Early Prediction of Birth weight Based on Maternal Factors

Bratin Das

Ramakrishna Mission Vivekananda Educational and Research Institute

Abstract:

A low birth weight baby (birth weight < 2.5 kg) faces numerous health related and developmental problems throughout its life. Hence if a potential LBW case is identified during an early stage of pregnancy based on maternal factors, this can be brought under appropriate medical intervention scheme so that eventually the LBW can be avoided. This exercise was carried out using Regression and Logistic Regression models. As the regression model was not found to be satisfactory, the prediction formula was developed based on the logistic regression model only. Sensitivity (72.5%), specificity (54.05%) and misclassification (41.06%) for the model came out to be moderately satisfactory.

Key words: Low birth weight (LBW), Regression, Logistic Regression, Sensitivity, Specificity, Misclassification.

1. Introduction

According to a definition adopted by WHO in 1950, a human birth weight less than 2,500 gms. is termed as Low Birth Weight (*LBW).* The term LBW includes pre-term babies (those born before 37^{th} week of pregnancy), as well as full term babies who are small for date due to intra-uterine growth retardation (IUGR). While pre term birth, till date, is a phenomenon of largely unknown aetiology, IUGR is caused due to various abnormal foetal conditions, or poor maternal conditions – anthropometric, physical, and clinical or socio economic.

In our country, the current estimate of incidence of LBW is approximately 30%.

The LBW phenomenon has been identified the world over as a public health problem of the first rank, because of a good many hazards associated with this as indicated below.

Neonatal mortality and infant mortality rates are significantly higher among LBW babies than their normal birth weight (NBW) counterparts (e.g., 1, 4, and 5). Moreover LBW survivors as a group are subject to a good many long-term problems such as morbidity and development disorders like higher incidence of cerebral palsy (e.g., 4). Cognitive and neuropsychological problems are also evident as reflected in the LBW group recording significantly lower IQ scores, conduct disorders, hyperactivity and attentional weaknesses, shyness, \unassertiveness and withdrawn behaviour syndrome, as also learning problems, poor academic performance etc.(e.g., 4). These apart, LBW children, the world over, have been found to experience higher incidence of asthma, repeated upper and lower respiratory

Correspondence e-mail: bratin.das@gmail.com

infection and ear infection and epilepsy, as also to develop malnutrition and weakened immunity (e.g.,9). In addition, LBW phenomenon has a compounding effect in that women who were LBW babies themselves, are more prone to give birth to LBW babies (e.g., 9).

In view of the above, the LBW phenomenon has emerged as a scientific problem of immense Interest in recent years, and a good many studies across the globe on identifications of correlates of LBW (e.g., 1, 2, 6, 8, 11, 12), prediction of LBW at an early stage of pregnancy etc. (e.g., 1, 3, 7, 10), have been reported, However, most of these studies are either not suitable under Indian conditions or require sophisticated instruments for assessment of maternal factors, often not suitable to be used by community health workers.

The objective of the present study is

1) To identify a set of correlates of LBW that can be assessed by even community level health workers with a little training for taking measurements on BMI, mid-arm circumference, head circumference, abdominal girth and fundal height.
2) Based on these correlates, to develop suitable tools for classifying pregnant women into two classes - prospective LBW mothers and NBW mothers, at the 28th week of pregnancy.
3) Finally validating the developed formula using different measures.

This exercise is carried out based on longitudinal data on 651 rural pregnant women for development of a prediction formula for birthweight, using Regression Analysis and Logistic Regression Analysis carried out in R language.

The motivation is: once a case turns out to be a prospective LBW, the mother is brought under intensive medical care so that she does not eventually give birth to an LBW baby. It may be mentioned here that the present study is a part of a bigger project aiming to develop screening tools to be applicable during 12th, 20th and 28th week of pregnancy based on sequentially available data, to facilitate progressive monitoring of the cases.

2. Data:

The data in the study are those collected from two reputed NGOs – Child in Need Institute in South 24 Parganas and Nivedita Community Care Centre in Hooghly, West Bengal. Longitudinal data have been collected from pregnant women through home visits during 12th week, 20th week and 28th week of pregnancy and immediately after child-birth. Mothers who came to respective health centres for antenatal care during a specific period have been chosen as potential candidates for this study. Data for 651 cases complete in all respects have been used.

Correspondence e-mail: bratin.das@gmail.com

3. Identification of significant correlates:

3.1 Based on the findings in the previous studies, we started with the probable correlates of LBW phenomenon among maternal factors listed below:

Physical Measurement: Height, Weight, Body Mass Index, (BMI) (BM1= (Weight in Kg)/ (Height in metre) ^{2}), mid arm circumference, head circumference, abdominal girth, fundal height (at 20th week & 28th week of pregnancy)

Information on current pregnancy: Age at pregnancy, Order of gravida (parity), Age at marriage.

Socio – economic factors and Habits: Religion, No of members in the family, No of adult women (aged >-18) in the family, Educational level (Illiterate, Primary education, High school & above), Economic level (from selected surrogates (e.g. absence of own latrine, own tube well, radio/television, bicycle/scooter/moped, pucca house etc.) Occupation, Food Habits (how many times Protein, Carbohydrate, Vitamins etc. consumed on weekly basis), Tobacco consumption habit, Habit of taking rest after lunch for two hours.

Current Illness: Presence of anaemia, infection, blurring vision, BP (Systolic and Diastolic), asthma, nagging headache, convulsion.

Delivery Reports: Birth weight(s): single, twin or triplet: delivery at home or institutional: sex of the baby (babies).

3.2 Analysis

651 data points are available. Of these a randomly selected 500 data points are considered as training data and the remaining 151 are considered as test data. We will build the model with the help of training data and validate it with test data.

Running regression using software R with y as child birth-weight and others as x_1, x_2, x_3 etc ., the following factors have come as significant:-

x_1 = parity = Parity or order of gravida.

x_2= mage = Mother's age.

x_3 = occup = occupation of mother.

x_4= f11 = Number of times protein taken in a week during 12 weeks of pregnancy.

x_5 =fand1 = Fundal height at 20th weeks of pregnancy

x_6 = ecostat = Economic status of mother based on a few surrogates

Correspondence e-mail: bratin.das@gmail.com

The prediction formula comes out as below:

Y = 1.9425 +.1333 * x_1 ***+ .0169**** x_2 ***- .0857 **** x_3***+* +0.0315**** x_4
-0.0464* x_5***+.0252**** x_6

Here Adjusted R^2 = .2152 which shows that the fit is not satisfactory.

We test the followings:

1. **Test for auto correlation**

   Test for auto correlation by using Durbin Watson test. The value of Durbin Watson has come as 1.98828 which is very close to 2. That means there is no Auto correlation.

2. **Test for Multicollinearity:**
   Existence of multi-collinearity I will use "Variance Inflation Factor" (VIF) where VIF= 1(/1- (R_I, Square)) , where R_I, Square = coefficient of determination of Regression equation in step one, with Xi on the left hand side, and all other predictor variable. (All the other variable than x in the Right hand side).
   VIF of **5 or more** indicates there is multicollinearity.
   I have obtained VIFs are as follows:

Predictor	**VIF**
parity	1.094
mage	1.105
Occup	1.1
f11	1.048
fand1	1.018
ecostat	1.096

As all the variables are less than < **5**, we conclude that there is no multicollinearity.

Correspondence e-mail: bratin.das@gmail.com

3. Test for Heteroscedasticity:

To test the existence of homoscedasticity I have used Breusch-Pagan Test.

The p -value of BP Statistics has come up as .0341. So that means there is no Heteroscedasticity.

4. Analysis of data using Logistic Regression

Now we run logistic regression using software R with y as child birth-weight, and others variables as x_1, x_2, x_3.. .

4.1 Analysis

The following factors have come as significant:-

x_1 = mage = Mother's age.

x_2 = occup = Mother's occupation.

x_3 = mwt2 = Mother's weight at 20^{th} week of pregnancy.

x_4 = belly1 = abdominal girth at20th weeks of pregnancy

x_5 = fand1 = Fundal height at 20^{th} week of pregnancy.

x_6 = rest = Rest taken by mother after lunch for two hours at 20^{th} week of pregnancy.

x_7 = mwt3 = Mother's weight at 28^{th} week of pregnancy.

x_8 = f13 = Number of times protein consumed by mother in a week at 28^{th} week of pregnancy.

The prediction formula will be given by:-

P (=indicator of childwt) = -7.6889 +.1526* x_1 ***-.7682**** x_2***-.2375**** x_3***+ .1434**** x_4 ***+.0957**** x_5 ***+.7513**** x_6 ***+ .1269**** x_7 ***-.2298**** x_8

For selection of optimal p value we consider the performance of the tool and proceed as follows.

4.2 Validation:

Correspondence e-mail: bratin.das@gmail.com

Once the tool is finalized, the following 2*2 table emerges by comparing actual outcomes with predicted outcomes.

Actual outcome	**Predicted Outcome**		**Total**
	LBW	**NBW**	
LBW	a	b	**a+b**
NBW	c	d	**c+d**
Total	**a+c**	**b+d**	**a+b+c+d =n**

Table 1:- Classification of cases according to actual and predicted outcomes

To identify the optimal P-value above which a case is to be classified as NBW, we note that

Sensitivity = Percentage of actual LBW cases screened as LBW

= 100*a/ (a+c).

Specificity = Percentage of actual NBW cases screened as NBW

= 100*d/ (b+d)

Percentage of misclassification = 100*(b+c)/n

We select that p-value for which the above measures are satisfactory.

We have considered several trial P values and note the consequences below

Cuttoff : P	**a**	**b**	**c**	**d**	**Sensitivity**	**Specificity**	**Missclassification**
0.5	7	33	7	104	17.50%	93.69%	26.49%
0.6	13	27	13	98	32.50%	88.29%	26.49%
0.7	15	25	29	82	37.50%	73.87%	35.76%
0.8	29	11	51	60	72.50%	54.05%	41.06%
0.82	30	10	55	56	75.00%	50.45%	43.05%
0.81	29	11	52	59	72.50%	53.15%	41.72%
0.83	30	10	60	51	75.00%	45.95%	46.36%
0.86	35	5	66	45	87.50%	40.54%	47.02%
0.88	36	4	70	41	90.00%	36.94%	49.01%
0.9	37	3	76	35	92.50%	31.53%	52.32%
0.92	37	3	85	26	92.50%	23.42%	58.28%

Table 2: Selection of optimal P value

From the above table the best combination of Sensitivity, Specificity and Misclassification percentage is given at the cut-off point P = .8 with Sensitivity = 72.5%, specificity = 54.05 % and misclassification = 41.06%.

Correspondence e-mail: bratin.das@gmail.com

Here ***area under curve*** = .7621
Thus ***Gini's Coefficient*** = (2*.7621) – 1 = .5242, so that it can be considered as a moderate fit based on the available data.

There is a considerable scope for improvement which we shall take up in subsequent studies.

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Correspondence e-mail: bratin.das@gmail.com

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Correspondence e-mail: bratin.das@gmail.com

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Correspondence e-mail: bratin.das@gmail.com