternal age and gestational weight gain.

Data on the effect of maternal height on gestational weight gain are very limited. In 1990, the IOM committee reported that short women (<62 inches) tend to gain less than taller (>67 inches) women (Institute of Medicine, 1990). In a study of 4,791 Hispanic women living in Los Angeles, short stature (<62 inches) increased the risk of poor total weight gain by 50% among underweight and normal-weight women, but not among overweight or obese women (Siega-Riz and Hobel, 1997). The interactions among maternal pre-pregnancy BMI status and stature in affecting gestational weight gain need further evaluation.

Rodrigues *et al.* (2010) suggest that women of shorter stature (<157 cm) are more than two times likely to present insufficient GWG. It is well documented that short stature may act as a marker of nutritional deficiency in early life and pregnancy is an important period of insults. It was verified in a prospective study that having short stature was an independent risk of insufficient GWG for underweight or normal pre-pregnancy BMI women. The high magnitude of short stature and inadequate GWG observed in Brazilian pregnant women may represent an increase in the risk of several maternal–child adverse outcomes such as low birth weight.

A study by Yong *et al.* (2016) also identified similar findings among Malaysian women. They found that women of short stature (<153 cm) were at nearly twofold greater risk of inadequate GWG rate. Short stature is a marker of early life nutritional deficiency, which could extend into adulthood. The author postulated women of short stature have experienced undernutrition during childhood and nutritional deficiency was aggravated during pregnancy especially those who were impoverished. The exact underlying mechanisms, however, remain unclear.

The important modifiable factors of gestational weight gain and it's impact towards maternal and fetal consequences is a pre-pregnancy weight. The best mesurement of pre-pregnancy weight is the body mass index (BMI); mesurement of body fat based on weight and height which computed by weight (kilograms)/height $(m)^2$. Pre-pregnancy BMI have been updated in the new guideline into four categories which is underweight (<18.5kg/m^2), normal weight (18.5 – 24.9 kg/m^2) , overweight (25.0-29.9 kg/m^2) and obese (>30 kg/m^2) developed by World Health Organization (WHO) and adopted by the National Heart,Lung and Bloood Institute (NHLBI) (Rasmussen and Yaktine, 2009).

Consistent with previous studies, Ebrahimi *et al.* (2015) have showed that pre-pregnancy BMI is an important predictor of gestational weight gain among pregnant women (Wise *et al.*, 2010). In a study among 103 pregnant women, Weisman *et al.* (2010) reported that being overweight substantially increases the odds approximately three times of exceeding the IOM guidelines compared to normal pre-pregnancy BMI. Being overweight or obese before pregnancy or having low pre-pregnancy BMI was