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Predicting factors of neonate birth weight

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ABSTRACT

One of the most important health indices in different societies is the birth weight of neonates which is affected by several factors. It is essential to be aware of these factors for further care of both mother and her fetus during pregnancy. The association between birth weight of neonates and some influential factors on them were examined in this study. In this cross sectional research, 245 neonates of Shoushtar County were studied in 2013. The data were collected from medical files and by interviewing with mothers. The neonate and mother characteristics, pregnancy and delivery statues were determined. Data were analyzed by SPSS 16 software, Chi square and T tests, analysis of variance, ROC curve and multiple regression. Mean (±SD) of the examined babies' weight was 3258(±436) grams. Gestational age(P<0.001), gender(P=0.04), rank of birth(P=0.012) and period between two pregnancies(P=0.028) had a significant relationship with birth weight. Regression model also included gestational age, rank of birth, type of delivery and gender(R^2=0.242). and gestational age variable had a higher sensitivity(0.85) and specificity(0.91) by ROC curve. In this study, gestational age, rank of birth, period between two pregnancies and gender had a meaningful relation with birth weight and regression model could illustrate and anticipate 24% of changes in dependent variables. Prevention of preterm delivery and preparing of exclusive cares for mothers with low duration between two pregnancies and in primiparous can increase probability of infants born with normal weight.

Keywords: Birth weight, Neonate, Related factors, Maternity.

INTRODUCTION

Children are the future of the country and tomorrow's capitals of human societies. Protection of physical and mental health of children is one of the best ways to invest in economic and social development of nations. Therefore, children's health is essential to be the topmost priority in each country. Birth weight is one of the main criteria in growth and one of main determining components of survival, physical and neurological development of children and is a valid indicator of fetal growth, health and maturity [1,5]. Babies who are overweight or below normal weight are at risk of death and physical and neurological diseases [3,4,6]. Reports indicate that the number of babies with low birth weight in Iran from 1955 and in the world from 2000 has increased 22% and 3%, respectively [7]. Lack of attention to the health of newborns increases the chance of developing diseases that in addition to psychological problems, imposes high costs on their families, who are often vulnerable population[1]. Studies show that increased perinatal morbidity and mortality, such as stillbirth, birth asphyxia, meconium aspiration, hypoglycemia and hypothermia in newborns and the prevalence of abnormal neurological development such as mental retardation,

learning disabilities, vision problems and movement problems, have significant associations with birth weight [4, 7, 8]. It has been hypothesized that mortality and morbidity in adulthood and the risk of diseases such as hypertension, atherosclerosis, diabetes type 2 and even cancers link with fetal and infant health and birth weight [9]. World Health Organization reports every year children's physical and mental development based on weight, height, head circumference and other variables and especially emphasizes on children's weight [10]. Reduction of infant mortality and disability depends on the prevention of abnormal birth weight, prenatal diagnosis and early treatment of the weight factors. In addition, in developing countries where modern equipment for evaluation before delivery is not available, searching for an easier way to assess pregnant women, including measurements that are easily accessible, is very important [6]. Many maternal factors such as age, job, number of pregnancies, interval between pregnancies, length of gestation, race, economic status, body mass index and intentional pregnancy can affect the outcome of pregnancy[11,12] . It is worth noting that many studies have been done in this area but because of the importance and the vital role of baby's birth weight, more research is still needed in this field. Also with regard to previous articles we see that the birth weight is various in different societies and since no studies on this issue have been done in the county of Shoushtar, we decided to examine birth weight and some of maternal risk factors and predictors of birth weight in the county of Shoushtar in 2013.

MATERIALS AND METHODS

In this cross-sectional study (descriptive - analytical), born-alive infants were studied in the county of Shoushtar in 2013. From a total of 1800 recorded birth in 2013, with 95% confidence and 0.5 precision, sample size of 245 was calculated. Samples were selected by convenience sampling from three health and treatment centers in the county. Required data were extracted from available files. Collected data consisted of two parts: the first part was about the characteristics of the neonates (such as birth weight, gestational age, gender, rank of birth, last pregnancy time, and type of delivery) and the second part was about the characteristics of mothers of the neonates (including age, occupation, education, former abortion, number of pregnancy, number of children, body mass index (BMI) in the first three months, hemoglobin (HB) in the last three months, and fasting blood sugar (FBS) in the last three months). Exclusion criteria were incompleteness of records and multiple pregnancy. The weight of all infants in the first day of life had been recorded using baby scale. Collected data were analyzed using SPSS 16 software. To describe underlying variables, descriptive statistics methods were used including calculation of central measures, dispersion measures, and frequency distribution tables. Then, data were analyzed using statistical methods including correlation test, chi-square test, t-test and one way analysis of variance. The regression models and ROC curve were used to predict birth weight. In order to evaluate interaction effect of independent variables on the dependent variable, stepwise method in multiple regression was used. In this method, the independent variables were entered into the regression equation in order to their importance in explaining the dependent variable, and variables that had played no role in explaining the dependent variable were taken out of the equation.

RESULTS

The average weight of 245 studied infants was (3258 ± 436) grams. About 48 percent of infants were females and their average weight was less than the average weight of males. Go with the higher maternal age, the average birth weight was more. When gestational age was lower, the average birth weight was also lower. The distribution of frequency, average and standard deviation weight depending on other variables is expressed separately (Table 1).

Statistically, a significant direct relationship was found between maternal weight and birth weight ($P = 0.03$, $r = 0.139$). Birth weight and the number of pregnancy had a statistically significant relationship ($P = 0.03$, $r = 0.136$). Between gestational age and infants birth weight was a statistically significant direct relationship, so that, with less gestational age, birth weight decreased ($P < 0.001$, $r = 0.423$). Between birth weight and birth rank was a statistically significant direct relationship ($P = 0.013$, $r = 0.158$) (Table 2).

Table 1. Frequency distribution, mean and standard deviation of birth weight according to other variables

Variables	Mean ± SD		Freq. (%)
Mother age (year)	<18	3075±276	8(3.3)
	18-25	3239±364	78(31.8)
	26-35	3270±473	137(55.9)
	>35	3311±480	22(9.0)
Mother education	Low	3283±403	92(37.6)
	Diploma	3259±505	86(35.1)
	High	3220±385	67(27.3)
Mother Job	No	3255±439	216(88.2)
	Yes	3275±419	29(11.8)
Former abortion	No	3248±422	208(84.9)
	Yes	3313±511	37(15.1)
Gestational age (week)	<37	2572±502	11(4.5)
	37	2954±346	33(13.5)
	38	3345±386	117(47.8)
	39	3286±367	61(24.9)
	≥ 40	3502±433	23(9.4)
Body mass index	Thin	2950±341	4(1.6)
	Normal	3241±398	101(41.2)
	Over weight	3277±457	88(35.9)
	Obese	3281±476	52(21.2)
Anemia	Yes	3246±436	197(80.4)
	No	3306±437	48(19.6)
Blood sugar	Yes	3406±526	8(3.3)
	No	3252±433	237(96.7)
Parity	Nulliparous	3206±377	96(39.2)
	Multigravida	3290±468	149(60.8)
Delivery type	NVD	3259±435	88(35.9)
	C/S	3257±438	157(64.08)
Neonate gender	Girl	3200±421	117(47.7)
	Boy	3310±444	128(52.2)
Duration from before pregnancy	First Preg.	3206±372	99(40.4)
	>3 year	3195±417	56(22.8)
	≤3year	3353±496	90(36.7)
Child rank	1	3206±377	96(39.2)
	2	3233±443	112(45.7)
	3	3498±495	31 (12.2)
	≥4	3314±569	6(2.2)

Table 2. Comparison of birth weight mean according to other variables

Variables		Statistics	P- value
Mother age (year)		R=0.124	0.053
Mother education	Low Diploma High	F=0.41	0.664
Mother Weight(kg)		R=0.139	0.03*
Abortion number		R=0.026	0.68
Pregnancy number		R=0.136	0.03*
Gestational age (week)		R=0.423	<0.001*
Blood sugar		R=0.084	0.18
Anemia		R=0.050	0.43
Parity	Nulliparous Multigravida	T =-1.47	0.14
Delivery type	NVD C/S	T=-0.046	0.96
Neonate gender	Girl Boy	T= -1.98	0.048*
distance of the previous pregnancy		R=0.099	0.123
Ranking the birth of child		R=0.158	0.013*

In this research, simultaneous effect of independent variables on the dependent variable was also examined. The independent variables were entered into the regression equation in order to their importance in explaining the dependent variable (Table 3). Since Model 4 has the highest coefficient of determination, it is selected as the final model. As you see, these four variables (gestational age (GA), parity (BR), mode of delivery (DM), gender (NG)) altogether could explain and predict about 24 percent of the dependent variable (i.e., birth weight). Multiple regression equation with an error probability of 0.05 is as follows.

$$y = \beta_0 + \beta_1 x_1 + \beta_2 x_2 + \beta_3 x_3 + \beta_4 x_4 + e \quad (1)$$

BW = 0.474×GA + 0.203×BR + 0.167×DM – 0.119×NG (2)

Table 3. The results of regression analysis for the prediction of birth weight with the all independent variables

model	variables	(b)	SE(β)	(β)	T-test	P-value	R	R^2
1	constant	-2383.06	156.86		-3.476	0.001	0.42	0.18
	Gestational age	163.50	22.47	0.423	7.28	0.000		
2	constant	-3185.59	844.85		-3.77	0.000	0.46	0.21
	Child rank Gestational age	164.26	22.06	0.425	7.45	0.000		
		100.75	31.64	0.182	3.18	0.002		
3	constant	-4066.66	890.44		-4.57	0.000	0.49	0.24
	Gestational age	184.31	22.90	0.477	-8.048	0.000		
	Child rank	111.524	31.435	0.201	3.55	0.000		
	Delivery type	151.69	54.11	0.167	2.80	0.005		
4	constant	-3976.89	884.99		-4.49	0.000	0.50	0.25
	Gestational age	183.22	22.74	0.474	8.06	0.000		
	Child rank	112.48	31.21	0.203	3.60	0.000		
	Neonate gender Delivery type	151.12	53.72	0.167	2.81	0.005		
		-103.73	48.72	-0.119	-2.13	0.034		

To investigate further, regression method was also calculated only for the independent variables which had a significant relationship with birth weight (Table 4). In this regression method, only independent variables which related to dependent variable (gestational age, infant birth rank, infant gender, and interval with previous pregnancy) were entered into the model using stepwise method. Among these 4 variables, three variables (gestational age, parity, and infant gender) altogether could explain and predict about 22 percent of the dependent variable changes. Multiple regression equation with an error probability of 0.05 is as follows.

$$Y = \beta_0 + \beta_1 x_1 + \beta_2 x_2 + \beta_3 x_3 + e \quad (3)$$

BW = 0.425×GA + 0.171×BR – 0.117×NG (4)

Table 4. The results of regression analysis for the prediction of birth weight with the meaningful independent variables

model	variables	(b)	SE(β)	(β)	T-test	P-value	R	R^2
1	constant	-2983.06	858.16		-3.48	0.001	0.42	0.18
	Gestational age	163.50	22.47	0.423	7.28	0.000		
2	constant	-3229.91	848.56		-3.81	0.000	0.46	0.21
	Child rank Gestational age	165.41	22.12	0.428	7.48	0.000		
		97.37	32.62	0.171	2.99	0.003		
3	constant	-3142.81	844.06		-3.72	0.000	0.47	0.22
	Gestational age	164.40	21.98	0.425	7.48	0.000		
	Child rank	97.21	32.41	0.171	3.00	0.003		
	Neonate gender	-101.63	49.55	-0.117	-2.05	0.041		

To determine the sensitivity and specificity of some of the variables in the diagnosis of neonatal weight ROC curve was plotted. For determine of low birth weight the variables; gestational age, spacing pregnancies, hemoglobin and maternal age has a high area of ROC curve. To detect macrosomia in newborns, the variables; maternal age, parity, spacing pregnancies, Child rank and maternal weight has high area under ROC curve. Variable gestational age for diagnosis of low birth weight has 85.5 and 90.9%, the sensitivity and specificity, respectively, which were higher than other variables (Table 5 and Figure 1, and 2).

Table 5. The area under the ROC curve, sensitivity and specificity of variables for determine low birth weight and macrosomia cut off point

Weight Cut point	Variables	ROC Area	Std. Error	P-value	Cut off value	Sensitivity	Specificity
LBW	Gestational age	0.888	0.066	0.000	37.50	0.855	0.909
	Distance pregnancy	0.755	0.060	0.044	0.5	0.818	0.585
	Hemoglobin	0.751	0.077	0.052	10.75	0.675	0.364
	Mother age	0.698	0.065	0.061	27.50	0.818	0.513
MBW	Mother age	0.821	0.053	0.001	31.50	0.727	0.252
	N0 pregnancy	0.779	0.070	0.002	2.50	0.727	0.209
	Distance pregnancy	0.788	0.069	0.016	1.50	0.727	0.350
	Child rank	0.843	0.073	0.002	1.50	0.636	0.128
	Mother weight	0.802	0.068	0.005	71.75	0.818	0.252

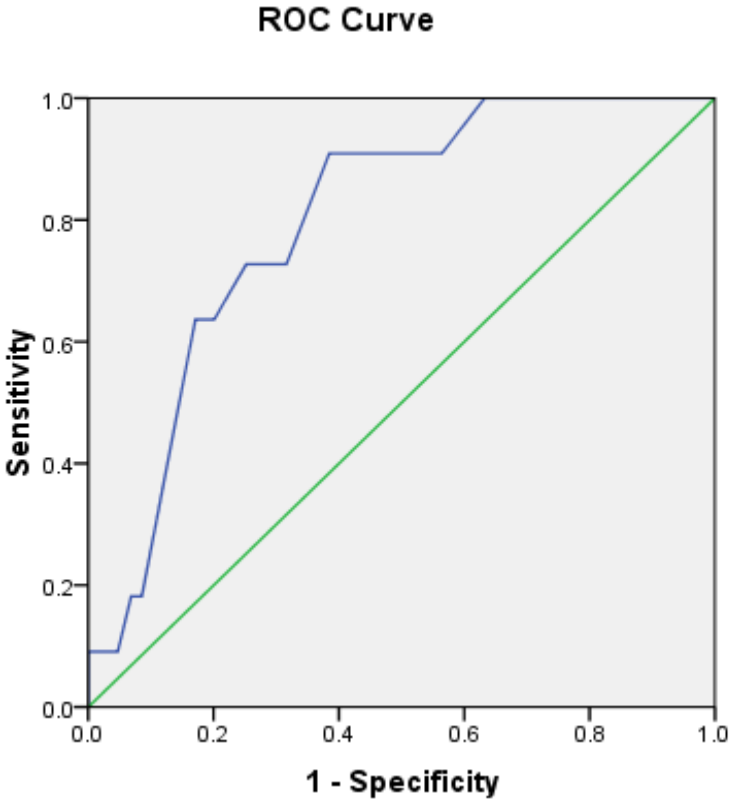

Figure 1. ROC curve for mothers age and macrosomia birth weight

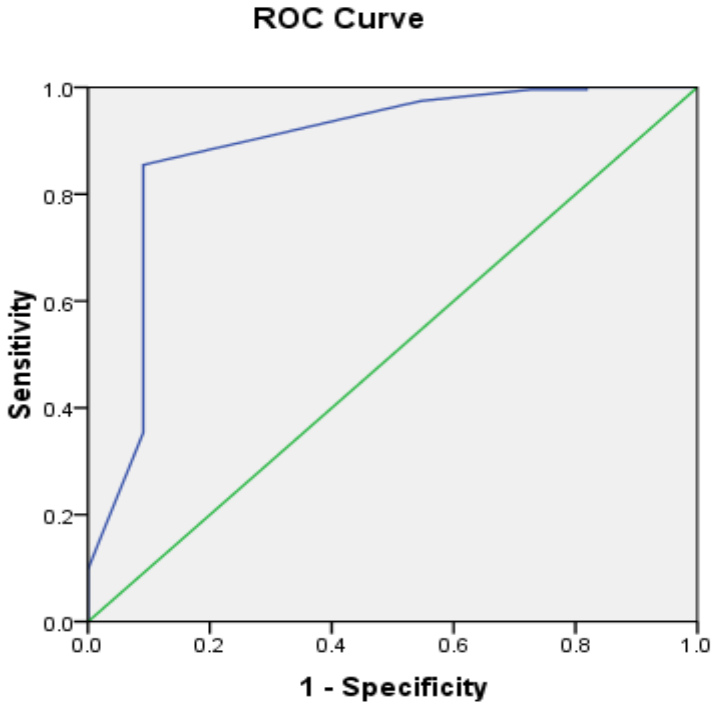

Figure 2. ROC curve for end pregnancy and Low Birth Weight

DISCUSSION

Based on the research findings, among the studied factors, gestational age, gender, birth rank, and interval with previous pregnancy variables had significant statistical relationship with birth weight. Of all variables, gestational age variable had a higher sensitivity and specificity by ROC curve. Like other previous studies, boys' birth weight was more than girls [13-16]. Boys' birth weight was 1.03 times more than girls and baby's gender was significantly associated with birth weight. In this study, despite the fact that no statistically significant relationship was found

between the birth weight mean and mother age, but with increasing maternal age, birth weight mean increased. Due to the low number of mothers under 18 years in this study, evaluation of the relationship between the mean of infant birth weight and maternal age in this group of women was not possible [18-20]. In this study, the gestational age and birth weight had a relatively strong statistical relationship. Mothers with less gestational age were more likely to have babies with less birth weight, so that with each week addition to gestational age, the risk of low birth weight infants decreases that previous researches also confirm this issue [17,18]. Other factor associated with newborns birth weight was birth rank of infant which a look in the results shows that birth weight of the first babies of family is less than other babies and it shows that infants birth weight increases in higher births, so that, weight mean in the third child has the highest amount and this growth in fourth child will be low again. Perhaps it is largely due to higher experience of mother in pregnancies and better preparation of the uterus environment for growing infants with higher weight and some studies have also confirmed this[18,21-23]. Second, unlike other studies, there was no statistical relationship between parity and infant's birth weight, but the average birth weight of newborns in nulliparous women was less than the average weight of newborns in multigravida and this has been confirmed in other studies [16,22-25]. Perhaps one of the reasons for this is insufficient experience of women at first pregnancy that effects on birth weight. Infants' birth weight in mothers with a college education were less than other mothers. Researcher believes that busy working mothers with a college education or perhaps being a student are deprived of sufficient rest that it causes low birth weight infants in this group. But in general, no significant relationship was found between maternal education and infant birth weight. This finding is consistent with findings from other studies [20, 26]. Like Toosi and Sam studies, no significant relationship was found between employment status of mother and birth weight [20, 26]. The low number of working mothers in the above study might affect the mentioned result. While Biernacka and colleagues reported that infants of working women have less weight[5]. This difference is likely due to the different conditions in the workplace for women in this study. In the present study, like Parichehr Tootoonchi study and Sareer Badshah study , infants' weight of mothers who had abortions was more than mothers without abortion[18,24]. It is thought that the fear of miscarriage in mothers who have had abortions, causing them to relax and be more alert during pregnancy. But, in general, there was no statistically significant relationship between infants' birth weight and mothers' abortion history. Unlike previous studies, there was no significant relationship between maternal body mass index in the first three months of pregnancy and infant birth weight [26,27]. There is a direct relationship between the weight gain of mother during pregnancy and infant birth weight [3, 4], which was not mentioned in our study. In other studies as well as the present study, the average birth weight of infants of mothers who had iron deficiency anemia was less than others, but this relationship was not statistically significant as our study [26, 28-30].

In this research, mothers who had gestational diabetes during pregnancy had infants with higher birth weight compared to mothers without this problem. But, no statistical relationship was found between infant birth weight and presence of pregnancy blood sugar in mother. Perhaps the main reason for the lack of relationship between these two is the small number of mothers with gestational diabetes. There was no relationship between mode of delivery and infant birth weight. But, high frequency percentage of cesarean section (64.08 percent) compared to vaginal delivery (35.91 percent) was arguable, that the possible causes of this high percentage are the growing number of elective cesarean sections without any medical need in addition to emergency deliveries by cesarean section. It is worth noting that the type of delivery was entered in the regression model. In this study, like other studies, the relationship between birth weight and interval from previous pregnancy was significant [20, 21]. It is obvious that after each pregnancy, body takes some time to be able to restore the lost energy reserves, and if mother gets pregnant with a short interval from previous one, it impacts on fetal growth and the risk of low birth weight infant increases. Unintended pregnancies have also inverse relationship with infant weight[31], that, in our study, was not considered due to lack of proper response. Looking carefully at regression model, we found that in the presence of other examined factors in the regression model, four variables (gestational age, birth rank, type of delivery, gender) altogether could predict and explain 24 percent of the dependent variable changes and the remaining 76 percent are determined by other factors affecting birth weight that were outside the control of the researcher. It is suggested to do other studies in this area by examining other factors related to infant birth weight such as maternal nutritional status, family economic status, pregnant mother activity and rest, mother social relations during pregnancy, diseases, and etc., to detect the relationship between these factors and infant size at birth with more confidence and precision and it can be used to identify pregnant mothers at risk for low birth weight or macrosomia, and to take necessary measures for preventing it. The limitation of this study was lack of full access to other information that effect on infants' birth weight, since data collection was through reviewing of files.

CONCLUSION

In this study, gestational age, infant rank, interval from previous pregnancy, and gender variables had a statistically significant relationship with infants' birth weight and in the presence of other factors in the regression model, four variables (gestational age, birth rank, type of delivery, gender) altogether could predict and explain 24 percent of the

dependent variable changes. Legislation to prevent preterm delivery, particularly in cesarean deliveries, and the identification of nulliparous women and mothers who are pregnant with a short interval from their previous delivery and providing education and more care of these mothers increases the possibility of having infants with normal size.

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