ASSOCIATION BETWEEN MATERNAL BODY MASS INDEX AND WEIGHT GAIN WITH LOW BIRTH WEIGHT IN EASTERN THAILAND

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Abstract. We conducted a retrospective study to determine the association between maternal body mass index and pregnancy weight gain with low birth weight newborns (LBWN) at Phrapokklao Hospital in eastern Thailand. We evaluated the files of 2,012 women who delivered at the hospital. Data obtained from the charts were parity, maternal age, body mass index (BMI), prepregnancy weight, weight gained during pregnancy, gestational age, hematocrit level, referral status, place of residence, fetal presentation, completion of antenatal care visits and maternal HIV infection**.** Sixty-five point two percent of subjects were aged 20-34 years old. Fifty-seven percent of subjects had a normal BMI and 13.2% were anemic. Thirty-seven point five percent, 32.9% and 29.6% gained too little, the correct amount and too much weight during pregnancy, respectively. Primiparity, too little weight gain and gestational age less than 37 weeks at delivery were all significantly associated with LBWN. Preterm babies were 25 times more likely to have a low birth weight than term infants (adjusted OR=24.995; 95%CI: 16.824-37.133, $p < 0.001$). When maternal weight gain of any BMI group was inadequate, the subject had a 3.4 times greater risk (adjusted OR=3.357; 95%CI: 22.114-5.332, $p < 0.001$) of having a LBWN. Primiparous women had a 1.7 times (adjusted OR=1.720; 95%CI: 1.182-2.503, *p*-0.005) greater risk of having a LBWN. The results from this study may be useful to plan maternal health programs for eastern Thailand.

Keywords: low birth weight, pregnancy weight gain, prepregnancy BMI

INTRODUCTION

The World Health Organization and United Nations Child's Fund define low birth weight (LBW) as a birth weight less than 2,500 grams regardless of gestational age (The United Nations Children's Fund and World Health Organization, 2004). The mortality rate for low birth weight newborns (LBWN) is higher than normal weight newborns (The United Nations Children's Fund and World Health Organization, 2004). LBW is a common cause of perinatal mortality (Hack *et al*, 1995; Whincup, 1995; Reichman, 2005). Newborn birth weight can be affected by maternal health and nutrition during pragnancy and may be an indicator of newborn survival, health, social and behavioral development (The United Na-

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tions Children's Fund and World Health Organization, 2004).

LBW can be the result of preterm birth (born prior to 37 weeks gestation), intrauterine growth restriction (IUGR) or both (The United Nations Children's Fund and World Health Organization, 2004). IUGR is a major cause of LBW; the mortality rate of IUGR infants is relatively high during the first year of life (Katz *et al*, 2013). IUGR infants have greater morbidity and a higher chance of impaired growth and/or cognitive and motor system development than normal infants (Pitcher *et al*, 2011). IUGR newborns are also at risk for having a lower-than-normal intelligence quotient (IQ), and of developing several medical problems later in life (Barker, 1992), such as hypertension, heart disease, diabetes mellitus and infection (The United Nations Children's Fund and World Health Organization, 2004).

Some conditions are associated with LBWN, such as teenage pregnancy, primiparity, under weight mother, a low prepregnancy body mass index (BMI), gestational weight gain of less than 10 kilograms and incomplete antenatal care (ANC) (Chumnijarakij *et al*, 1992; Chiang Mai Low Birth Weight Study Group *et al*, 2012; Hung *et al*, 2013). These factors vary by region (WHO, 2006).

Phrapokklao Hospital in Chanthaburi Province, eastern Thailand, serves as a major referral center for advanced care in the province. It is the second largest government hospital in eastern Thailand. The objective of this study was to determine the association between various maternal factors and a LBWN at our hospital.

MATERIALS AND METHODS

This retrospective study was approved by the Chanthaburi Ethics Committee. Data from all pregnant women delivering during January 1 - June 30, 2013 was obtained from the hospital medical records. Data obtained about each mother included parity, maternal age, gestational age at delivery, hematocrit level during the third trimester, prepregnancy weight, gestational weight gained, newborn birth weight, place of residence, fetal presentation at birth, maternal HIV infection and completion of antenatal care (defined as attending at least 5 prenatal visits). Pregnancy with intrauterine fetal demised and multifetal pregnancies were excluded from the study. Associations between these factors and LBWN were studied.

Body mass index (BMI) was checked prior to pregnancy. BMI was defined as body weight in kilograms (kg) divided by the height in meters squred (kg/m^2). Individuals with a BMI <18.5, 18.5-24.9, 25-29.9 and >29.9 were considered underweight, normal weight, overweight and obese, respectively. Categorization of weight gain during pregnancy was made following weight gain recommendations for pregnancy by the US Institute of Medicine, National Academies (US National Academies *et al*, 2007). According to these guidelines, appropriate weight gain during pregnancy is 12.5-18 kg, 11.5-16 kg, 7-11.5 and 5-9 kg in those underweight, normal weight, overweight and obese, respectively, based on their prepregnancy BMI (US Institute of Medicine, 2009). Pregnant women who gained less weight than recommended for their BMI category were classified as under the normal range and more than the recommended weight gain, were classified as over the normal range (US National Academies *et al*, 2007; US Institute of Medicine, 2009).

Data were analyzed using the Statistical Package for the Social Sciences Version 17 (IBM, Armonk, NY). Maternal

and newborn data were compared between LBWN and normal birth weight newborns (NBWN) using an unpaired *t*-test, a chi-square test and multivariate logistic regression. A p-value < 0.05 was considered statistically significant.

RESULTS

Two thousand twelve pregnant women were included in our study; the mean maternal age was 26.8 ± 7.1 years. Sixty-three point four percent of participants were multiparous and 18.4% were teenagers. Nearly half the participants resided in a rural area and 4.0% were referred from another hospital. The prevalence of maternal HIV infection was 0.8% and 13.2% of the participants were anemic. Thirty-six point one percent of the participants did not have at least 5 prenatal visits (Table 1).

Ninety-five percent of the newborns were cephalic presentation at birth. Nine point one percent were LBWN. Nine point two percent delivered before 37 weeks gestation.

Fifty-seven percent of participants had a normal prepregnancy BMI. Thirty-eight percent of participants had inadequate weight gain during pregnancy and 29.6% had too much weight gain during pregnancy.

A low maternal prepregnancy BMI was associated with an increased chance of having a LBWN (Table 1). A low prepregnancy weight, inadequate weight gain during pregnancy, being a referred case, having a non-cephalic fetal presentation at birth, not having at least 5 antenatal care visits, maternal HIV infection and gestational age less than 37 weeks at delivery were all significantly associated with an increased risk for having a LBWN. Maternal age, anemia and place of residence, were not significantly associated with risk for having a LBWN (Table 1).

The characteristics of LBWN and NBWN are compared in Table 2. The mean birth weights of among LBWN (2,137.9±405.7) and NBWN (3,118±374.9) were significantly different (Table 2). A non-cephalic fetal presentation at birth was significanly more common among LBWN (10.4%) than NBWN (4.8%). The mean fetal lengths (44.7±4.9 *vs* 49.4±1.8) and head circumferences (30.8±2.7 *vs* 33.5±1.3) were significantly shorter and smaller respectively, in LBWN than NWN (Table 2).

The infants born prior to 37 weeks are more likely to have a LBW than term infants. Infants born prior to 37 weeks gestation had a 25 times greater risk of being a LBWN (adjusted OR=24.995; 95% CI: 16.824-37.133, p< 0.001). Maternal weight gain was associated with newborn birth weight (Table 1). Infants born to mothers with inadequate pregnancy weight gain had a 3.4 times greater risk of having a LBW (adjusted OR=3.357; 95% CI: 2.114-5.332, p< 0.001) (Table 3).

Primiparous mother in our study were significantly more likely to have a LBWN (adjusted OR=1.720; 95% CI: 1.182-2.503, p=0.005). Low prepregnancy BMI and and having at least 5 antenatal care (ANC) visits were not significantly associated with a LBWN (adjusted OR= 0.749; 95% CI: 0.475-1.182, p=0.215 and adjusted OR=0.964; 95% CI: 0.666-1.395, p=0.844, respectively). Participants with a prepregnancy BMI above normal (>24.9) did not hav an inceased risk of having a LBWN (adjusted OR=0.738; 95% CI: 0.410-1.327, p=0.310) (Table 3).

DISCUSSION

The rate of LBWN is used as an indicator of public health effectiveness since it can reflect maternal health, lifestyle, nutrition and health care during pregnancy.

Table 1
Association between various maternal factors and newborn birth weight.

Variables	All (*n*=2,012) Mean±SD / No. (%)	LBWN (*n*=183) Mean±SD / No. (%)	NBWN (*n*=1,829) Mean±SD / No. (%)	*p*-value
Multiparity	1,276 (63.4)	104 (56.8)	1,172 (64.1)	0.052
Maternal age (years)	26.8 ± 7.1	26.42 ± 7.79	26.89 ± 6.98	0.431
<20 (adolescence)	371 (18.4)	47 (25.7)	324 (17.7)	
20-34 (normal age)	1,312 (65.2)	104 (56.8)	1,208 (66.0)	
≥35 (advanced age)	329 (16.4)	32 (17.5)	297 (16.2)	
Body mass index	22.1 ± 4.7	21.2 ± 4.4	22.2 ± 4.7	0.003
Body mass index category				
Underweight (BMI<18.5 kg/m^2)	423 (21.0)	49 (26.8)	374 (20.4)	
Normal weight (BMI 18.5-24.9 kg/m^2)	1,151 (57.2)	101 (55.2)	1,050 (57.4)	
Overweight and obese (BMI>24.9 kg/m^2)	438 (21.8)	33 (18.0)	405 (22.1)	
Prepregnancy weight (kg)	55.1 ± 12.4	51.8 ± 11.9	55.5 ± 12.4	<0.001
Weight gain (kg)	12.6 ± 5.9	9.5 ± 5.1	12.9 ± 5.9	<0.001
Weight gain during pregnancy				
Inadequate	755 (37.5)	124 (67.8)	631 (34.5)	
Normal	662 (32.9)	30 (16.4)	632 (34.6)	
Too much	595 (29.6)	29 (15.8)	566 (30.9)	
Referral case	81 (4.0)	14 (7.7)	67 (3.7)	0.009
Rural residence	1,002 (49.8)	80 (43.7)	922 (50.4)	0.084
HIV infection - positive	17 (0.8)	3 (1.6)	14 (0.8)	0.03
Hematocrit (%)	36.6 ± 3.6	36.2 ± 4.1	36.6 ± 3.5	0.081
Anemia (hematocrit < 33%)	266 (13.2)	29 (15.8)	237 (13.0)	0.271
Less than 5 ANC visits	726 (36.1)	84 (45.9)	642 (35.1)	0.004
Gestational age at delivery (weeks)	38.3 ± 2.0	35.3 ± 3.7	38.6 ± 1.4	<0.001
<37	186 (9.2)	100 (54.6)	86 (4.7)	
≥37	1,826 (90.8)	83 (45.4)	1,743 (95.3)	

NWN, normal birth weight newborn; LBWN, low birth weight newborn; ANC, antenatal care.

Newborns weighing less than 2,500 grams are considered to be LBWN following WHO definitions (The United Nations Children's Fund and World Health Organization, 2004). The goal for the Thai Ministry of Public Health for 2012 was for the incidence of LBWN to be ≤7% (Department of Health, 2015). In our study, the incidence of LBWN was 9.1%, close to the 9% reported for Thailand by the World Bank and reported in the Chiang Mai Low Birth Weight Study Group *et al* in 2012, but lower than 15.5% estimated worldwide incidence (The United Nations Children's Fund and World Health Organization, 2004). Nine point two percent of the infants in our study were born prior to 37 weeks gestasion.

Many factors can affect the risk for delivering a LBWN: poor life-long maternal nutrition, nutrition during pregnancy, small maternal physique, teenage pregnancy, primiparity, alcohol, tobacco and drug use during pregnancy, maternal

Table 2
Newborn characteristics by birth weight.

Characteristics	All (*n*=2,012) Mean±SD / No. (%)	LBWN (*n*=183) Mean±SD / No. (%)	NBWN (*n*=1,829) Mean±SD / No. (%)	*p*-value
Live birth	1,993 (99.1)	170 (92.9)	1,823 (99.7)	<0.001
Non-cephalic presentation	106 (5.3)	19 (10.4)	87 (4.8)	0.001
APGAR score < 7 (at 1 minute)	69 (3.4)	26 (14.2)	43 (2.4)	<0.001
Birth weight	3,028.9 ± 471.4	2,137.9 ± 405.7	3,118 ± 374.9	<0.001
Crown to heel length in cm	48.9 ± 2.6	44.7 ± 4.9	49.4 ± 1.8	0.041
Occipito-frontal head circumference in cm	33.3 ± 1.6	30.8 ± 2.7	33.5 ± 1.3	0.029

NBWN, normal birth weight newborn; LBWN, low birth weight newborn; SD, standard deviation.

Table 3
Adjusted odd ratio of risk factors for LBWN.

Variables	Risk for LBWN (*n*=2,012)		
	Adjusted OR	95% CI	*p*-value
Parity			
Multiparous (reference group)	1		
Primiparous	1.720	1.182-2.503	0.005
Body mass index (kg/m^2)			
18.5-24.9 (reference group)	1		
<18.5	0.749	0.475-1.182	0.215
>24.9	0.939	0.578-1.527	0.801
Gestational weight gain category			
Normal (reference group)	1		
Inadequate	3.357	2.114-5.332	<0.001
Too much	0.738	0.410-1.327	0.310
Antinatal care			
≥5 visits (reference group)	1		
<5 visits	0.964	0.666-1.395	0.844
Gestational age at delivery			
≥37 weeks (reference group)	1		
<37 weeks	24.995	16.824-37.133	<0.001

LBWN, low birth weight newborn.

illness during pregnancy, premature birth and low socioeconomic status (WHO, 2006; Hung *et al*, 2013). In our study significant factors were: primiparity, short duration of pregnancy and poor nutrition during pregnancy. We did not see a significant association with low BMI or teenage pregnancy.

Preterm delivery as a risk factor for a LBWN. In Thailand, the incidence of preterm infants increased from 9.44% in

2004 to 13.70% in 2010 (Chawanpaiboon and Kanokpongsakdi, 2011). In our study, the incidence of preterm birth was 9.2%. Many factors affect preterm birth. One study found in countries with a low per capita income, 12% of newborns were born premature and in countries with a higher per capita income, 9% of babies were preterm (Blencowe *et al*, 2012). The mothers who themselves were born prematurely have a higher risk of delivering a LBWN (Bener *et al*, 2013). This could not be evaluated in our study because of limited data from our retrospective chart review. We did find infants born prematurely a 25 times higher risk of being a LBWN (adjusted OR=24.995; 95% CI: 16.824-37.133, $p<0.001$) (Table 3).

Previous studies have reported poor prepregnancy nutritional status and small maternal physique can affect newborn birthweight (WHO, 2006). Underweight women were found to have a 1.64 times greater risk of having a LBWN (Han *et al*, 2011); this was not seen in our study. In our study, a low prepregnancy BMI was not significantly associated with having a LBWN (adjusted OR=0.749; 95% CI: =0.475-1.182, $p=0.215$). High prepregnancy BMI was also not associated with a LBWN. Weight gained during pregnancy was more important than prepregnancy BMI in the risk for having a LBWN in our study. Women with inadequate weight gain in our study, no matter their prepregnancy BMI, were 3.4 times more likely to have a LBWN (adjusted OR=3.357; 95% CI: 2.114-5.332, $p<0.001$) (Table 3).

One study from northern Thailand found having adequte numbers of antenatal visits was significantly associated with having a normal weight infant (Odds ratio=11.04) (Chiang Mai Low Birth Weight Study Group *et al*, 2012). Mumbare *et al* (2012) reported inadequate ANC was associated with a 4.98 greater risk of having a LBWN. Although ANC does not control for socioeconomic status and environmental factors that contribute to a LBWN, it worth in identifying factors, such as cigarette smoking, alcohol consumption, drug use, and poor diet. If confounding factors can be identified, the risk for delivering a LBWN may be reduced or eliminated through prenatal counseling. Women who do not have at least 5 antenatal visits may not benefit from the provided hospital educational sessions about maternal and fetal health. In our study, we did not found an association between having 5 ANC visits and having a LBWN (adjusted OR=0.964; 95% CI: 0.666-1.395, $p=0.844$) even though only two-thirds of participants in our study had at least 5 ANC visits. This unexpected finding may be due to confounding factors not controlled for in the study.

Primiparous participants were significantly more likely to have a LBWN in our study (adjusted OR=1.720; 95% CI: 1.182-2.503, $p=0.005$). This is the same finding as that previously reported from India (Odds ratio=1.58) (Deshmukh *et al*,1998).

In conclusion, in our study, delivering prematurely, being a primiparous women and inadequate weight gained during pregnancy for the maternal BMI were all significantly associated with increased risk of having a LBWN. These data may be helpful for developing methods to reduce the risk for delivering a LBWN in the study area. Further testing is needed to determine if interventions would indeed reduce the incidence of LBWN in the study area.

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