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## Excessive and Inadequate Gestational Weight Gain among Malaysian Pregnant Women in Rural Area: Are There Any Associated Factors?

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**Abstract:** Inadequate and excessive gestational weight gain during pregnancy is associated with adverse maternal and child outcomes. The aim of this study is to determine the prevalence, associated factors and outcomes of gestational weight gain among pregnant women in a rural district in Kelantan in a year of 2013. Data was derived from antenatal and birth registry. Pregnant women who registered for antenatal booking during first trimester in health clinics and fulfilled the inclusion criteria were included in this study. No sampling method was applied. Information on sociodemographic data, obstetric characteristics, maternal and fetal outcomes were recorded. Gestational weight gain were classified into three categories (inadequate, adequate and excessive) based on pre-pregnancy body mass index using Institute of Medicine, 2009 guidelines. Simple and multiple logistic regression analyses were carried out to identify factors associated with inadequate and excessive gestational weight gain, respectively. Based on the inclusion and exclusion criteria, 422 women were included in this study. The prevalence of inadequate and excessive gestational weight gain was 54.5% (95% CI; 49.6, 59.3) and 13.0% (95% CI; 10.0, 16.7), respectively. Advanced maternal age women ( $\geq 35$  years old) (AOR 0.45; 95% CI: 0.23, 0.87), pre-pregnancy BMI of overweight and obese (AOR 0.39; 95% CI: 0.24, 0.62) and who received primary or lower education (AOR 5.73; 95% CI: 1.72, 19.13) were significantly associated with inadequate gestational weight gain. While pre-pregnancy overweight and obese status was the only factor found to be significantly associated with excessive gestational weight gain (AOR 3.25; 95% CI: 1.49, 7.06). There was a significant association between low birth weight with three categories of gestational weight gain ( $p$ -value = 0.021). Nutritional requirement before conception and during pregnancy is crucial. Identification for risk factors of inadequate or excessive gestational weight gain is needed in order to plan for intervention in reducing risk for maternal and foetal outcomes.

**Key words:** Gestational weight gain, pregnant women, associated factors, outcomes

### INTRODUCTION

Weight gain during pregnancy also known as gestational weight gain (GWG) is a unique and complex biological phenomenon. It is one of the predictors that supports fetal growth and development as well as determinant of the mother's health (Institute of Medicine, 2009). Published literatures support significant adverse effects of excessive and inadequate gestational weight gain. Previous studies have shown the association of excessive gestational weight gain with higher fetal and maternal complications including fetal deaths, gestational diabetes, macrosomia, pre-eclampsia and complicated deliveries. Although many women return to their pre-pregnancy weight after delivery, there are few women who had significant postpartum weight retention and it is an important contributor to the obesity epidemic among women. This give a major implications for long term health effect of women and also add a burden to future health care cost in the society (Restall *et al.*, 2014). On the other hand, inadequate weight gain has

significant relationship with small-for-gestational age, low birth weight and preterm delivery (Chasan-Taber *et al.*, 2008; Ebrahimi *et al.*, 2015).

Institute of Medicine (2009) suggests that woman should have normal body mass index (BMI) before conception. Apart from that, weight gain within recommended range throughout pregnancy should be achieved for optimal maternal and child health. In 2009, U.S Institute of Medicine published revised gestational weight gain guidelines based on pre-pregnancy BMI. The guidelines ranges for underweight, normal, overweight and obese women recommended by the World Health Organization regardless of age, parity, smoking history, race and ethnic background (Institute of Medicine, 2009). Table 1 shows the recommended gestational weight gain according to pre-pregnancy BMI (American College of Obstetricians and Gynecologists, 2013).

There are three classifications of gestational weight gain according to IOM guidelines which are inadequate,

adequate and excessive. In developed countries, women generally have more prevalence of excessive gestational weight gain in a range of 45.0 to 75.0% compared to inadequate gestational weight gain (Brawarsky *et al.*, 2005; Chasan-Taber *et al.*, 2008; Nohr *et al.*, 2008; Chu *et al.*, 2009; Fraga and Theme Filha, 2014; Restall *et al.*, 2014). In addition, only about 33.0 to 40.0% of them gained weight within the recommended range (Olson, 2008). Several literatures documented higher mean gestational weight gain in United States and Europe which was in the range of 13-14.2 kg (Nielsen *et al.*, 2006; Chasan-Taber *et al.*, 2008). On the contrary, a higher prevalence of inadequate gestational weight gain has been shown in Malaysian pregnant women although in urban area, which was about 43.0% (Norfazlin *et al.*, 2012). Yekta *et al.* (2006) reported average gestational weight gain among Iranian women was 8.8 kg. In Vietnam, Ota *et al.* (2011) showed that mean gestational weight gain was 12.2 kg.

Literatures showed an increased prevalence of excessive and inadequate weight gain which leads to negative consequences to mothers and foetus. Previous studies have documented many factors influenced gestational weight gain such as maternal age, height, pre-pregnancy BMI, parity, ethnicity, educational level, marital status and number of prenatal visits (Caulfield *et al.*, 1996; Rodrigues *et al.*, 2008; Ebrahimi *et al.*, 2015). Other than that, the amount of weight gains also depends on socioeconomic factors, access to healthy foods, opportunities for physical activity, family and partner support (Ebrahimi *et al.*, 2015). However, evidence regarding associated factors and outcomes of maternal weight are still scarce. Thus, it is important to identify the predictors, to instill awareness and knowledge for future intervention program. The present study aims to determine the prevalence and factors associated with inadequate and excessive gestational weight gain, respectively as compared to adequate gestational weight gain. The second objectives was to look for comparison between maternal and fetal outcomes between three categories of gestational weight gain among pregnant women in Gua Musang District, Kelantan, Malaysia.

## MATERIALS AND METHODS

**Subjects and design:** A study was conducted in Gua Musang District, Kelantan a rural area of Northeastern Peninsular Malaysia. The records of an eligible pregnant women who fulfilled the inclusion and exclusion criteria from seven health clinics were reviewed. However, during data collection two health clinics were badly involved in a big flood that abstained the process of antenatal records review. Therefore, out of 850 pregnant women who registered at first trimester antenatal booking, only 422 met the selection criteria. Data were reviewed from January 2013 to December 2013 from a

maternal card (KIK/1(b)/96) and birth registry. Those who delivered full term, singleton and live born infants were included in this study. While, pregnant women with pre-existing medical illness, delivered through elective lower segment caesarean section and defaulted follow-up were the exclusion criteria.

Data gathered included sociodemographic, antenatal care, maternal and foetal outcomes. Age was classified into 3 categories of less than 19, 20-34 and more than 35 years old (World Health Organization, 2009). Educational level was categorized into three categories which were primary/less, secondary and tertiary education. Based on definition by Ministry of Health Malaysia, adequate antenatal visits defined as minimum 8 visits throughout pregnancy. The parity refers to a total number of foetus delivered by individual mothers, which was categorized into nulliparous and multiparity. Maternal outcomes include the presence of emergency lower segment caesarean section (LSCS), gestational diabetes mellitus (GDM) and hypertensive disorder in pregnancy. Foetal outcomes include presence of low birth weight, macrosomia and low Apgar score.

The outcome measure in this study was gestational weight gain adequacy, which was classified as inadequate, adequate or excessive. All women were categorized according to their Body Mass Index (BMI) groups based on World Health Organization's definition. The four BMI categories were underweight (BMI < 18.50 kg/m<sup>2</sup>), normal weight (BMI = 18.50-24.99 kg/m<sup>2</sup>), overweight (BMI = 25.00-29.99 kg/m<sup>2</sup>) and obese (BMI = 30.00 kg/m<sup>2</sup>) (Institute of Medicine, 2009; Norfazlin *et al.*, 2012). Total weight gain was calculated as the differences between maternal weight measured at the last antenatal checkup (at or after 37 weeks period of amenorrhoea) and pre-pregnancy weight (weight during first trimester booking measured at  $\leq 12$  weeks of period of amenorrhoea) (Chen *et al.*, 2010). Based on the gestational weight gain calculation, maternal weight gain was classified into three categories of outcome; inadequate, adequate and excessive. IOM guidelines cut-points for inadequate gestational weight gain are less than 12.5, 11.5, 7.0 and 5.0 kg for underweight, normal, overweight and obese women, respectively whereas those for excessive gestational weight gain are more than 18, 16, 11.5 and 9.0 kg for underweight, normal, overweight and obese women, respectively.

**Statistical analysis:** Data were analyzed using Statistical Package for Social Sciences (version 22). Descriptive statistics were computed for all variables. Prevalence of inadequate and excessive gestational weight gain were calculated by numbers of pregnant women with inadequate and excessive gestational weight gain respectively, divided by total numbers of pregnant women in Gua Musang District in 2013. Two separate multiple logistic regression models were used

to determine factors associated with inadequate and excessive gestational weight gain, as compared to adequate gestational weight gain. The outcome was a binary variable coded "0" for adequate gestational weight gain and "1" for excessive or inadequate gestational weight gain. Multiple logistic regression using a backward stepwise method controlling for each variables was performed. The associations of independent variables with inadequate and excessive gestational weight gain model were expressed as odds ratios (ORs) with 95% confident intervals (CI). A statistical probability level of  $p < 0.05$  was considered significant. A Pearson's Chi Square test was used to compare maternal and fetal outcomes between three categories of gestational weight gain.

**Ethical approval:** This study was approved by the Medical Research and Ethics Committee, Ministry of Health (NMRR-14-1603-23479) and Human Research Ethics Committee, Universiti Sains Malaysia (USM/JEPeM/14120515). Participants and the attending doctors' confidentiality were maintained, anonymous and no information will be exposed.

## RESULTS

**Prevalence of gestational weight gain:** According to IOM guideline (2009), about 32.5% (95% CI: 28.0, 36.9) of the women gained weight within the recommended range and 54.5% (95% CI: 49.6, 59.3) of women failed to gain sufficient weight during pregnancy. Accordingly, 13.0% (95% CI: 10.0, 16.7) women in this study had excessive gestational weight gain.

**Characteristics of respondents:** A total of 422 pregnant women met the eligibility criteria and their maternal characteristics are shown in Table 2. Their mean (SD) age was 28.0 (5.95) years. Majority were Malays (91.2%), obtained secondary and tertiary education (91.7%) and only (37.4%) were employed. All the pregnant women in this study were married and they achieved adequate antenatal care requirement which was more than 8 visits during their pregnancy.

In regards to pre-pregnancy BMI, about 48.0% were in normal group, 28.2% were overweight, 15.2% were obese and less than 10.0% were underweight. The mean (SD) gestational weight gain for each BMI group was 12.5 (0.68), 9.82 (0.29), 8.50 (0.43) and 5.54 (0.61) kg for underweight, normal, overweight and obese, respectively. Majority of women in underweight (55.3%), normal (67.2%) and obese (48.4%) group had inadequate gestational weight gain during pregnancy. Almost half of the women (47.3%) who had excessive weight gain were from overweight pre-pregnancy BMI group.

Table 3 shows the overall maternal and foetal outcomes in this study. In general, only 10.7%

underwent lower segment caesarean, only 6.6% were diagnosed as having gestational diabetes mellitus and only 3.3% dealt with hypertensive disorder in pregnancy. Less than 9.0% delivered low birth weight babies, only 1.9% babies were macrosomic and 0.7% had low Apgar score.

**Factors associated with inadequate and excessive gestational weight gain:** Table 4 indicates the multiple logistic regression models for factors associated with inadequate gestational weight gain. The first model shows that advanced maternal age ( $\geq 35$  years old) ( $p = 0.017$ ), primary and lower education ( $p = 0.005$ ) and pre-pregnancy BMI of overweight and obese ( $p < 0.001$ ) were significantly associated with inadequate gestational weight gain, as compared to adequate gestational weight gain.

Advanced maternal age ( $\geq 35$  years old) had significant decreased odds about 55.0% to get inadequate gestational weight gain as compared to those who were teenage when adjusted for educational level and pre-pregnancy BMI (AOR = 0.45; 95% CI: 0.23, 0.87). Pregnant women who received primary education and lower had almost 6 times higher odds to get inadequate gestational weight gain during pregnancy as compared to those who had tertiary educational level after adjusted for pre-pregnancy BMI and maternal age (AOR = 5.73; 95% CI: 1.72, 19.13). While, women with pre-pregnancy nutritional status of overweight and obese had significant decreased odds about 60.0% to get inadequate gestational weight gain as compared to those who were normal BMI when adjusted for educational level and maternal age (AOR = 0.39; 95% CI: 0.24, 0.62).

In the second model as shown in Table 5 indicates that pre-pregnancy BMI of overweight and obese ( $p = 0.003$ ) was significantly associated with excessive gestational weight gain as compared to adequate gestational weight gain. Women with pre-pregnancy BMI of overweight and obese status had three times likelihood to exceed gestational weight gain recommendation as compared to those with a normal BMI (AOR = 3.25; 95% CI: 1.49, 7.06).

**Comparison of maternal and fetal outcomes between three categories of gestational weight gain:** Pearson Chi square and fisher exact test analysis found a significant association between low birth weight with three categories of gestational weight gain. More than half of low birth weight infants (76.5%) were delivered by mothers with inadequate gestational weight, as shown in Table 6. However, the strength of association could not be determined.

## DISCUSSION

Findings from our study are comparable with the previous study conducted among urban Malaysian

Table 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 <sup>2</sup> )	Total weight gain range (kg)	Rates of weight gain 2nd and 3rd trimester (mean range in kg/week)
Underweight	<18.5	12.5-18.0 kg	0.51 (0.44-0.58)
Normal weight	18.5-24.9	11.5-16.0 kg	0.42 (0.35-0.50)
Overweight	25.0-29.9	7.0-11.5 kg	0.28 (0.23-0.33)
Obese (Include all classes)	≥30.0	5.0-9.0 kg	0.22 (0.17-0.27)

Ref: Report Brief on Weight Gain During Pregnancy: Reexamine the Guideline, May 2009 (Institute of Medicine, 2009)

Table 2: Socio-demographic and obstetric characteristics according to gestational weight gain (GWG) among pregnant women (n = 422)

Variables	Overall n = 422	Inadequate GWG n = 230 n (%)	Adequate GWG n = 137 n (%)	Excessive GWG n = 55 n (%)
<b>Age (years)</b>				
≤19	22 (5.2)	9 (3.9)	7 (5.1)	6 (10.9)
20-34	332 (78.7)	175 (76.1)	115 (83.9)	42 (76.4)
≥35	68 (16.1)	46 (20.0)	15 (11.0)	7 (12.7)
<b>Ethnicity</b>				
Malay	385 (91.2)	208 (90.5)	128 (93.4)	49 (89.0)
Chinese	15 (3.6)	7 (3.0)	5 (3.7)	3 (5.5)
Others	22 (5.2)	15 (6.5)	4 (2.9)	3 (5.5)
<b>Educational level</b>				
Non-formal	5 (1.2)	4 (1.7)	0 (0)	1 (1.8)
Primary	30 (7.1)	20 (8.7)	4 (2.9)	6 (10.9)
Secondary	315 (74.6)	171 (74.4)	106 (77.4)	38 (69.1)
Tertiary	72 (17.1)	35 (15.2)	27 (19.7)	10 (18.2)
<b>Employment status</b>				
Unemployed	264 (62.6)	142 (61.7)	86 (62.8)	36 (65.5)
Employed	158 (37.4)	88 (38.3)	51 (37.2)	19 (34.5)
<b>Pre-pregnancy BMI*</b>				
Underweight	38 (9.0)	21 (9.1)	12 (8.8)	5 (9.0)
Normal	201 (47.6)	135 (58.7)	56 (40.9)	10 (18.2)
Overweight	119 (28.2)	43 (18.7)	50 (36.5)	26 (47.3)
Obese	64 (15.2)	31 (13.5)	19 (13.8)	14 (25.5)
<b>Parity</b>				
0	115 (27.3)	59 (25.7)	37 (27.0)	19 (34.5)
≥1	307 (72.7)	171 (74.3)	100 (73.0)	36 (65.5)

\*Based on World Health Organization's definition Norfazlin *et al.* (2012)

Table 3: Maternal and fetal outcomes of pregnant women (n = 422)

Outcomes	Yes n (%)	No n (%)
<b>Maternal outcomes</b>		
Lower segment caesarean section	45 (10.7)	377 (89.3)
Gestational diabetes mellitus	28 (6.6)	394 (93.4)
Hypertensive disorder in pregnancy	14 (3.3)	408 (96.7)
<b>Fetal outcomes</b>		
Low birth weight	34 (8.1)	388 (91.9)
Macrosomic	8 (1.9)	414 (98.1)
Low Apgar score	3 (0.7)	419 (99.3)

population. Norfazlin *et al.* (2012) found a higher prevalence of inadequate gestational weight gain compared to the other categories which was 42.9%, followed by excessive gestational weight gain (29.4%) and adequate gestational weight gain (27.7%). It is almost similar with this study finding which indicate a low prevalence of adequate gestational weight gain where by only 32.5% of pregnant women achieved within the recommended range of gestational weight gain. However, in western countries gaining excessive weight gain was more common than inadequate with the ratio of almost about 2:1 (Stotland *et al.*, 2006; Chasan-Taber *et al.*, 2008; Rodrigues *et al.*, 2010; Fraga and Theme Filha, 2014).

In the final model, advanced maternal age, educational level and pre-pregnancy overweight and obese were the variables significantly associated with inadequate gestational weight gain after controlling for potential confounders. It was found that older women (age more than 35 years old) had significant decreased odds of about 55.0% to get inadequate gestational weight gain as compared to the reference group of women aged less than 19 years old after controlling for educational level and pre-pregnancy BMI. The possible explanations include advanced maternal age were knowledgeable and complied to the dietary intake and physical activity during pregnancy, thus they more aware of adequate gestational weight gain (Restall *et al.*, 2014). In this study, age 20-34 years old is marginally significant and they still had low odds to get inadequate gestational weight gain if compared to pregnancy at younger age. Other studies have showed conflicting findings on relationship between age and gestational weight gain. Prysak *et al.* (1995) reported that older women (≥35 years old) had significant associated with lower mean gestational weight gain as compared to younger women (25-29 years old). A study done among 4791 low income

Table 4: Multiple logistic regression of factors associated with inadequate gestational weight gain during pregnancy (n = 367)

Variables	Crude OR <sup>a</sup> (95% CI)	Adjusted OR <sup>b</sup> (95% CI)	Wald statistic <sup>b</sup> (df)	p-value <sup>b</sup>
<b>Maternal age (years)</b>				
≤19	1.00	1.00		
20-34	1.18 (0.43, 3.27)	0.31 (0.09, 1.02)	3.69 (1)	0.055
≥35	2.39 (0.76, 7.51)	0.45 (0.23, 0.87)	5.72 (1)	0.017
<b>Educational level</b>				
Tertiary	1.00	1.00		
Secondary	1.24 (0.71, 2.17)	1.48 (0.82, 2.65)	1.71 (1)	0.191
Primary/lower	4.63 (1.43, 14.94)	5.73 (1.72, 19.13)	8.06 (1)	0.005
<b>Pre-pregnancy BMI</b>				
Normal	1.00	1.00		
Underweight	0.73 (0.34, 1.58)	0.77 (0.35, 1.71)	0.41 (1)	0.525
Overweight and obese	0.46 (0.28, 0.70)	0.39 (0.24, 0.62)	15.47 (1)	<0.001

<sup>a</sup>Simple logistic regression

<sup>b</sup>Multiple logistic regression, Hosmer-Lemeshow p=0.052, Classification table 64.9%, ROC area under the curve 0.647, No interaction, no multicollinearity

Table 5: Multiple logistic regression of factors associated with excessive gestational weight gain during pregnancy (n = 192)

Variables	Crude OR <sup>a</sup> (95% CI)	Adjusted OR <sup>b</sup> (95% CI)	Wald statistic (df)	p-value <sup>b</sup>
<b>Pre-pregnancy BMI</b>				
Normal	1.00	1.00		
Underweight	2.33 (0.67, 8.08)	2.33 (0.67, 8.08)	1.79 (1)	0.181
Overweight and obese	2.91 (1.28, 6.63)	3.25 (1.49, 7.06)	8.81 (1)	0.003

<sup>a</sup>Simple logistic regression

<sup>b</sup>Multiple logistic regression, Hosmer-Lemeshow p = 1.00, Classification table 71.4%, ROC area under the curve 0.622, No interaction, no multicollinearity

Table 6: Association of maternal and fetal outcomes between three categories of gestational weight gain among pregnant women in GuaMusang (2013)

Variables	----- Gestational weight gain -----			X <sup>2</sup> stat (df)	p-value
	Inadequate n (%)	Adequate n (%)	Excessive n (%)		
<b>Maternal outcomes</b>					
Lower segment caesarean section					
No	206 (54.6)	124 (32.9)	47 (12.5)	1.08 (2)	0.582
Yes	24 (53.3)	13 (28.9)	8 (17.8)		
Gestational diabetes mellitus					
No	209 (53.0)	131 (33.3)	54 (13.7)	5.50 (2)	0.064
Yes	21 (75.0)	6 (21.4)	1 (3.6)		
Hypertensive disorder in pregnancy					
No	224 (54.9)	132 (32.4)	52 (12.7)		0.468 <sup>a</sup>
Yes	6 (42.9)	5 (35.7)	3 (21.4)		
<b>Fetal outcomes</b>					
Macrosomic					
No	228 (55.0)	134 (32.4)	52 (12.6)		0.076 <sup>a</sup>
Yes	2 (25.0)	3 (37.5)	3 (37.5)		
Low birth weight					
No	204 (52.6)	130 (33.5)	54 (13.9)	7.77(2)	0.021 <sup>a</sup>
Yes	26 (76.5)	7 (20.6)	1 (2.9)		
Low Apgar score					
No	228 (54.4)	137 (32.7)	54 (12.9)		0.237 <sup>a</sup>
Yes	2 (66.7)	0 (0)	1 (33.3)		

<sup>a</sup>Fisher exact test p-value

Mexican immigrants showed that younger women was associated with decreased odds of getting inadequate gestational weight gain (Siega-Riz and Hobel, 1997). Other studies also reported older women were more likely to have inadequate gestational weight gain while younger women had higher risk to get excessive gestational weight gain (Olson and Strawderman, 2003; Stuebe *et al.*, 2009; Rodrigues *et al.*, 2010). In term of educational level as one of the associated factors, women who received primary or lower education had almost 6 times higher odds to get inadequate gestational weight gain during pregnancy compared to those who received tertiary education after controlling for maternal age and pre-pregnancy BMI. Literatures have

well documented that women who have deviation of weight gain from IOM recommendation were significantly associated with their educational level. According to a study in the United States in 1992, inadequate gestational weight gain was nearly three times more prevalent among women with low education compared to those who have high education (Hickey, 2000). A similar finding was also noted from a study done by Chu *et al.* (2009) who found that women with less than 12 years duration of education were more likely to gain inadequate gestational weight gain and less likely to gain excessive gestational weight gain, compared to women with more than 12 years of education. Low education indirectly reflect limited purchasing power and

less access to nutritious food (Rodrigues *et al.*, 2008). Whitehead and Dahlgren theory on social determinants of health also explained regarding people who lived in poverty and have low educational level will lead to insecure employment and consequently having foods with low nutritional value (Bambra *et al.*, 2009).

Our data suggest that women who enter pregnancy with overweight and obesity had a decreased odds of about 40.0% to get inadequate gestational weight gain as compared to those who had normal BMI when adjusted for education level and maternal age. The findings are similar to other studies reported (Drehmer *et al.*, 2010; Rodrigues *et al.*, 2010). This results shows that overweight and obese women are less likely to experience inadequate gestational weight gain. This is well documented in published literatures which support the finding (Caulfield *et al.*, 1996; Olson and Strawderman, 2003; Brawarsky *et al.*, 2005; Fraga and Theme Filha, 2014; Restall *et al.*, 2014).

Mean gestational weight gain among pregnant women who were overweight and obese before pregnancy were lower compared to those who were underweight and normal weight. This finding was similar to results from previous study by Chasan-Taber *et al.* (2008). This is partially explained by the lower recommended gestational weight gain for overweight and obese women as compared to those with normal BMI (Chasan-Taber *et al.*, 2008). Although the mean gestational weight gain was lower among overweight and obese women in this study, they were approximately three times more likely than normal-BMI women to get excessive gestational weight gain after controlling for maternal age and educational level. The increase odds of getting excessive gestational weight gain among overweight and obese women are well documented in the literature and corroborates findings from Brazilian studies (Walker *et al.*, 2009; Rodrigues *et al.*, 2010; Restall *et al.*, 2014). Thus, high pre-pregnancy BMI was concluded as a strong predictor of excessive gestational weight gain. Observational data shows that women with higher pre-pregnancy BMI are more likely to have poor health and pregnancy outcomes. For instance, women with pre-pregnancy overweight and obese are more likely to develop gestational diabetes mellitus and having macrosomic baby (Torloni *et al.*, 2009). This explained regarding women with higher pre-pregnancy BMI tend to have excessive gestational weight gain.

From this study, there were no statistical significant association between excessive gestational weight gain with maternal age, ethnicity, educational level, occupation and parity. This is supported by Fraga and Theme Filha (2014) and Walker *et al.* (2009) who showed that there were also no relationship between maternal age, ethnicity, education level, occupation, parity and gestational weight gain. Our study population

have adequate antenatal visits with an average of 14 visits throughout pregnancy indicates that all women are easily assessed to health services irrespective of ethnicity and occupational status. It might explain the findings of insignificant association between the above factors with excessive gestational weight gain.

This study revealed that there was a significant association between inadequate gestational weight gain and low birth weight. The percentage of low birth weight was highest (76.5%) among those who obtained inadequate gestational weight gain. It was comparable with one local study by Norfazlin *et al.* (2012) which found women who gained gestational weight gain less than the recommendation have high risk to get low birth weight infants. These findings were supported by other literature which stated a significantly higher risk to get low birth weight and small-gestational age infants among women who gained less than recommendation (Abrams *et al.*, 2000; Nielsen *et al.*, 2006; DeVader *et al.*, 2007). In contrast to a study by Frederick *et al.* (2008), there was no significant association between risks of low birth weight and gestational weight gain categories. However, they found 76.0% increased risk of delivering a macrosomic infant among women who gained excessive gestational weight gain. These findings may reflect the higher prevalence of macrosomia relative to low birth weight in the sample and also in U.S population.

This study has some limitations. First, pre-pregnancy BMI was based on weight measurement from antenatal records which was measured at first trimester visit. The ideal measurement of pre-pregnancy weight in calculating the BMI is using weight before conception. However there was no available database in Malaysia regarding pre-pregnancy weight. In addition, using the weight measured at first trimester visit or booking may underestimate the real total weight gain throughout the pregnancy. Nevertheless, this is the best available measurement and by excluding women who booked after the first trimester helps to increase the validity of the data.

Second, the common problems encountered during research using secondary data are the missing data and incomplete information. In this study, only 100% complete data were selected as a sample of the study. Fortunately, this study managed to get enough sample size based on sample size calculation to achieve 80% power of study. Other important determinants of gestational weight gain such as dietary intake, physical activity, eating behaviour, psychological factors and postpartum weight retention could not be explored from this data.

**Conclusion:** As a conclusion, this study shows the prevalence of inadequate gestational weight gain was high, thus it was an important nutritional problem among

pregnant women in Gua Musang District, which is relatively considered rural area. The factors found to be associated with inadequate gestational weight gain were advanced maternal age, low educational level and pre-pregnancy body mass index. While, pre-pregnancy BMI was the only factor found to be associated with excessive gestational weight gain. Therefore, strategies or intervention should be aimed to identify women at risk prior to conception and focus on modifying risk factors such as obesity. These factors are easily identified in early pregnancy and are potential predictors of unfavourable outcomes. Targeting programmes should be given more attention to achieve adequate gestational weight gain and focus to obtain optimum body mass index before conception. These efforts help to reduce rates of maternal and neonatal complications.

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