Are Women In Low Income Setting Gaining Adequate Gestational Weight? A Prospective Cross Sectional Study In Urban Uganda

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ABSTRACT

Introduction: Pre-pregnancy weight and weight gained during pregnancy significantly influence maternal and infant health. Little information is available regarding prevalence of optimal GWG in relation to pre-pregnancy body mass index (BMI) in Uganda. This study aimed at determining the prevalence of inadequate, adequate and excessive GWG in women pregnant for the first and second time.

Methods: The study was prospective cross sectional by design and involved HIV negative women pregnant for the first or second time. It was conducted in a health centre IV and recruitment women at ≤18 weeks of gestation. Follow up measurements were done at 26 and 36 weeks gestation age. Maternal height and weight were measured and used to calculate BMI. Depending on BMI category, GWG was categorized as inadequate, adequate and excessive based on the Uganda Ministry of Health guidelines.

Results: The participants' mean±standard deviation (Sd) age was 20.9±2.7 years and mean±Sd BMI was 21.40±2.73kg/m^2. None of the participants was obese and 68.8% (n=132) were primigravidae. The mean±Sd GWG at time of delivery was 10.58±2.44kg. Inadequate GWG was recorded in 62.5% (n=120/192) while only 3.1% (n=6/192) of the participants gained excessive gestational weight.

Conclusion: About 62% of primigravidae and secundigravidae in low income urban Kampala do not gain adequate gestational weight

Key words: Pregnancy, Body mass index, Gestational weight gain, Maternal, Uganda

1.0 BACKGROUND

Pregnancy is a critical stage of development during which maternal nutrition strongly influence obstetric and neonatal outcomes (Kramer, 2003). Optimal nutrition is necessary to maintain the health of the mother, to help ensure a normal, healthy delivery, and also to reduce the risk of birth defects, sub-optimal fetal development and chronic health problems in childhood (American Dietetic Association, 2008). In Uganda just like other developing countries, maternal undernutrition and inadequate gestational weight gain (GWG) are very common (Black *et al*., 2013; Ministry of health Uganda, MoH, 2010; Uganda Bureau of Statistics, UBoS, 2012). The prevalence of obesity or overweight in pregnancy is also rising and is of international concern (Davies *et al*., 2010; Furber *et al*., 2013). Both excessive and inadequate GWG are associated with many adverse maternal and fetal outcomes, either at short or long term (Black *et al*., 2013; Chasan-Taber *et al*., 2008; Crane *et al*., 2009; Ebrahimi *et al*., 2015; Fyfe *et al*., 2012; Gardosi *et al*., 2013; Mann *et al*., 2013; Salihu *et al*., 2012). The adverse outcomes include preterm birth, fetal deaths, gestational diabetes, low birth weight and intrauterine growth restriction or small for gestational age babies, pre-eclampsia and complicated deliveries among others. If a woman gains excessive gestational weight and fails to return to her pre-pregnancy weight after delivery,

the retained weight has long term health effects on a woman and also adds a burden to future health care cost in the society (Restall *et al*., 2014).

The Uganda Ministry of Health currently recommends GWG of 12.5 to 18.0kg for women with pre-gestational body mass index (BMI) less than 18.5kg/m^2, 11.5 to 16.0kg for women with adequate pre-gestational BMI (18.5-24.99kg/m^2), 7.0 to 11.5kg for women with overweight (pre-gestational BMI 25.0-30.0kg/m^2) and 5.0 to 9.0kg for obese women at the time of becoming pregnant, based on the MoH recommendations adopted from the Institute of Medicine (IOM) (IOM, 2009; MoH, 2010), see table 1. Ideally, this recommendation restores maternal fat stores in underweight women while minimizing fat gain in obese women. There are three classifications of GWG according to IOM guidelines; these are inadequate, adequate and excessive GWG.

In developing countries, inadequate GWG is more prevalence than adequate GWG in women(Black *et al*., 2013; Esimai & Ojofeitimi, 2014; Farhana, Rohana & Alina, 2015; Norfazlin *et al*., 2012; Yekta *et al*., 2006) and the reverse is true in developed countries(Chasan-Taber *et al*., 2008; Chu *et al*., 2009; Nohr *et al*., 2008; Restall *et al*., 2014). For example, a recent report from Nigeria indicated than over 96% of the pregnant women failed to gain adequate gestational weight (Esimai & Ojofeitimi, 2014) while the average GWG among Iranian women was 8.8 kg (Yekta *et al*., 2006). In developing countries, a bigger proportion of pregnant women do not receive advice from health professionals about appropriate GWG (Phelan *et al*., 2011). Health professionals' advice about specific or range of weight gain may be limited by their lack of awareness of the well-documented guidelines (Olagbuji *et al*., 2015).

1.1 RESEARCH OBJECTIVE

Despite the high prevalence of maternal undernutrition, inadequate GWG in developing countries and evidence of undesirable maternal, fetal and neonatal outcomes associated GWG less or more than that recommended, little information is available regarding the GWG in Uganda. Therefore, this present study aimed at determining the prevalence of inadequate, adequate and excessive GWG in Ugandan primigravidae and secundigravidae women according to their pre-pregnancy BMI.

2.0 METHODS

2.1 ETHICAL CONSIDERATION

Ethical approval was obtained from Research and Ethics Committee of the School of Medicine, Makerere University. Uganda National Council for Science and Technology cleared and registered the study protocol. Health Department of Kampala Capital City Authority granted as permission to conduct the study at Kawempe Health Centre IV. Every participant had to sign a consent form before enrollment into the study.

2.2 STUDY DESIGN, SITE AND POPULATION

This was a one year prospective cross sectional study conducted at the antenatal clinic of Kawempe Health Centre IV (now called Mulago referral hospital, Obsteric and Gynecology Department). The Hospital is supported by the Uganda Ministry of Health and the services provided are free to the public. The Hospital serves mainly low-income population in Kampala and Wakiso Districts in Uganda. The study enrolled only HIV negative women who were pregnant for the first or second time.

2.3 ENROLLMENT AND FOLLOW UP

The study employed consecutive sampling method where pregnant women who met the inclusion criteria were selected. The selection of women was done after they had registered at the antenatal clinic. After selection, the study objectives, procedures and benefits were clearly explained to selected individuals and those who volunteered to participant had to give written consent. Only women with equal to or less than 18 weeks of gestation based on the reported last menstrual period were enrolled. The inclusion criteria were being HIV negative and pregnant for the first or second time, carrying a singleton pregnancy. Furthermore, one had to be 18–35 years of age and free of any systemic illness such as active peptic ulcers, hypertension and diabetes mellitus. Nevertheless, some individuals were excluded from based on the following criteria; having a genetic abnormality like sickle cell disease, not able to schedule their return visits, not able to recall their pre-pregnancy weight, history of drug or alcohol abuse and mentally ill. Based on the set exclusion criteria, a total of fifty six pregnant women were disqualified from our study. Twenty-eight of them could not recall their pre-pregnancy weight, fourteen could not adhere to the scheduled return visits, six had active peptic ulcers, four had alcohol related problems, two were carrying twin pregnancies and two had sickle cell disease. Anthropometric measurements were made at recruitment, 26 weeks of gestation and 36 weeks of gestation.

2.4 ANTHROPOMETRIC MEASUREMENTS

Anthropometric measurements were performed by a trained anthropometrist in a private room when participants were in light clothing with the help of a midwife. A portable adult beam scale with 150 kg capacity divided into 0.5kg increments (Gmbh & co.kg, Germany model 7621019009) was used to measure weight of participants. A portable stadiometer consisting of a non-extendable 2 meter measuring tape divided into 0.1cm increments was used to measure height of participants. To measure height, participants were barefooted and in an orthostatic position. Both weight and height measurements were performed twice on every participant and the mean of the readings was taken to calculate BMI. The BMI of each participant was calculated as follows: BMI = pre-pregnancy weight (kg)/height (m) squared. The BMI was categorized using the World Health Organization criteria as follows; underweight (<18.5 kg/m^2), normal weight (18.5-24.9 kg/m^2), overweight (25.0-29.9 kg/m^2), obese (≥ 30.0 kg/m^2) (World Health Organization, 1995). Pre-pregnancy weight (W_{Pre}) considered in this study was that reported by the participant at recruitment. The measured gestation weight at each time point (GW_{Rec} = weight at recruitment, GW_{26} = weight at 26 weeks of gestation and GW_{36} = weight at 36 weeks of gestation) were recorded. Rate of GWG during second trimester was calculated as {(GW_{26} –

GW_{Rec})/(26 – gestation age at recruitment)}kg/week. Similarly, rate of GWG during third trimester was calculated as {(GW_{36} – GW_{26})/10} kg/week. GWG by 36 weeks was got by subtracting W_{Pre} from W_{36}. We subtracted 36 weeks from gestation age at delivery in weeks and multiplied with rate of GWG during the third trimester to get the weight gained (WG_d) from last measurement at 36 week to delivery; WG_d = {(gestation age at delivery – 36)*rate of GWG during the third trimester}kg. Total GWG was estimated as follows; GWG = {(GW_{36}+WG_d) – W_p}kg.

3.0 DATA ANALYSIS AND RESULTS

3.1 ANALYSIS OF DATA

Statistical Package for Social Sciences (SPSS) V.15.0 was used to analyze the data. Socio-demographic characteristics and anthropometric variables were presented as frequencies and mean ± standard deviation (Sd). The outcome variables of interest were GWG at delivery and the rates of GWG during the second and third trimesters of pregnancy. These two outcome variables were compared to the recommendations by the IOM and level of statistical significance was set at $p<0.05$.

3.2 RESULTS

A total of 221 women pregnant for the first or second time enrolled and followed until 36 weeks of gestation. Twenty six of the enrolled participants were lost to follow up and two of the participants lost their pregnancies before 36 weeks of gestation and one delivered a preterm baby on the day she was supposed to come for measurement at 36 weeks of gestation. This left us with us with 192 participants to consider for the analysis.

3.2.1 SOCIO-DEMOGRAPHIC CHARACTERISTICS OF THE PARTICIPANTS BY GWG

Table 2 shows the socio-demographic characteristics of the participants by GWG. Most of the participants (118/192) were pregnant for the first time. The majority of participants were married (168/192) and (145/192) had no employment, that is, they were only house wives. Almost all participants were nonsmokers (190/192) and were not taking alcohol (182/192). Of the study population, 110/192 were positive for *Helicobacter pylori* infection. A good number of participants had attended vocational or tertiary training (150/192) however very few households (11/192) were earning more than 250 US dollars per month.

3.2.2 MEAN±SD OF SOME OF THE PARTICIPANTS' CHARACTERISTICS BY PRE-PREGNANCY BMI CATEGORY

Table 3 shows the mean±Sd of the continous characteristics of participants by pre-pregnancy BMI category. The mean±Sd age (years) for underweight, normal weight and overweight participants was 19.82±1.44, 20.97±2.49 and 22.24±4.11 respectively. The mean±Sd weight (kg) for underweight, normal weight and overweight participants was 43.57±3.62, 53.16±5.73 and 65.14 ±4.79 respectively. The mean±Sd BMI (kg/m^2) for underweight, normal weight and overweight participants was 17.65±0.83, 21.39±1.75 and 26.56±1.28 respectively. Here we observe that BMI increased with increasing age and weight of the participants. The

mean±Sd GWG (kg) for underweight, normal weight and overweight participants was 11.31±2.98, 10.54±2.30 and 9.78±2.41 respectively. The mean±Sd rate GWG (kg/week) during the second and third trimesters for underweight, normal weight and overweight participants was 0.32±0.08, 0.30±0.08 and 0.28±0.09 respectively. We observe that GWG and rate of GWG decreased with increasing BMI.

3.2.3 MEAN GWG AND RATE OF GWG DURING SECOND AND THIRD TRIMESTERS BY PRE-PREGNANCY BMI CATEGORY ACCORDING TO MOH RECOMMENDATION

Table 4 shows the numbers of participants who gained less than, adequate or above the recommended GWG and their corresponding mean GWG and mean rates of GWG by BMI categories. Overall, only 34.4% (66/192) gained adequate gestational weight based on the Uganda MoH recommendation. The majority of the participants, that is, 62.5% (120/192) gained less than recommended GWG while only 3.1% (6/192) gained above recommended. The mean±Sd GWG for those who gained less than recommended was 9.34±1.44 kg while it was 12.43±2.30 kg for those who gained adequate gestational weight. The mean±Sd GWG for those who gained more than recommended was 14.83 ± 2.12 kg. By BMI categories, no participant in the underweight category gained gestational weight above the Uganda MoH recommendation. However, two participants from the normal weight category and four participants from the overweight category gained above the Uganda MoH recommendation. Over 70% (20/28) of the underweight participants and 68.5% (98/143) of the normal weight participants gained weight below the Uganda MoH recommendation. However, most of the overweight participants, 71.4% (15/21), gained the weight within the acceptable range. From table 4 also we observed that underweight participants gained the most weights and had the greatest rates of GWG (kg/week) while overweight participants had the least rates of GWGW. For example, underweight and overweight participants who gained the recommended gestational weight had mean±Sd values of 15.23 ± 1.10 kg and 9.15 ± 1.20 kg respectively.

3.2.4 COMPARISON OF PARTICIPANTS' MEAN RATES OF GWG BY BMI CATEGORY AGAINST MOH RECOMMENDATION

Table 5 shows participants mean rates of GWG during second and third trimesters against the IOM recommendation by BMI categories. The mean rate of GWG for underweight participants was 0.32 kg/week and this was lower than 0.51 which is recommended by the IOM and significantly different (95 CI: (-0.22, -0.15; P<0.001). Similarly, the mean rate of GWG for normal weight participants was 0.30 kg/week and was significantly lower than 0.42 kg/week which is recommended by the IOM (95 CI: (-0.13, -0.11; P<0.001). However, there was no statistically significant difference between the mean rate of GWG for overweight participants (0.28 kg/week) and that recommended by the IOM (95 CI: (-0.04, -0.05; P=0.869).

4.0 DISCUSSION

Generally, it is recognized that the pattern of maternal GWG has significant influence on fetal growth (IOM, 2009). Although, several studies have reported how differences in the timing of maternal weight gain may be related to fetal growth outcomes (Abrams & Selvin, 1995; Crane *et al*., 2009; Ebrahimi *et al*., 2015; Norfazlin *et al*., 2012), the information on the pattern of GWG by pre-pregnancy BMI in Uganda is very limited.

The mean pre-pregnancy BMI of our participants was 21.40±2.72 kg/m² (table 3). This is close to 22.9±0.12 that was reported in Nigeria (Esimai & Ojofeitimi, 2014) but was lower than 23.2 kg/m² and 23.7kg/m² reported in Brazil and Nigeria study respectively (Baba *et al*., 2012; Carvalho Padilha *et al*., 2009). Our low BMI could be explained by the fact that our study enrolled only women who were pregnant for the first or second time and the majority were relatively young, mean age of 20.9 years. This is in agreement with studies which have reported that BMI increases with increasing parity and age (Sperrin *et al*., 2015). Furthermore, our study found about three quarters (74.5%) of participants with a normal pre-pregnancy BMI. This is close to that reported in a Nigerian study (Esimai & Ojofeitimi, 2014), but is higher than 65.4% that was reported in a study conducted in Vietnam (Ota *et al*., 2011).

The mean GWG among pregnant women who were overweight before pregnancy was lower compared to those who were underweight and normal weight (table 4). This finding is similar to results from previous studies done in both developed and developing countries (Chasan-Taber *et al*., 2008; Norfazlin *et al*., 2012; Olson 2008). This is partially explained by the lower recommended gestational weight gain for overweight women as compared to those with normal BMI (IOM, 2009). Although the mean GWG was lower among overweight participants in this study, it was the BMI category where we registered the highest percentage of participants gaining adequate (71.4%). Furthermore, it was only in the overweight category where we found participants gaining excessive gestational weight. This data suggests that women who enter pregnancy when overweight have reduced chances of getting inadequate gestational weight gain as compared to those with normal BMI or underweight. Our findings are in agreement with the findings of other studies done in Brazil and England (Drehmer *et al*., 2010, Fraga & Theme Filha, 2014; Gardosi *et al*., 2013). It is also important to note that the mean rates of GWG for underweight and normal weight participants during second and third trimester were lower and significantly different from those recommended by IOM. However, there was no difference between the mean rate of GWG for overweight participants and that recommended by the Uganda MoH. We had 1.4% and 19.0% of our participants gaining excessive gestational weight in the normal weight and overweight categories respectively (table 5). As much as we did not have obese (BMI ≥ 30 kg/m²), there is evidence to show that overweight and obese women have a higher risk of gaining excessive gestational weight (Fraga & Theme Filha, 2014; Gardosi *et al*., 2013).

Overall the prevalence of inadequate GWG in our study population was 62.5%. This is close to with the findings of Faraha *et al* (2015) in rural Malaysia and is higher than that of other studies conducted in other developing countries like countries Malaysia and Iran and developed countries like United States of American and Canada (Norfazlin *et al*., 2012; Restall *et al*., 2014). Norfazlin *et al*., (2012) found a prevalence of inadequate gestational weight gain of 42.9% in an urban setting in Malaysia. Our higher prevalence of inadequate GWG could be as a result of poverty, food insecurity, economic instabilities and frequent infections which are common in Sub Sarahan Africa (Lartey, 2008). However, our prevalence of women gaining inadequate gestational weight is lower than 80% and 97% that have been reported among pregnant women in Iran and Nigeria respectively (Esimai & Ojofeitimi, 2014; Maddah, 2005). Furthermore, our study found a low prevalence (34.4%) of participants gaining adequate weight based on their pre-pregnancy BMI according to the recommendation of the Uganda MoH (MoH, 2010). This is close to 32.5% that was found by Faraha *et al.,* (2015) in their study on Malaysian pregnant women in rural Area. However, our finding of is lower than 27.5% and 27.7% that were reported in urban Brazil and urban Malaysia respectively (Fraga & Theme Filha, 2014; Norfazlin *et al*., 2012). Although our prevalence of women gaining adequate gestational weight is low, it is higher than (3.1%) that was reported in Nigeria (Esimai & Ojofeitimi, 2014). The majority of our participants with underweight and normal BMI gained less than the recommended weight gain for their pre pregnancy BMI whereas most of the overweight participants gained weight within the acceptable ranges. In addition, only a few women in the normal weight and overweight categories gained weights higher than the recommended. These findings are similar to the findings of Esimai and Ojofeitimi (2014) in Nigeria. However, the findings of our study are different from those in the study done in Iran which registered the highest percentage of participants gaining inadequate gestational weight in the overweight category (Farajzadegan, Bahrami & Jafari, 2012).

Despite the majority of our population having normal BMI at the time of getting pregnant and existence of guidelines on maternal nutrition in Uganda, only 34.4% of our participants adequate GWG. This shows that, in Ugandan, prenatal care services are inadequately addressing maternal weight gain during pregnancy. This may be true since reports in Uganda indicate that there is shortage of trained and motivated health care professionals including midwives who are central to the provision of antenatal services (MoH, 2010; UBoS, 2012). Furthermore, less than 50% of the Ugandan women attend four quality antenatal visits (UBoS, 2012). Besides in other developing countries it has been observed that more than 50% of the women who come for antenatal care are not counseled on specific weight gain for their pre-pregnancy BMI (Olagbuji *et al*., 2015). This means that the majority of pregnant women in Uganda do have minimal access to interventions that address maternal malnutrition since this is part of the antenatal care package (MoH, 2010). Unfortunately, this study did not collect data on number of antenatal visits. However, existing data show that several factors are responsible for maternal health outcomes in Sub Saharan Africa (Kawungezi *et al*., 2015; Pell *et al*., 2013).

The prospective design of our study made it to have strength. We were able to take care of some of the recognized risk factors for inadequate GWG such as parity, multiple pregnancy, HIV infection and chronic diseases. Furthermore, we enrolled a more uniform population and we are able to generalize our findings to a similar population. However, our study had the following limitations; we considered a small sample and data on other risk factors for inadequate GWG such as level of physical activity, anemia, number of antenatal visits, previous poor pregnancy outcome for those pregnant for the second time and complications which occurred during pregnancy were not collected. In addition, this study did not take into account other infections, such as malaria and helminths, which are prevalent in Uganda and have been associated with inadequate GWG (*De Beaudrap et al*., 2013; Woodburn *et al*., 2009) neither did we collect data on whether the women received counseling on optimal GWG.

5.0 CONCLUSION

Despite the availability of measures to ensure adequate GWG in Uganda, more than 62% of the women pregnant for the first or second time in low income urban setting do not gain adequate gestational weight. However, women who are overweight prior to getting pregnant have higher chances of gaining adequate gestational weight. There is a need for Uganda to assess whether the 2009 IOM anthropometric recommendations for pregnant women are appropriate for preventing adverse pregnancy outcomes across populations in Uganda.

ABBREVIATIONS USED

BMI	body mass index
GW	gestational weight
GWG	gestational weight gain
IOM	Institute of Medicine
Kg	kilograms
M	metres
MoH	Ministry of Health
Sd	standard deviation

AUTHORS' CONTRIBUTIONS

R Wanyama developed the study protocol and supervised the data collection process. He also did data entry wrote the draft manuscript. G Obai did data analysis and interpreted the data and participated in the writing of the draft manuscript. MN Kagawa and P Odongo assisted in the writing of the study protocol and offered important revision of the draft manuscript produce the final copy. RK Baingana did laboratory analysis and critically revised of the manuscript for intellectual content.

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7.0 TABLES

Table 1: Uganda MoH recommendations for total and rate of weight gain during pregnancy, by pre-pregnancy BMI

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	0.51 (0.44–0.58)
Normal weight	18.5–24.9	11.5–16	0.42 (0.35–0.50)
Overweight	25.0–29.9	7–11.5	0.28 (0.23–0.33)
Obese	≥ 30.0	5–9	0.22 (0.17–0.27)

Source: Guidelines on Maternal Nutrition in Uganda (2010) adopted from Institute of Medicine, 2009

Table 2: Socio-demographic Characteristics of the Participants by GWG

Variable	Overall Total n (%)	Less GWG n (%)	Adequate GWG n (%)	Excess GWG n (%)
Parity				
Primigravidae	118 (61.5)	72 (61.0)	42 (35.6)	4 (3.4)
Secundigravidae	74 (38.5)	48 (64.9)	24 (32.4)	2 (2.7)
Occupation				
House wife	145 (75.5)	94 (64.8)	48 (33.1)	3 (2.1)
Employed	38 (19.8)	23 (60.5)	12 (31.6)	3 (7.9)
Student	9 (4.7)	3 (33.3)	6 (66.7)	0 (0.0)
Marital status				
Married	168 (87.5)	109 (64.9)	53 (31.5)	6 (3.6)
Single	19 (9.9)	10 (52.6)	9 (47.4)	0 (0.0)
Widowed	2 (1.0)	0 (0.0)	2 (100.0)	0 (0.0)
Separated/divorced	3 (1.6)	1 (33.3)	2 (66.7)	0 (0.0)
Smoking				
Yes	2 (1.0)	0 (0.0)	2 (100.0.)	0 (0.0)
No	190 (99.0)	120 (63.1)	64 (33.7)	6 (3.2)
Alcohol				
Yes	10 (5.2)	3 (30.0)	7 (70.0.)	1 (10.0)
No	182 (94.8)	118 (64.8)	59 (34.4)	5 (2.8)
Building type				
Permanent	190 (99.0)	119 (62.6)	65 (34.2)	6 (3.2)
Temporary	2 (1.0)	1(50.0)	1 (50.0)	0 (0.0)
H. pylori status				
Negative	82 (42.7)	45 (54.9)	33 (40.2)	4 (4.9)
Positive	110 (57.3)	75 (68.2)	33 (30.0)	2 (1.8)
Education level				
Low (< secondary)	7 (3.7)	3 (42.9)	3 (42.9)	1 (14.2)
Medium (secondary)	35 (18.2)	23 (65.7)	12 (34.3)	0 (0.0)
High (vocational/tertiary)	150 (78.1)	94 (62.7)	51 (34.0)	5 (3.3)
Household monthly income ($)				

Low income (< 100)				
Medium income (101-250)	94 (49.0)	59 (62.8)	31 (33.0)	4 (4.2)
High income (> 250)	87 (45.3)	51 (58.6)	34 (39.1)	2 (2.3)
	11(5.7)	10 (90.9)	1 (9.1)	0 (0.0)

n = number, GWG = gestational weight gain, underweight = BMI< 18.5 kg/m^2, normal weight = BMI 18.5-24.9 kg/m^2, overweight is BMI= 25.0-29.9 kg/m^2

Table 3: *Mean±Sd of Some of the Participants' Characteristics by Pre-pregnancy BMI category*

Variable	Overall Mean±Sd	Pre-pregnancy BMI (kg/m^2)		
		Underweight (< 18.5)	Normal weight (18.5-24.9)	Overweight (25.0-29.9)
Age (years)	20.94±2.65	19.82±1.44	20.97±2.49	22.24±4.11
Weight (kg)	53.07±7.61	43.57±3.62	53.16±5.73	65.14±4.79
Height (cm)	157.4±5.77	157.0±5.4	157.6±5.8	156.9±6.3
BMI (kg/m^2)	21.40±2.73	17.65±0.83	21.39±1.75	26.56±1.28
GWG (kg)	10.58±2.44	11.31±2.98	10.54±2.30	9.78±2.41
RGWG (kg/week)	0.30±0.08	0.32±0.08	0.30±0.08	0.28±0.09

GWG = gestational weight gain, RGWG = rate of gestational weight gain during the second and third trimesters

Table 4: *Participants' mean GWG and rate of GWG during second and third trimesters by pre-pregnancy BMI category according to MoH recommendation*

Pre-pregnancy BMI (kg/m^2)	Number (%)	Mean GWG±Sd	Mean rate of GWG±Sd (kg/week)
Underweight (< 18.5)			
Less than recommended GWG	20 (71.4)	9.75±1.76	0.30±0.08
Recommended GWG	8 (28.6)	15.23±1.10	0.39±0.05
Above recommended GWG	0.0 (0.0)	Not applicable	Not applicable
Normal weight (18.5-24.9)			
Less than recommended GWG	98 (68.5)	9.31±1.32	0.27±0.06
Recommended GWG	43 (30.1)	13.06±1.34	0.35±0.08
Above recommended GWG	2 (1.4)	17.03±0.78	0.46±0.08
Overweight (25.0-29.9)			
Less than recommended GWG	2 (9.5)	6.60±0.00	0.23±0.03
Recommended GWG	15 (71.4)	9.15±1.20	0.26±0.08
Above recommended GWG	4 (19.0)	13.73±1.53	0.40±0.09
Overall			
Less than recommended GWG	120 (62.5)	9.34±1.44	0.23±0.03
Recommended GWG	66 (34.4)	12.43±2.30	0.34±0.10
Above recommended GWG	6 (3.1)	14.83±2.12	0.38±0.07

BMI=Body mass index, GWG= Gestational weight gain, Sd = Standard deviation, IOM= Institute of Medicine, MRGWG= mean rate of gestational weight gain during the second and third trimesters

Table 5: *Comparison of participants' mean rates of GWG by BMI Category against MoH recommendation*

Pre-pregnancy BMI (kg/m^2)	Mean GWG (kg/week)	Test value††	MD (kg/week)	P value (95% CI)
Underweight (< 18.5)	0.32	0.51	-0.19	<0.001 (-0.22, -0.15)
Normal weight (18.5-24.9)	0.30	0.42	-0.12	<0.001 (-0.13, -0.11)
Overweight (25.0-29.9)	0.28	0.28	0.00	0.869 (-0.04, 0.05)
Obese (≥ 30.0)	None	0.22	None	None

†† test value is the rate of gestational weigh gain recommended by the IOM for BMI category, GWG = Gestational weight gain, MD = mean difference between the participants' mean and that recommended by IOM, CI confidence interval