ORIGINAL ARTICLE

Maternal Factors in Predicting Low Birth Weight Babies

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SUMMARY

This study examines the association between maternal factors and low birth weight among newborns at a tertiary hospital in Malaysia. This was a cross-sectional study where mothers were followed through from first booking till delivery. There were 666 mothers who delivered from May 2007 to March 2008. Infants' birth weight were compared with maternal age, pre-pregnancy BMI, fathers BMI, parity, ethnicity, per capita monthly income, and maternal blood pressure during pregnancy. A multiple logistic regressions was used to determine the relationship of maternal factors and low birth weight, while the ROC curve was constructed to assess the sensitivity and specificity of the predictive model. Among the significant risk factors of low birth weight were older age (35 years and above), low pre-pregnancy BMI (<20 kg/m2), parity of 4 and above, Indian origin, economically under privileged, and low and high blood pressure. Blood pressure during pregnancy was an important risk factor for LBW, by using this parameter alone the risk of LBW could be predicted with a sensitivity rate of 70% and a specificity rate of 70%. The sensitivity and specificity was further improved to 80% and 75% percent respectively when other factors like maternal factors such as maternal age, pre-pregnancy BMI, ethnicity, and per capita monthly income were included in the analysis.

KEY WORDS:
Low birth weight, blood pressure, maternal factors, newborns

INTRODUCTION

Low birth weight (LBW) is defined as birth weight (BW) of less than 2,500g. Low birth weight newborns are at higher risk for perinatal and infant mortality[1, 2, 3] and other health complications such as hypertensive adults[4]. The incidence of LBW in any population reflects its socio-economic development and it is a good proxy to gauge the developmental status of the country. According to WHO, about 20 million or approximately 15.5 percent of births worldwide are low birth weight and 96% of these are from developing countries[1]. LBW together with preterm delivery has also been recognized as a strong biological predictor of unfavorable developmental outcomes[5,6]. There is a dearth of evidence linking very low birth weight to health disadvantage such as cognitive deficits, motor delays, cerebral palsy, and other behavioral and psychological problems[6] while infants weighing 1500 – 2500 gm. at birth are at higher risk developing these complications[5].

Low birth weight is a consequence of either preterm (<37 weeks of gestation) delivery or intrauterine growth retardation or of both[1, 7, 8]. In full term pregnancy, birth weight is greatly influenced by the fetal growth, which is closely linked to nutritional status during the pregnancy period and also after birth to next pregnancy[1, 9]. Usually mothers in poor socio-economic conditions are at higher risk of giving birth to low birth infants. The causes of LBW are multifactorial and often the result of complex interactions of both socio-demographic and biological factors. Among the factors associated with birth weight are mother's age, ethnicity, gestational age, economic condition, pre-pregnancy BMI, gestational weight gain, maternal hemoglobin (Hb) level during pregnancy, blood pressure level, and inter pregnancy interval. Previous studies have shown that maternal factors have significant association with birth weight of infants[10, 11, 22]. The aim of this study is to investigate the association of certain maternal factors (maternal blood pressure, age, ethnicity, pre-pregnancy BMI and per capita monthly income) and birth weights of infants in the Malaysian context.

MATERIALS AND METHODS

This was a cross-sectional study and the study period was between May 2007 to March 2008 at the Seremban General Hospital in Negeri Sembilan, Malaysia. All deliveries during the study period and the maternal factors were recorded. The inclusion criteria was that the mother is not suffering from any medical and/or surgical condition before pregnancy and at the time of enrollment, delivered a singleton live born baby, and has no diabetes (any form). Newborns' birth weight was recorded immediately to the precision of 1 g. The exclusion criterion was still births. A total of 666 mother–baby pairs were included in the study and there were 573 normal birth weights and 93 low birth weights (LBW). Among the maternal factors assessed for association with low birth weight were mothers' age, pre-pregnancy BMI, parity, per capita monthly income, ethnicity, and blood pressure and fathers' BMI. Since age and BMI have significant associations with mothers' blood pressure during pregnancy, the blood pressure was corrected for these two variables (age and BMI) in the analysis. Blood pressure was taken routinely at every antenatal visit so the average systolic and diastolic blood pressure readings were used in the analysis. Mothers pre-pregnancy BMI was determined by adjusting the BMI for gestation week at first booking using the simple linear regression method. The per capita monthly income was used as proxy to gauge the socio-economic status of the pregnant mothers.

Statistical Package for the Social Sciences (SPSS) version 15 was used to do the statistics. The Chi-Square statistics and

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odds ratios were used to test the association between birth weight and maternal variables. The statistical significance level used in this study was at $p<0.05$. A predictive model for low birth weight was defined using multiple logistic regressions. The logistic regression was used to predict the factors contributing to low birth weight in order of importance while the ROC curve was used to estimate the sensitivity and specificity of the model. A step wise regression model was done where the independent variables were included in hierarchical fashion and the likelihood ratio test was used to test the differences between the initial model and the various nested models which are subsets of the first model. Each regression coefficient indicates the effect of the variable on birth weight after controlling for the rest of the variables listed.

RESULTS

Out of the 666 live births there were 93 (13.96%) low birth weight (LBW) babies and 573 (86.03%) were normal birth weights. The maternal factors that were significant for low birth weight were mother's age, mother's BMI, parity, race, per capita income and blood pressure readings. (Table I) The low birth weight babies among older mothers (35 years and above) is 23.89 percent and this is significantly higher than the percentage of low birth babies for mothers in the other age categories ($p = 0.004$). Higher percentage (22.1%) of low birth weight was also noticed among mothers with BMI values lower than 20 kg/m^2 when compared with BMI 20-24.9 kg/m^2 and 25 kg/m^2 and above($p= 0.042$). Fathers' BMI was also analyzed for association with LBW and although there were more LBW cases when fathers' BMI is less than 20 kg/m^2 however this was not significant ($p=0.05$). Mothers who were Para 4 and above have higher percentage of LBW infants. ($p= 0.022$)

The percentage of LBW cases was higher among the Indians (19.35%) followed by Malays (13.27%), and Chinese (8.51%). ($p=0.0046$). Further analysis revealed that higher percentage of the Indians were from the lower socio-economic strata, mainly having per capita monthly income of less than RM 500 (75%) and not highly educated (Secondary school or below). Mothers with per capita monthly less than RM 500 recorded significantly higher percentages of LBW ($p=0.015$). Maternal blood pressure is another important parameter associated with low birth weight. Blood pressure readings were taken at every ante-natal visit. Although there are studies that use the highest blood pressure readings[12-15], the average blood pressure readings were preferred in this study due to fluctuating blood pressure readings recorded for most mothers. The results show that mothers with systolic blood pressure (adjusted for BMI and age) less than 110mmHg or more than 130mmHg were more prone to have low birth infants. The percentages of LBW in both the categories were higher compared to mothers with blood pressure in the normal range. The crude odds ratio of LBW among mothers with low systolic blood pressure compared to those in normal range is 2.45 (95% CI 1.87 – 3.11) while mothers with higher systolic blood pressure (>130mmHg) is 3.01 (95% CI 2.67 – 3.58) times at higher risk of LBW. Similarly mothers with diastolic blood pressure less than 75mmHg or more than 85mmHg are at higher risk of low birth weight. The relative risk of LBW among these mothers are 1.58 (95% CI 1.21 – 1.98) and 1.96 (95% CI 1.77 – 2.21) respectively compares to mothers in the normal range (adjusted diastolic blood pressure 75 – 85mmHg).

A multiple logistic regression was done to assess the association between the various maternal factor and birth weight. (Table II) In the logistic regression model the dependent variable was defined as the birth outcome and the independent variables were maternal factors that have significant association with birth weight. The results show that mothers aged 35 and above were at higher risk of LBW infant. The odds ratio is 1.25 (95% CI 1.03 – 1.51) compared to mothers of age ranging from 25 to 29 years. In terms of ethnicity, Indian mothers were at higher risk followed by Malay and Chinese. The odds ratio for LBW in Indian is 1.34 (95% CI 1.14 – 1.54) compared to the Chinese while the odds ratio for Malays is 1.26 (95% CI 1.04 – 1.53) for similar comparison. Mothers with pre-pregnancy BMI less than 20 kg/m2 have significantly higher risk of LBW, the odds ratio is 1.84 (95% CI 1.20 – 2.82) compared with those with BMI ranging from 20 to 24.9 kg/m^2. Comparison on social economic status showed that mothers from the higher income bracket (RM >500) shows lower risk of LBW, the odds ratios 0.83 (95% CI 0.71 – 0.97) compared to the economically less privileged. As for the blood pressure, mothers' blood pressure (both systolic and diastolic) during pregnancy was significantly influenced the birth weight of infants. Mothers with systolic blood pressure less than 110mmHg were significantly at higher risk of LBW compared with those with systolic blood pressure 110 – 130 mmHg, the odds ratio is 1.22 (95% CI 1.02 – 1.46). This is also the case for mothers with systolic blood pressure greater that 130mmHg, the odds ratio is 1.38 (95% CI 1.11 – 1.73). Similarly low and high diastolic blood pressure increases the risk of LBW. The odds ratios for mothers with diastolic blood pressure less than 75mmHg and diastolic blood pressure greater than 85mmHg are 1.25 (95% CI 1.01 – 1.52) and 1.54 (95% CI 1.24 – 1.92) respectively compared to the reference group (the reference group is mothers with DBP 75 – mmHg). Figure I shows that the logistic regression model used in this study is a predictive model and using blood pressure as single factor, the model had a sensitivity rate of 70% with 70% specificity. On including other maternal factors like age, ethnicity, per capita monthly income, and pre- pregnancy BMI improved the model to be 80% sensitive and 75% specific in ROC curve for this model.

DISCUSSION

This study examined the influence of maternal socio-demographic and obstetrics factors on birth weight of infants. The study showed that the older mothers (> 35 years) are at a higher risk of having low birth weight babies when compared with women of age 20 – 29 years. (OR 1.25) Similar results were noticed by Khoshnood *et al* who found that that maternal age 35 and above were higher risk of low birth weight among African Americans, Mexican Americans, Non-Hispanic whites, and Puerto Ricans[16]. The estimated risk of LBW was highest among the Indian mother which was 34% higher than Chinese mothers and the LBW among the Malay mothers was 26 % higher than the Chinese mothers.

Table I: Infant birth weight according to selected maternal factors

Maternal factors		Birth Weight		p-value
		Less than 2500	2500 and above	
Mothers' Age	less than 24	18 (15.25%)	100 (84.75%)	0.004
	25 - 29	27 (10.00%)	243 (90.00%)	
	30 - 34	21 (12.73%)	144 (87.27%)	
	35 and above	27 (23.89%)	86 (76.11%)	
Mothers BMI	<20	21 (22.11%)	74 (77.89%)	0.042
	20 – 24.99	42 (13.21%)	276 (86.79)	
	>= 25	30 (11.86%)	223 (88.14%)	
Fathers' BMI	<20	11 (18.04%)	50 (81.97)	0.587
	20 – 24.99	39 (14.13%)	237 (85.17%)	
	>= 25	43 (13.07%)	286 (86.93%)	
Parity	0	27 (11.59%)	206 (88.41%)	0.022
	1	24 (15.48%)	131 (84.52%)	
	2-3	28 (12.33%)	199 (87.67%)	
	>= 4	14 (27.49%)	37 (72.55%)	
Race	Malay	60 (13.27%)	392 (86.73%)	0.0046
	Chinese	8 (8.51%)	86 (91.49%)	
	Indian	18 (19.35%)	75 (80.65%)	
Family Per Capita Income	< RM 500 per capita	49 (17.88%)	225 (82.12%)	0.015
	> RM 500 per capita	44 (11.22%)	348 (88.78%)	
Blood pressure readings corrected for mothers' age and BMI	< 110 mmHg	44 (18.49%)	194 (81.51%)	0.0001
	110 – 130 mmHg	24 (7.55%)	294 (92.45%)	
	> 130 mmHg	25 (22.73%)	85 (77.27%)	
Blood pressure readings corrected for mothers' age and BMI	< 75 mmHg	39 (16.12%)	203 (83.88%)	0.018
	75 – 85 mmHg	32 (10.19%)	282 (89.81%)	
	> 85mmHg	22 (20.00%)	88 (80.00%)	

Table II: Results of the Multiple Logistic Regression Analysis

Parameters	B	S.E.	Wald	df	Sig.	Exp(B)	95.0% C.I.for EXP(B)	
							Lower	Upper
Age (25 – 29 years) (reference group			6.084	3	0.014			
Age (< 24)	0.543	0.285	3.628	1	0.057	1.721	0.984	3.008
Age (30 - 34)	0.305	0.216	1.988	1	0.159	1.357	0.888	2.084
Age (>= 35)	0.221	0.097	8.39	1	0.009	1.247	1.031	1.509
Race (Chinese) reference group			5.033	3	0.029			
Race (Indian)	0.291	0.083	6.223	1	0.013	1.338	1.137	1.574
Race (Malay)	0.230	0.098	4.211	1	0.041	1.259	1.039	1.525
BMI(20 – 24.9) reference group			7.68	2	0.011			
BMI (<20)	0.611	0.218	7.894	1	0.005	1.843	1.203	2.823
BMI (>= 25)	0.410	0.306	1.792	1	0.181	1.507	0.827	2.748
Income < RM 500	-0.189	.080	5.520	1	0.019	0.828	0.707	0.969
Systolic blood pressure (110 – 130) mmHg reference group			6.877	2	0.012			
Systolic blood pressure (< 110)	0.199	0.092	5.397	1	0.023	1.220	1.019	1.462
Systolic blood pressure (> 130)	0.325	0.113	6.877	1	0.012	1.384	1.109	1.727
Diastolic blood pressure (75 – 85)mmHg reference group			4.256	2	0.039			
Diastolic blood pressure(<75)	0.216	0.103	5.332	1	0.027	1.241	1.014	1.519
Diastolic blood pressure (>85)	0.433	0.113	4.011	1	0.042	1.540	1.236	1.924
Constant	0.536	0.477	1.262	1	0.261	1.707		

Variable(s) entered on step 1: age, race, maternal BMI, income, systolic blood pressure, diastolic blood pressure.

However, this could be due to socio-economic factors as 85% of the Indian mothers belonged to the lower socio-economic class (less than RM 500 per capita monthly income). Even though the ethnicity cannot be clearly singled out as one of the factor contributing to the birth weight of infants, in Malaysia the trend seem to persist. In a study by Yadav[17] on low birth weight among various ethnic groups in Malaysian newborns it was found that amongst the various ethnic groups the LBW was the highest in Indians (17.5%) compared to Malays (14.6%) and Chinese (6.5%) [17].

The relationship between pre-pregnancy BMI and fetal growth is well known and that the smaller size women tend to have smaller babies[1]. Even though the direct relationship between pre-pregnancy BMI and fetal growth is not known, a study by Frederick *et al* also found that women with pre-pregnancy BMI less than 19.8kg/m^2 were 51% higher risk of delivering a LBW infant compared to those with BMI ranging from 19.8 –20.6kg/m^2. He concluded that pre-pregnancy body mass index (BMI) and gestational weight gain influence infant birth weight and play significant roles in adverse

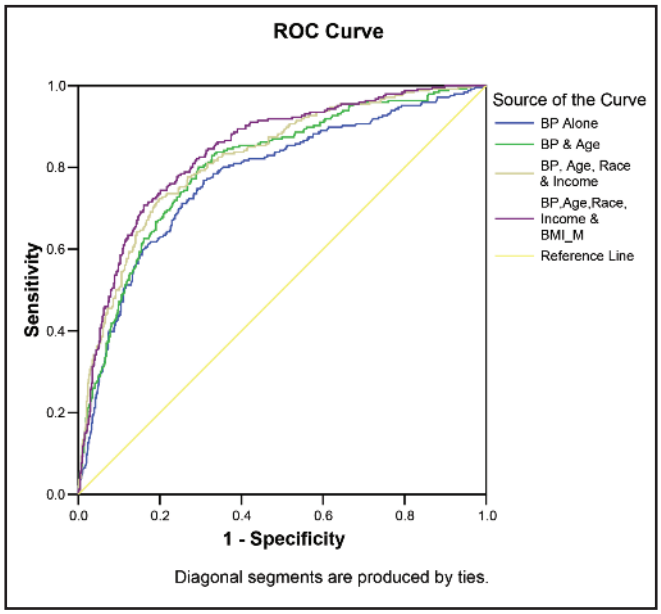

Fig. 1: The ROC curve for the regression model.

pregnancy outcomes[10]. Similar findings were noticed in a previous study where the pre-pregnancy body mass index (BMI) and gestational weight gain was shown to have some influence on infant birth weight[10]. Mothers in poor socio-economic conditions frequently have low birth weight infants[13] and mothers with per capita monthly income less than RM 500 had 1.59 times higher risk of delivering LBW infants compared with those with per capita income greater than RM 500. A similar finding by Shamiran *et.al* also concluded that the per capita daily income of mothers' of low birth infant was significantly lower than those of normal weight infants[18].

Both high and low systolic blood pressure and diastolic blood pressure during pregnancy were found to be important risk factors of LBW. Steer *et.al* also found that low as well as high blood pressure contributes positively to the risk of low birth weight[12], while Odell C.D *et.al* pointed out that among Haitian and African -America women hypertension leads to higher risk of LBW[19]. In has been shown that hypertension during pregnancy has a significant association and low birth weight[14, 20, 21].

CONCLUSION

The maternal factors that can affect infants' low birth weight were pre-pregnancy BMI, parity, race, per capita income and blood pressure readings. Using the logistic regression the significant factors were older age (>35 years), low pre-pregnancy BMI (<20 kg/m^2), parity of 4 and above, Indian origin, economically under privileged, and low and high blood pressure. By using blood pressure alone the risk of LBW could be predicted with a sensitivity rate of 70% and a specificity rate of 70% using the ROC curve. When other factors such as maternal age, pre-pregnancy BMI, ethnicity, and per capita monthly income were included in the analysis the sensitivity and specificity was further improved to 80% and 75% percent respectively.

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