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Assessment of Risk Factors for Low Birth weight of Infants in Zanjan Province Using Quantile Regression Analysis

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Abstract

Background: Low birth weight is one of the key indicators to assess the health of infants, and appropriate birth weight is one of the most important goals of any health system which also reflects the quality of prenatal care.

Objectives: The present research aimed to study some of the factors associated with low birth weight using quantile regression analysis.

Methods: A cross-sectional study was carried out on 621 infants born weighing less than 2500 grams in the period 2012-2013. The data were collected from the medical records of infants in health care centers of Zanjan Province which were selected based on multi-stage cluster sampling. The obtained data were statistically analyzed using quantile and multiple regression analysis in SAS-9.2.

***Results*:** In this study, 320 infants (51.5%) were female, and the mean age of mothers and the mean weight of infants were 27.1±5.8 years and 2236±299 grams, respectively. The results showed that low birth weight is significantly related to age, educational attainment, and the number of children. In addition, there was a significant relationship between infant weight and maternal age only in the tenth percentile (P=0.007), while such a relationship was not found in the higher percentiles (50 and 90) (P=0.0, 953.585).

Conclusion: Some of the demographics of mothers such as educational attainment and gestational age were influential in the low birth weight of infants. Maternal age and birth weight were not statistically significant in all areas.

Key words: Risk factors, Low birth weight, Quantile regression analysis

Introduction

One of the most important indicators of the health of any society is the infant mortality rate which is influenced by several factors [1]. Low birth weight (LBW) is one of the main causes of death in infants and newborns. According to the World Health Organization's definition, LBW is to have a weight of less than 2500 grams at birth regardless of gestational age [2]. One of the goals of the World Health Organization in developing countries is that more than 90% of infants have a weight of above 2500 grams. Realization of this objective requires training mothers in the health and nutrition during pregnancy and prevention of frequent childbirth. By identifying and controlling risk factors, mainly associated with social and biological conditions, the birth of LBW infants can be prevented and thereby the mortality rate of infants can be reduced [3]. The factors affecting fetal growth and intrauterine weight may also influence the subsequent health outcomes in adulthood [4]. Pregnancy at an early age or at close intervals, infant gender, and the age, height, and educational attainment of the mother are the most important factors associated with LBW [5]. Previous studies have shown that there is a significant relationship between child mortality in the first years of life and LBW [6] and LBW infants who survive may suffer from short-term and long-term disabilities more than twice as other children [7].

There are different reports about low birth weight in Iran, as it determined to be 1.19% in Hamden, 5.9% in Isfahan, and 4.6% in Ardebil [4,5,8]. The rate of LBW has been reported to be about 4% in developed countries and 16.4% in developing countries [3]. A study conducted in Sweden indicated that the rate of mortality and birth of LBW infants is significantly higher among women with a lower educational attainment [9].

Despite being the most popular regression analysis, data analysis using simple linear regression sometimes presents poor performance. When the error distribution is abnormal, especially in asymmetric distributions with long tails, and the variance is heterogeneous, simple linear estimators are sensitive to remote data which may lead to biased estimates. Quantile regression analysis that can overcome the above-mentioned limitations.

Quantile regression analysis was introduced by Koenker et al and Bassett in 1978. This model is based on the asymmetric minimization of the weighted absolute value of residuals and aims to estimate a wide range of quantile functions [10]. Several studies have been conducted on the development of children with LBW. However, the selection of an appropriate statistical method for data analysis is of special importance in determining the risk factors. Using quantile regression analysis, the relationship between two variables can be evaluated more precisely. On the other hand, quantile regression has been less used in previous studies for the analysis of such data.

Given the role of nursing in the health of a society and the preventive care approach to neonatal health, the present research aims to study the factors associated with low birth weight in Zanjan Province using quantile regression analysis.

Methods

The required data for this cross-sectional study were collected from the medical records of infants covered by health care centers in the cities and villages of Zanjan Province. These medical records were selected using multi-stage cluster sampling method, accordingly, each city was considered a cluster and then some of the health care centers from each cluster were randomly selected. Medical records of infants born in the period 2011-2013 were reviewed. The weight of infant had been measured by a midwife or other relevant persons using a digital scale. The medical records of infants whose mothers were afflicted with underlying medical conditions such as chronic hypertension, diabetes mellitus, and renal, cardiac, pulmonary, hepatic, and blood diseases were excluded from the study. Finally, out of the 8456 medical records, a total of 621 ones related to infants weighing less than 2500 grams at birth were selected to be reviewed. In this study, a weight of below 2500 grams at birth was the dependent variables and place of residence, educational attainment, job, age, number of children, being under special care, weight gain during pregnancy, the mother's body mass index, intrauterine age, and infant gender were the independent variables. To observe the research ethics, the necessary permits were obtained from Research Department of Zanjan University of Medical Sciences, personal information was kept confidential, and data were analyzed as a whole.

Due to the asymmetric distribution of data related to the birth weight of infants (Figure 1). Quantile regression model was used to analyze the data. This model is based on the asymmetric minimization of the weighted absolute value of residuals and aims to estimate a wide range of quantile functions.

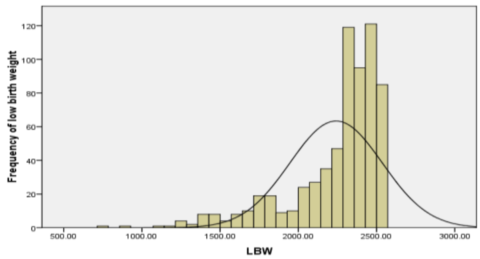

Figure 1: The frequency of infants weighing less than 2500 grams

The Pth quantile (0<p<1) of Variable Y, which is shown as $Ø_P(y/x_i)$, is equal to $Ø_P(y/x_i)= \alpha+\beta x_i+F^{-1}(P)$. Here, F () denotes standard normal distribution or any other symmetric distribution around the origin. Assuming that $Ø_P(\varepsilon_i/x_i)=0$, then the function of the Pth quantile of Variable Y distribution will be equal to $Ø_P(y_i/x'_i)= x'_I \beta_P$, i= 1, 2, …, n. To estimate the parameters of quantile regression model, the least absolute deviation (LAD) was used. In this method, the regression parameter of the Pth quantile was obtained as follows:

$$\hat{\beta}_P = Min\Big(\sum_{i\varepsilon\{i:y_i\geq x_i'\beta\}} p\left|y_i - x_i'\beta\right| + \sum_{i\varepsilon\{i:y_i< x'\beta\}}(1-p)\left|y_i - x_i'\beta\right|\Big)$$

This method purposively estimates conditional quantile functions and, unlike linear regression (minimization of the sum of squares of residuals), is based on the asymmetric minimization of the weighted absolute value of residuals [10]. The obtained data were statistically analyzed using quantile and multiple regression analysis in SAS-9.2.

Results

Out of the 621 LBW infants, 320 of them (51.5%) were female. In terms of educational attainment, 43 (7%) of mothers were illiterate and 205 (33%), 129 (20.8%), 135 (21.7%), and 109 (17.6%) of them had an elementary, guidance school, high school, and academic degree, respectively. Seventy-five mothers (10.1%) were employed and 546 (87.9%) of them were housewife. In addition, 331 (53.3%) of mothers were living in rural areas and 290 (46.7%) of them were urbanites (Table 1).

Table 1: Frequency distribution of weight (less than 2500 grams) of studied infants with different factors

Characteristics	Category	N(%)	Mean(gram)	SD*
Mother's education	Illiterate	43(9.9)	2179.5	327.0
	Primary school	205(33.0)	2277.5	273.3
	Secondary school	129(8.2)	2218.4	300.1
	Diploma	135(21.7)	2211.0	317.2
	Academic	109(17.6)	2233.2	305.9
Residency place	Urban	331(53.3)	2234.1	309.8
	Rural	290(46.7)	2238.7	286.8
Mother's job	Homemaker	546(87.9)	2241.0	297.7
	Employee	75(12.1)	2201.2	308.5
Neonate's gender	Boy	301(48.5)	2205.3	330.7
	Girl	320(51.5)	2265.3	263.1
Maternal special care	yes	326(62.5)	2257.6	260.8
	No	295(47.5)	2212.6	335.2
Weight gain in pregnancy	normal	516(83.1)	2264.4	299.1
	Un normal	105(16.9)	2230.5	272.7

***Standard Deviation**

The mean and standard deviation of age, number of children, and BMI of mothers and intrauterine age of infants were 27.1±5.8 years, 1.86±0.96 persons, 24.5±3.4, 37.7±2.41 weeks, respectively. The mean weight of infants with a weight of less than 2500 grams was 2236±299 grams. By using multiple regression model and assuming that independent variables are constant, a significant relationship was found between infant weight at birth and intrauterine age by week (P=0.001), as the infant weight increases by 79.5 grams with a one-week increase in intrauterine age. On the other hand, assuming that other independent variables are constant, there was a significant relationship between LBW of infants and educational attainments of mothers, as the weight of infants whose mothers had an academic degree was higher than those with an illiterate mother by 111.1 grams (P=0.021). Therefore, the odds of LBW reduces with the increase in educational attainment of mothers. In addition, a significant relationship was observed between LBW and maternal age (P=0.004) and the number of children (P=0.003). The results of quantile regression analysis have been presented in Table 2. Assuming that other independent variables are constant, linear regression model showed that maternal age was significantly related to the infant weight in all parts of the dependent variable. However, based on quantile regression analysis, there was a significant relationship between infant weight and maternal age only in the tenth percentile (P=0.007), while such a relationship was not found in the higher percentiles (50 and 90) (P=0.0, 953.585). A similar interpretation can be offered for other independent variables of the model (Table 2).

Table 2: Quantile and multiple regression coefficients for the relationship between the between the birth weight and independent variables

Quantiles		10			50			90			Multiple Linear regression		
Characteristics	Category	B*	SE**	P value	B*	SE**	P value	B*	E**	P value	B*	SE**	P value
Residency Place	Rural	2.8	40.1	0.94	18.0	21.2	0.40	-11.7	5.7	0.042	19.2	19.8	0.23
	Urban						reference						
Neonates gender	Girl	17.7	36.6	0.628	18.7	19.4	0.337	10.9	5.2	0.038	18.0	34.1	0.059
	Boy						reference						
Mother's Education	Illiterate	-309.7	97.8	0.002	-52.4	51.8	0.311	5.6	13.9	0.675	-111.1	48.0	0.021
	Primary school	-163.9	76.7	0.033	8.1	40.6	0.841	16.6	10.9	0.129	-72.1	37.8	0.057
	Secondary school	-203.7	76.0	0.011	-2.5	42.3	0.952	0.6	11.4	0.957	-90.5	39.3	0.022
	Diploma	-210.0	75.3	0.006	-19.2	39.9	0.943	-3.4	10.7	0.749	-98.5	37.1	0.008
	Academic						reference						
Mother's job	Homemaker	-66.6	80.0	0.405	9.4	42.4	0.825	-13.4	11.4	0.241	-59.0	39.5	0.135
	Employee						reference						
Maternal special care	Yes	-17.2	37.2	0.645	-4.0	19.7	0.839	3.8	5.3	0.479	-5.7	18.3	0.758
	No						reference						
Weight gain in pregnancy	Un normal	-5.7	49.2	0.907	-19.2	26.0	0.461	8.1	7.0	0.246	1.3	24.3	0.956
	Normal						reference						
Mother's age		-12.8	4.6	0.007	-1.3	2.4	0.585	0.04	0.649	0.953	-6.5	2.3	0.004
Parity		85.6	26.4	0.001	9.8	14.0	0.482	3.0	3.8	0.431	26.7	9.1	0.003
Gestational Age		95.6	7.8	0.001	71.9	4.1	0.001	16.9	1.1	0.001	79.5	3.8	0.001
Mother's BMI		-4.8	5.9	0.416	2.1	3.1	0.502	-1.8	0.84	0.037	0.13	2.9	0.946

***Estimate of the model parameter**
**** Standard error**

Discussion

In the present research, some of the factors associated with low birth weight were studied using quantile regression analysis. Based on the results, the mean weight of infants was 2236±299. This figure was reported to be 1925±513, 2120±370, and 2100±40 by Hamta et al (2013), Davoudi (2012), and Sutan et al (2014), respectively [11-13]. These differences may be due to the study design, statistical analysis, and sample size, on the one hand, or influenced by genetic-racial factors, quality of prenatal care, nutrition, and the difference in weight standards for children in different countries.

The study findings indicated that there is a significant relationship between the infant weight at birth and intrauterine age. Several studies have also shown that LBW and intrauterine age are significantly related to each other [14-16]. The results of this study suggested that there is a significant relationship between maternal age and LBW, which has been corroborated by some other studies [12-15]. However, some studies have reported conflicting results in this regard [17]. In addition, there was a significant relationship between LBW and educational attainment of mothers only in lower percentiles. In other words, this relationship was confirmed among the infants with lower weight (in the bottom 10%). Previous studies have reported conflicting results in this regard. While some studies have focused on the relationship between LBW and maternal educational attainment [16-20], other studies have not confirmed this association [15,17,21]. Furthermore, it seems that maternal educational attainment, especially academic education, can be effective in raising their health care information compared to illiterate mothers and those with lower educational attainment. As a result, recognizing the importance of health care in the health of children, they will feel more responsible for their health issues during pregnancy. In the present study, a significant relationship was observed between the number of children and LBW. This is consistent with the findings of Davoudi et al [12] but inconsistent with the results of Hamta et al [11].

In the upper percentiles (in the top 10% of infant weight), there was a significant difference between the mother's place of residence (rural or urban) and LBW. In other words, by controlling other variables in the model, the infant weight at birth in rural areas was lower than in urban areas by 117 grams. Eghbalian also confirmed the relationship between LBW and mother's place of residence, although he had not used quantile regression model [4]. However, Halileh et al. (2008) reported no significant relationship between mother's place of residence and LBW [17]. Although this difference was not so much, it may be due to more regular follow-up of urban mothers, enjoyment of more facilities during pregnancy, and access to specialists compared to mothers in rural areas. Although no significant relationship was found between LBW and maternal LBW in the present study, it was statistically significant in the upper percentile based on the results of quantile regression model. The findings of Pakniat et al. (2012) the infant birth weight increases with the increase in maternal BMI at the beginning of pregnancy [21]. In studies conducted by Eghbalian (2007) and Mirzarahimi et al. (2009), it was found that there is a significant relationship between LBW and maternal weight [4,22]. In another study, such a relationship has been reported [5].

The present study indicated that some of the demographic characteristics of mothers such as place of residence, educational attainment, age, and intrauterine age dramatically affect the birth weight. Although these differences may be due to sanitary issues and enjoyment of facilities, they could be statistically attributed to data analysis, sampling method, and sample size. However, statistical analyses showed that the results of linear regression and quantile regression were different. As a result, if the dependent variable (response) is asymmetric, it is necessary to use quantile regression method for data analysis.

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