Open Journal of Obstetrics and Gynecology, 2013, 3, 416-421 **OJOG**
http://dx.doi.org/10.4236/ojog.2013.34076 Published Online June 2013 (http://www.scirp.org/journal/ojog/)

High pre-delivery body mass index also caused adverse pregnancy outcomes*

Rajin Arora[1#], Darin Arora[1], Jayanton Patumanond[2]

[1]Department of Obstetrics and Gynecology, Lampang Regional Hospital, Lampang, Thailand
[2]Clinical Epidemiology Unit, Chiang Mai University, Chiang Mai, Thailand
Email: #drrajin@live.com

Received 30 January 2013; revised 1 March 2013; accepted 9 March 2013

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ABSTRACT

Background/Aims: It is known that high pre-pregnancy body mass index (BMI) and high gestational weight gain both can cause many adverse pregnancy outcomes. High pre-delivery BMI (PD-BMI), though theoretically could do similar effects, is rarely been studied. The objectives of this study were to show the distribution of PD-BMI of the delivery women and to identify its correlation with adverse pregnancy outcomes. Methods: This study was a cross sectional study. Data were collected retrospectively from hospital electronic database of Lampang Regional Hospital (LPH) along with manual retrieval from medical charts and labor records. Data of all pregnant women who delivered at labor room were collected from 1st February 2011 to 31st August 2012. After preterm and multifetal pregnancies were excluded, 4999 cases were into the analysis. Descriptive and inferential data analyses were used with both univariate and multivariate methods. Results: In this group of women, 93.9% were in the PD-BMI range of 20.0 - 34.9 kg/m^2. After multivariate analysis was used, higher PD-BMI was shown to be correlated with higher cesarean section, neonates weighing ≥ 3500 gm and long neonatal length with relative risk (RR) and 95% confidence interval (95% CI) of 1.11 (1.09 - 1.13), 1.15 (1.12 - 1.17) and 1.07 (1.05 - 1.09), respectively. Conclusions: High PD-BMI was correlated with multiple adverse pregnancy outcomes. Interestingly, their effect sizes were much smaller comparing to high pre-pregnancy BMI and high gestational weight gain. It confirmed the current recommendations to monitor pre-pregnancy BMI and gestational weight gain to avoid unwanted morbidities.

Keywords: Pregnancy; Outcome; Body Mass Index; Delivery

1. INTRODUCTION

In 2009, World Health Organization (WHO) announced obesity in pregnancy as one of the important non-communicable diseases that threaten maternal and child health [1]. The prevalence of obesity in pregnancy has been increasing along with the prevalence of obesity in general population [2,3]. It is also long known that this condition causes many complications ranging from increased risks of infertility, hypertensive disorders, gestational diabetes mellitus, pregnancy-related pelvic pain, preterm labor, post-term, obstructed labor, intrauterine fetal death, stillbirth, operative obstetrics procedure and cesarean section [2,4-21]. Excessive gestational weight gain was also known to be associated with adverse pregnancy outcomes [22-24]. They were preterm delivery, cesarean section, macrosomia, low Apgar score and even offspring overweight/obesity and abdominal obesity in adolescence [25-30].

This brings curiosity to investigate the risk of high pre-delivery body mass index (PD-BMI). The hypothesis of this research was that if high pre-pregnancy body mass index (BMI) or high weight gain could affect the adverse pregnancy outcomes, high pre-delivery weight should more or less have such effect as well. High pre-pregnancy BMI and obesity actually were the events that occurred before pregnancy. Their effects should be corrupted by many other factors during pregnancy. High weight gain though occurs during pregnancy, women with different body structure and pre-pregnancy BMI should response to its effect differently. High pre-delivery weight, in contrary, shows its effects acutely at the time of delivery. After thoroughly searched the articles in

*Disclosure: There is no financial or commercial conflict of interest. This paper was granted by Research Committee of Lampang Regional Hospital.
#Corresponding author.

Medline, there were only a few obvious studies reporting this issue. They reported that PD-BMI caused higher cesarean section and longer labor time [31-33].

The first objective of this study was to show the distribution of PD-BMI of women who delivered at Lampang Regional Hospital (LPH). The second objective was to identify its correlation with adverse pregnancy outcomes. LPH is one of the regional hospitals of Ministry of Public Health in northern Thailand. With the capacity of 800 beds and many excellent centers contained, it very well represents a tertiary care hospital of the country.

2. MATERIALS AND METHODS

2.1. Samples

This study was a cross sectional study. Data were collected retrospectively from hospital electronic database of LPH along with manual retrieval from medical charts and labor records. Data of all pregnant women who delivered at labor room LPH were collected from 1st February 2011 to 31st August 2012. There were 5640 cases that were delivered in this period. When excluded cases with incomplete data, there were 5583 cases left. This research aimed to study the effect of PD-BMI of term and singleton women. Hence, after preterm and multifetal pregnancies were excluded, 4999 cases were left for the analysis. The study flow is shown as **Figure 1**.

2.2. Data Collection

Data collection of this study were pre-delivery weight, height and BMI along with demographic, obstetric and pregnancy outcomes of both mother and child. The interested variables were maternal age, maternal height, gravidity, type of delivery case (private or general), frequency of antenatal care (ANC), health benefit scheme, places of ANC, HIV infection, 1st and 2nd hemoglobin (Hb) test, complication in pregnancy, gestational age, mode of delivery, presentation, neonatal sex, birth weight, neonatal length and Apgar score. This research had been endorsed by Ethics Committee of Lampang Regional Hospital.

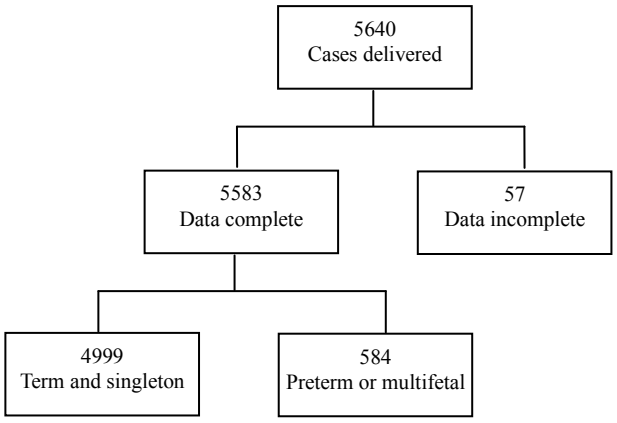

Figure 1. Number of cases delivered and number of illegible cases.

2.3. Analysis Procedure

In the analysis, mean and standard deviation (SD) of PD-BMI were calculated and compared among the subgroups for each variable. Data were analyzed using standard statistical software. Student t-test and Bonferroni test were used where applicable for univariate analysis. Then multivariate analysis was deployed to control the confounders and retrieve the final correlation.

3. RESULTS

Within these 19 months period, there were 4999 term singleton deliveries, which have complete data of PD-BMI and interesting variables. All cases were delivered at LPH. **Figure 2** shows the distribution of PD-BMI of these women. Majority of cases or 93.9% were in the PD-BMI range of 20.0 - 34.9 kg/m^2. Mean PD-BMI of this set of data was 27.3 kg/m^2 with SD of 4.2 kg/m^2. Minimum PD-BMI was 16.9 kg/m^2 and maximum PD-BMI was 61.3 kg/m^2.

Tables 1 and **2** show mean and SD of pre-delivery BMI comparing among the subgroups of each variable. The variables in **Table 1** are demographic and obstetric factors. While **Table 2** shows complications in pregnancy. Among maternal age group, elderly women had significantly higher mean PD-BMI. Women with gravidity ≥ 3 had significantly higher mean PD-BMI as well. Higher maternal height women (≥145 cm) had comparable PD-BMI with their counterparts. Though being private or general delivery case had comparable mean PD-BMI, it had statistical significant difference. Women who had antenatal care (ANC) ≥ 4 times had significant higher mean PD-BMI.

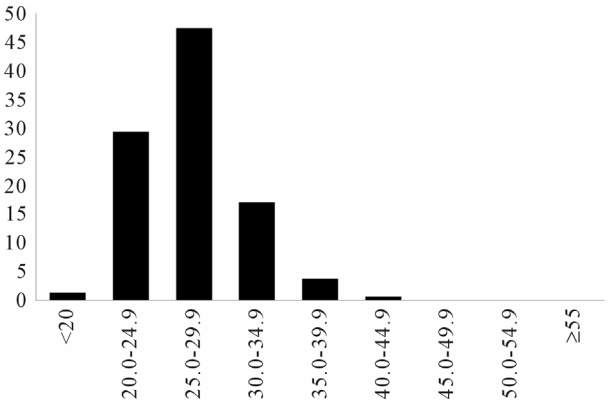

Figure 2. Distribution of pre-delivery body mass index (kg/m^2).

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Table 1. Pre-delivery BMI (mean, SD) classified by demographic and obstetric characteristics.

Characteristics	Pre-delivery BMI		P-value
	Mean	SD	
Maternal age group (year)			
<20	25.6	3.8	<0.001
20 - 34	27.5	4.2	
≥35	28.0	4.0	
Maternal height (cm)			
<145	27.0	4.1	0.501
≥145	27.3	4.2	
Gravida			
1	26.7	4.0	<0.001
2	27.7	4.1	
≥3	27.9	4.5	
Delivery case			
General	27.1	4.3	0.008
Private	27.5	3.9	
ANC frequency			
No ANC	25.9	4.4	<0.001
≥4	27.4	4.1	
Health benefit scheme			
No benefit	27.3	3.9	0.590
Universal coverage	27.3	4.5	
Place of ANC			
Lampang Hospital	27.2	4.3	0.078
Private clinics	27.5	4.0	
Community hospitals	27.3	4.2	
HIV positive			
No	27.3	4.1	0.892
Yes	27.3	5.9	
Hemoglobin (mg/dl)			
First test			
≥11	25.9	3.6	<0.001
<11	27.6	4.2	
Second test			
≥11	26.3	4.0	<0.001
<11	27.5	4.2	

Table 2. Pre-delivery BMI (mean, SD) classified by complications during pregnancy.

Pregnancy complications	Pre-delivery BMI		P-value
	Mean	SD	
1 complication			
No	27.3	4.0	0.994
Yes	27.3	4.4	
2 complications			
No	27.2	4.1	0.012
Yes	27.7	4.8	
3 complications			
No	27.3	4.2	0.174
Yes	27.9	4.3	
Preeclampsia			
No	27.2	4.1	<0.001
Yes	30.9	5.7	
Antepartum hemorrhage			
No	27.3	4.2	0.293
Yes	26.5	4.5	
Chorioamnionitis			
No	27.3	4.2	0.598
Yes	28.2	4.3	
Gestational diabetes			
No	27.2	4.1	<0.001
Yes	29.7	5.1	
Postpartum hemorrhage			
No	27.3	4.2	0.954
Yes	27.2	4.4	
Premature rupture of membrane			
No	27.3	4.2	0.831
Yes	27.2	4.0	

There is no significant difference of mean PD-BMI among women with 7 health benefit schemes. Moreover, among 9 subgroups of ANC places, there is no significant difference of mean PD-BMI. There is no significance difference of mean PD-BMI between women with positive and negative HIV results either. Women with no anemia from 1st and 2nd Hb test had significantly higher mean PD-BMI than those with anemia results. In this set of data, there is no women who had positive VDRL re-

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sult either from 1st routine or 2nd risk-based VDRL test.

Regarding complications in pregnancy in **Table 2**, women who had 2 complications had significantly higher PD-BMI. This was not shown in women having 1 or 3 complications. Women with preeclampsia and gestational diabetes significantly had higher mean PD-BMI. But women having antepartum hemorrhage, chorioamnionitis, postpartum hemorrhage and premature rupture of membrane had comparable mean PD-BMI with the women who had no such conditions.

Table 3 shows mean and SD of pre-delivery BMI comparing among the subgroups of each pregnancy outcome. Between term and postterm delivery group, there is no significant difference of mean PD-BMI. Women delivered by cesarean section had significantly higher mean PD-BMI than other mode of deliveries. Among 5 common cesarean indications, women with indication of previous cesarean and cephalopelvic disproportion (CPD) had significantly higher mean PD-BMI. Women with fetuses in vertex presentation and those with male neonates had comparable mean PD-BMI comparing to their counterparts. Among 3 birth weight groups, women with fetuses who weigh ≥ 3500 gm had significantly much higher PD-BMI. With mean of neonatal length of 49.9 and SD of 1.8, neonatal length was categorized as long neonatal length when it was ≥52 cm. Long neonatal length significantly correlated with higher PD-BMI. Regarding severe birth asphyxia, women with neonatal Apgar score 0 - 3 at 1, 5 and 10 minute tended to have lower PD-BMI comparing to other higher Apgar score groups. Nevertheless, it showed statistical significant difference with only Apgar score at 5 minute.

After univariate analysis was done to find correlation of PD-BMI with every interesting variable, multiple logistic regression analysis was used to control confounders. The results are shown in **Table 4**. Women with higher PD-BMI were still shown to be correlated with cesarean section with relative risk (RR) and 95% confidence interval (95% CI) of 1.11 (1.09 - 1.13). Women with higher PD-BMI were significantly correlated with neonates weighing ≥ 3500 gm with RR of 1.15 (1.12 - 1.17). Long neonatal length was also significantly correlated with higher PD-BMI with RR of 1.07 (1.05 - 1.09).

4. DISCUSSION

The distribution of PD-BMI of this group of women showed that 93.9% were in the range of 20.0 - 34.9 kg/m^2. Mean PD-BMI was at 27.3 kg/m^2 and SD at 4.2 kg/m^2. As there is no standard cut of point for high PD-BMI. Previous reports used either PD-BMI 30 or 40 kg/m^2 for analysis [31-33]. Hence, one could say that 6.1% of the women in this study had abnormally high PD-BMI. Actually, it is hard to state which woman had

Table 3. Pre-delivery BMI (mean, SD) classified by pregnancy outcomes.

Pregnancy outcomes	Pre-delivery BMI		P-value
	Mean	SD	
Gestational age (week)			
37 - 41	27.3	4.2	0.578
≥42	27.7	4.4	
Mode of delivery			
Normal	26.5	3.8	<0.001
Cesarean section	28.4	4.4	
Cesarean indications			
Previous cesarean	28.8	4.7	
CPD	28.6	4.3	<0.001
Fetal distress	27.5	4.8	
Presentation			
Vertex	27.3	4.2	0.436
Breech	27.4	3.5	
Neonatal sex			
Male	27.3	4.1	0.866
Female	27.3	4.2	
Birth weight group (gm)			
<2500	25.5	4.3	
2501 - 3499	26.9	3.9	<0.001
≥3500	29.5	4.5	
Neonatal length (cm)			
<52	27.0	4.1	<0.001
≥52	28.5	4.2	
Apgar score			
At 1 minute			
0 - 3	25.7	3.3	
4 - 7	27.4	4.2	0.383
8 - 10	27.3	4.2	
At 5 minute			
0 - 3	23.9	2.4	
4 - 7	29.8	5.9	0.003
8 - 10	27.3	4.1	
At 10 minute			
0 - 3	24.1	2.1	
4 - 7	28.0	6.9	0.181
8 - 10	27.3	4.1	

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Table 4. Outcomes of pregnancy significantly affected by pre-delivery BMI (in multivariable analysis).

Outcomes of pregnancy	Risk ratio*	95% Confidence Interval	P-value
Cesarean section	1.11	1.09 - 1.13	<0.001
Birth weight ≥ 3500 gm	1.15	1.12 - 1.17	<0.001
Longer neonate (≥52 cm)	1.07	1.05 - 1.09	<0.001

*Effect of 1 unit (kg/m^2) increase in BMI, adjusted for significant predictors by exponential risk (risk ratio) regression.

morbidly high PD-BMI or she was just fine in her acceptable range. More studies should be done in the future to exactly focus on PD-BMI. So, normal and abnormal criterion of PD-BMI could be established.

The second objective of this study was useful for obstetric community. After multivariate analysis was done to control confounders, women with higher PD-BMI were correlated with 3 clinical risks. They were cesarean section, neonates weighing ≥ 3500 gm and long neonatal length. This concurs with other previous studies [31-33]. So, along with high pre-pregnancy BMI and high weight gain, high PD-BMI alone could also predict adverse pregnancy outcomes.

Cesarean section and macrosomia were generally reported to be associated with high pre-pregnancy BMI and high weight gain [4-21,25-30]. But this study brought up one interesting finding. Long neonatal length was also correlated with high PD-BMI. This should initiate more studies in the future to confirm the correlation of neonatal body structure and maternal obesity. High PD-BMI women, in another word, large size mother could probably gain excessive weight or had large body structure before pregnancy. This could be a warning sign for health care givers. If one sees large size mother coming to delivery room, one could expect large size baby, both in terms of weight and length. Referring from large size baby, higher chance of cesarean section could be expected.

Though high PD-BMI showed correlation with 3 clinical risks as reported. Their RRs was quite small comparing to those of high pre-pregnancy BMI and high weight gain. Relative risk (RR) and 95% confidence interval (95% CI) of cesarean section, neonates weighing ≥ 3500 gm and long neonatal length were only at 1.11 (1.09 - 1.13), 1.15 (1.12 - 1.17) and 1.07 (1.05 - 1.09), respectively.

5. CONCLUSION

This could be concluded that high PD-BMI showed correlation with adverse pregnancy outcomes but the effect size was small. High pre-pregnancy BMI and high weight gain, though were seen as remote clinical factors but were stronger to predict unwanted gestational events. This study had at least 2 folds of usefulness. Firstly, it rang a bell for obstetric community to turn its eyes on PD-BMI. Most studies regarding maternal obesity were about high pre-pregnancy BMI and/or high gestational weight gain. High PD-BMI, as the factor which is right there before the delivery, should be more studied in the future. Secondly, it was very interesting to show that though higher PD-BMI were correlated with adverse pregnancy outcomes, the effect size was much smaller comparing to high pre-pregnancy BMI and high gestational weight gain. This needs more scientific explanations. But it confirmed the current recommendations to monitor pre-pregnancy BMI and gestational weight gain to avoid unwanted morbidities.

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