RISK FACTORS ASSOCIATED WITH LOW BIRTH WEIGHT

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SUMMARY

Objectives: Low birth weight (LBW) is one of the major factors affecting child morbidity and mortality worldwide. Every day, approximately 800 women die from causes related to pregnancy and childbirth worldwide. Maternal ill health increases the risk of LBW. This study seeks to investigate determinants and incidence of LBW.

Methods: This study was conducted based on the medical records of mothers and their 1,946 infants born in 2016–2019 at the Department of Gynaecology and Obstetrics of Louis Pasteur University Hospital in Košice. Data on mothers and newborn infants were obtained from the Reports on mothers at childbirth. The inclusion criteria were singleton births and birth weight > 500 g. The exclusion criteria were twins or multiple births, congenital anomalies and stillbirths, birth weight ≥ 4,000 g or ≤ 500 g, and Roma ethnicity. Roma children are more likely to be born prematurely, with low birth weight. Roma mothers have different lifestyle. Univariate analysis was employed to evaluate the association between the independent variables and LBW. Variables that were found to be statistically significant were then further analysed using multivariable logistic analysis for each dependent variable. The implementation of the research was approved by the Ethics Committee.

Results: Of 1,946 newborns, 271 (13.90%) have low birth weight. The mean of birth weight at delivery was 3,068.62 (SD 671.16) grams. Factors that were associated with LBW were primary maternal education (OR = 2.98, 95% CI: 1.08–8.21, p = 0.034), marital status single (OR = 2.88, 95% CI: 1.68–4.94, p < 0.001), number of prenatal care visits less than 8 (OR = 1.62, 95% CI: 1.01–2.61, p = 0.047), and preterm birth (OR = 74.94, 95% CI: 45.44–123.61, p < 0.001).

Conclusion: The reducing of LBW requires strategies to improve maternal lifestyle, maternal care before, during and after birth and to strengthen social support.

Key words: low birth weight, risk factors, newborn

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INTRODUCTION

Optimal foetal development is widely recognized as an important factor of infant's survival and subsequent social development. Low birth weight (LBW) is a major determinant of mortality, morbidity and disability in neonatal, infancy and childhood and has a long-term impact on health outcomes in adult life. Low birth weight results in substantial costs to the health sector and imposes a significant burden on the society as a whole (1–8).

The birth weight of an infant is the first weight recorded after birth, ideally measured within the first hours after birth, before significant postnatal weight loss occurs (9, 10). Low birth weight has been defined by the World Health Organization (WHO) as weight at birth of less than 2,500 grams (up to and including 2,499 g), irrespective of the gestation age (10–16). Low birth weight is further categorized into very low birth weight (<1,500 g) and extremely low birth weight (<1,000 g) (15, 17).

The high incidence of low birth weight occurs mostly in low and middle income countries representing more than 20 million of all births per year (3, 9, 13). There are marked global and regional variations in LBW rates. An estimated 6% of infants are born LBW in East Asia and the Pacific, 13% in Sub-Saharan Africa, and up to 28% in South Asia (9, 10). It is a global concern, as some developed countries such as Spain, Great Britain, Northern Ireland, and the United States of America also face high rates of LBW in their contexts (4, 18).

LBW is considered the single most important predictor of infant death within the first month of delivery and together with preterm births, they are indicators of potential lifelong consequences to individuals, families and communities at large. Birth weight is a good indicator of the reproductive and general health status of a population. It is not only about the baby's health and nutritional status but also the physical and psychosocial growth and development of babies and their chances of survival (3).

Infants weighing less than 2,500 g are approximately 20 times more likely to die than heavier babies (9). Babies born with LBW have been shown to have diminished cognitive development, and evidence now suggests that LBW babies are at an increased risk of chronic diseases later in life, including high blood pressure, non-insulin dependent diabetes mellitus, coronary heart disease, and stroke. Moreover, the WHO reports LBW as a serious disease that has become an important risk factor for increased disease burden worldwide (4, 8, 16, 17, 19, 20).

Low birth weight is a valuable public health indicator of maternal health, nutrition, healthcare delivery, and poverty. LBW is related not only to basic maternal characteristics during pre-pregnancy, but also to potential risk factors during pregnancy, including maternal age, educational attainment, lifestyle, health status, and diseases, of which maternal age, educational attainment, and marital status are more closely associated with LBW (12, 21).

Previous studies have shown that smoking (22) or exposure to second hand smoke (23), drinking (24), physical activity (25), and variations in energy intake may lead to higher rates of LBW. However, some studies examining the relationship between lifestyle factors and LBW have shown conflicting results (2, 3, 17, 26).

Despite the increasing incidence of low birth weight, there is a lack of knowledge regarding the prevalent maternal risk factors for LBW, which is necessary prerequisite for development of prevention strategies by the national health system and awareness initiatives among the public and health professionals. We aimed to assess the relation of demographic and maternal socioeconomic and lifestyle characteristics with the risk of low birth weight among pregnant women.

MATERIALS AND METHODS

Setting and Subjects

This study was conducted based on the medical records of 1,946 infants and their mothers. The inclusion criteria were singleton births and birth weight > 500 g. The exclusion criteria were as follows: twins or multiple births, congenital anomalies and stillbirths, birth weight ≥ 4,000 g or ≤ 500 g, and Roma ethnicity. Roma children are more likely to be born prematurely, with low birth weight. Roma mothers have different lifestyle. Finally, 1,946 women met these criteria, and their records were included in the study. The data in this study were obtained from January 2016 to December 2019. The collection of data took place in the context of the daily work of the Department and the academic and research activity of the Faculty of Medicine of Pavol Jozef Šafárik University and the Department of Gynaecology and Obstetrics of the Louis Pasteur University Hospital in Košice. This hospital is the East Slovakian centre for low birth weight and premature birth and this is the reason why there is also a higher concentration of mothers at risk.

Measurements

Basic medical records on mothers and basic data on newborns were collected from the medical record documentation. The data were obtained from the Reports on mothers at childbirth. From the records regarding mothers, we were primarily interested in the age, education, marital status, visits to antenatal care, but also risk behaviour such as smoking, alcohol and drug use. The age of mothers at the time of delivery was calculated on the basis of the date of birth indicated in the Reports on mothers at childbirth and delivery date. When observing the use of tobacco, in our file we considered for a smoker a woman smoking at least one cigarette a day during the pregnancy. For alcohol consumer we considered every woman who consumed 15 g of alcohol a day. This corresponds to 0.5 litres of 12-degree beer or 0.3 l of wine or 0.5 dl of hard spirits. Most of the mothers visited the antenatal care eight times, so we divided the set into two groups – the mothers who visited the doctor less than eight times and the group of mothers who visited the doctor eight times and more. Preterm birth was defined as less than 37 weeks of completed gestation, and low birth weight was defined as less than 2,500 g. The implementation of the research was approved by the Ethics Committee.

Statistical Analysis

The data were analysed using Statistical Product and Service Solutions (IBM SPSS Statistics for Windows, Version 23.0. IBM Corp., Armonk, NY, USA). In the first step, quantitative and qualitative data were analysed using t-test and Chi-square, respectively. The outcome variable for this study is birth weight, which is binary recorded as 1 "birth weight < 2.5 kg" and 0 "birth weight ≥ 2.5 kg". The birth weight at delivery was analysed as the dependent variable. From the available data, ten exposure variables were selected based on potential to influence birth weight. These exposure variables include infant's gender, maternal age, marital status, maternal education, and alcohol, tobacco and drug consumption during pregnancy. Others include the time of the mother's first visit to a gynaecologist, the number of visits to the gynaecologist and gestational age. Univariate analysis was employed to evaluate the association between the independent variables and low birth weight. Bivariate analysis was carried out by calculating the ORs and their 95% confidence interval (CI) for each of the independent variables. Then, to control for potential confounders, a multivariate logistic regression was performed. Variables that were found to be statistically significant (p-value < 0.05) in the bivariate analysis were further analysed using multivariable logistic analysis for each dependent variable.

RESULTS

A total of 271 birth records of babies with low birth weight and 1,675 birth records of babies with normal birth weight were reviewed in this study. The mean weight of the newborns was 3,068 (SD 671.16) grams. Among these low-birthweight newborns, there were 212 preterm and 59 term newborns. The mean gestational age was 38.3 weeks (SD 2.87).

The age of mothers ranged from 15–45 years with mean (SD) of 30.26 (5.02) years. Overall, majority of the mothers were in the age group of 19–34 years (78.1%). The proportion of mothers aged ≤ 18 years was relatively small: 27 (1.4%).

Table 1 shows socio-demographic factors that, after the univariate logistic regression model analysis, showed an association with the risk for LBW. Among the influential socio-demographic variables, there was an increased risk of LBW at maternal ages less than or equal to18 years (OR = 4.61, 95% CI: 2.11–10.09, p < 0.001).

The status of mothers who were single (OR = 2.85, 95% CI: 2.09–3.87, p < 0.001) or separated/divorced/widowed (OR = 2.79, 95% CI: 1.24–6.32, p = 0.014) was associated with an increased risk of LBW (Table 1).

Maternal academic background appears to be another factor associated with LBW (Table 1), specifically, mothers who only had primary education had a higher risk of LBW (OR = 4.11, 95% CI: 2.48–6.80, p < 0.001) compared with women with high school (reference group).

Babies born to mothers who had history of smoking during pregnancy were about five times more likely to have low birth weight as compared to babies born to mothers who did not have such history (OR = 5.05, 95% CI: 3.15–8.07, p < 0.001). Alcohol and drug consumption during pregnancy was low and results regarding alcohol and drug use are statistically not significant (Table 1).

Various prenatal factors indicated an increased risk of low birth weight (Table 2), such as time of the first visit to a gynaecologist during pregnancy (OR = 1.64, 95% CI: 1.14–2.34, p = 0.007) and number of prenatal counselling visits (OR = 3.57, 95% CI: 2.73–4.67, p < 0.001). Among 16.5% of women who had a low-birthweight newborn, the pregnancy was diagnosed by gynaecologist only after the first trimester. Regarding mothers from normal-birthweight newborn group, 10.8% of women (p < 0.001) visited the doctor during their pregnancy for the first time only after the first trimester (Table 2). Figure 1 shows the relationship between birth weight and the onset of prenatal care. The onset of prenatal care had significant association with birth weight (p < 0.001). Up to 63.2% of women who had a low-birthweight newborn visited the doctor during pregnancy less than 8 times, while only 32.5% of women who had a normal-birthweight new-

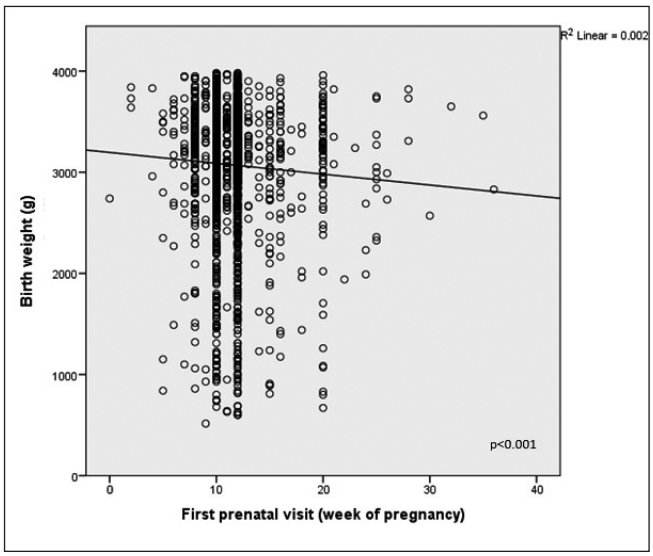

Fig. 1. *Scatter plot displaying statistically significant association between birth weight and the onset of prenatal care (p < 0.001).*

Table 1. *Univariate analysis showing association of low birth weight with socio-demographic characteristics (N = 1,946)*

Variables	LBW n (%)	NBW n (%)	OR (95% CI)	p-value
Maternal age group				
≤ 18	11 (4.1)	16 (1.0)	4.61 (2.11–10.09)	**< 0.001**
19–34	197 (72.7)	1,322 (78.9)	1.0 (ref.)	
> 34	63 (23.2)	337 (20.1)	1.26 (0.92–1.71)	0.149
Marital status				
Single	89 (42.2)	284 (21.1)	2.85 (2.09–3.87)	**< 0.001**
Married	114 (54.0)	1,035 (77.0)	1.0 (ref.)	
Divorced/widowed	8 (3.8)	26 (1.9)	2.79 (1.24–6.32)	**0.014**
Education				
Primary	31 (15.4)	43 (3.4)	4.11 (2.48–6.80)	**< 0.001**
High school	110 (54.7)	627 (48.9)	1.0 (ref.)	
University	60 (29.9)	613 (47.8)	0.56 (0.40–0.78)	**< 0.001**
Smoking during pregnancy				
No	210 (86.4)	1,477 (97.0)	1.0 (ref.)	
Yes	33 (13.6)	46 (3.0)	5.05 (3.15–8.07)	**< 0.001**
Alcohol consumption during pregnancy				
No	242 (99.6)	1,524 (99.9)	1.0 (ref.)	
Yes	1 (0.4)	2 (0.1)	3.14 (0.28–34.79)	0.351
Drug consumption during pregnancy				
No	241 (99.2)	1,521 (99.9)	1.0 (ref.)	
Yes	2 (0.8)	2 (0.1)	6.31 (0.89–45.02)	0.066

LBW – low birth weight; NBW – normal birth weight; OR – odds ratio; CI – confidence interval
Numbers in bold indicate statistically significant values.

Table 2. *Univariate analysis showing association of low birth weight with prenatal characteristics (N = 1,946)*

Variables	LBW n (%)	NBW n (%)	OR (95% CI)	p-value
First visit of a gynaecologist				
1st trimester	222 (83.5)	1,486 (89.2)	1.0 (ref.)	
Later	44 (16.5)	180 (10.8)	1.64 (1.14–2.34)	**0.007**
Visits to prenatal counselling				
≥ 8	98 (36.8)	1,126 (67.5)	1.0 (ref.)	
< 8	168 (63.2)	541 (32.5)	3.57 (2.73–4.67)	**< 0.001**
Newborn gender				
Male	127 (46.9)	860 (51.3)	1.0 (ref.)	
Female	144 (53.1)	815 (48.7)	1.20 (0.93–1.55)	0.172
Preterm birth				
No	59 (21.8)	1,597 (95.3)	1.0 (ref.)	
Yes	212 (78.2)	78 (4.7)	73.57 (50.96–106.22)	**< 0.001**

LBW – low birth weight; NBW – normal birth weight; OR – odds ratio; CI – confidence interval
Numbers in bold indicate statistically significant values.

born visited the antenatal care less than 8 times ($p < 0.001$) (Table 2). More prenatal visits during prematurity could theoretically avert low birth weight. Figure 2 presents the relationship between birth weight and the number of prenatal counselling visits. The number of prenatal counselling visits had significant association with birth weight ($p < 0.001$).

Mothers who had a low-birthweight newborn were more likely (OR = 73.57, 95% CI: 50.96–106.22, $p < 0.001$) to have a preterm birth (78.2% vs. 21.8 %). The variable such as sex of the newborn had no significant association with low birth weight.

The results of multivariate analysis for low birth weight are summarized in Table 3. Multivariate analysis was undertaken and all variables that had a significant relationship with low birth weight in the univariate analysis were entered into the model. In multivariate logistic regression analysis, factors that were associated with low birth weight were primary maternal education (OR = 2.98, 95% CI: 1.08–8.21, $p = 0.034$), marital status single (OR = 2.88, 95% CI: 1.68–4.94, $p < 0.001$), number of prenatal care visits less than 8 (OR = 1.62, 95% CI: 1.01–2.61, $p = 0.047$), and preterm birth. Babies who were born preterm (premature babies) were almost 75 times more likely to have low birth weight as compared to those born at their full term (OR = 74.94, 95% CI: 45.44–123.61, $p < 0.001$) (Table 3).

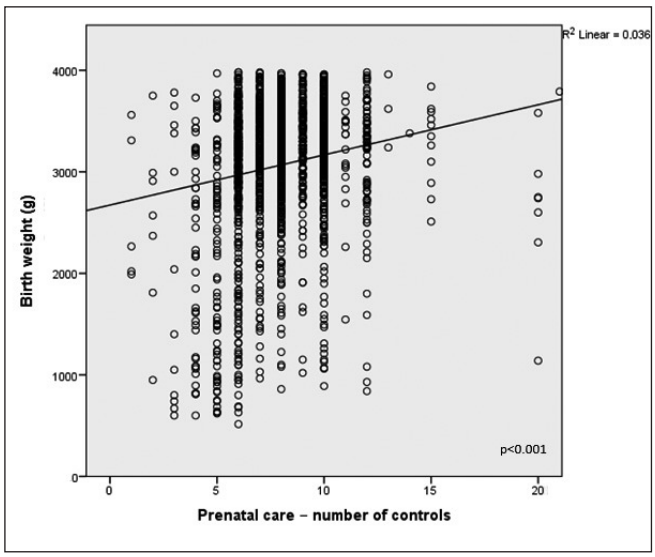

Fig. 2. *Scatter plot displaying statistically significant association between birth weight and number of prenatal counselling visits ($p < 0.001$).*

DISCUSSION

This study investigated some maternal and pregnancy related factors associated with low birth weight. Maternal age less than or equal to 18 years and older than 34 appears to be associated with LBW in accordance with other studies. Many studies (3, 5, 17, 27) have found that younger and older mothers are at higher risk of low-birthweight infants. There was an increased risk of LBW at maternal ages less than or equal to 18 years (OR = 4.61, 95% CI: 2.11–10.09, $p < 0.001$). There are social disadvantages such as low socioeconomic status, low education, poor nutrition, and low body mass index responsible for these results in younger mothers; however, in the older mothers, biological factors such as chromosomal anomalies, preeclampsia and diabetes are responsible for the higher risk (17).

Mothers living without a partner are socially more vulnerable and such a marital status is a risk factor for gynaecological and neonatal health indicators (27). In our multivariate logistic regression analysis, single mothers had a positive relationship with low birth weight (OR = 2.88, 95% CI: 1.68–4.94, $p < 0.001$), but this association was not significant in the divorced/widowed group.

A higher level of maternal education may be associated with more healthy behaviours and better nutrition, which may lead to improvement in infant birth weight (12). Likewise, this was observed by some authors such as Hidalgo-Lopezosa et al. (5), Jafari et al. (27) or Tamura et al. (28), who concluded that a high level of parental education acts as a protective factor for newborns that were small for their gestational age. In multivariate logistic regression analysis, factor associated with low birth weight was

Table 3. *Multivariate logistic regression showing predictors of low birth weight*

Variables	OR	95% CI	p-value
Maternal age group			
≤ 18	2.00	0.51–7.80	0.318
19–34	1.0 (ref.)		
> 34	1.00	0.56–1.78	1.000
Marital status			
Single	2.88	1.68–4.94	**< 0.001**
Married	1.0 (ref.)		
Divorced/widowed	2.43	0.56–10.60	0.236
Education			
Primary	2.98	1.08–8.21	**0.034**
High school	1.0 (ref.)		
University	1.18	0.71–1.96	0.514
Smoking during pregnancy			
No	1.0 (ref.)		
Yes	2.20	0.74–6.47	0.154
First visit of a gynaecologist			
1st trimester	1.0 (ref.)		
Later	0.92	0.44–1.95	0.835
Visits to prenatal counselling			
≥ 8	1.0 (ref.)		
< 8	1.62	1.01–2.61	**0.047**
Preterm birth			
No	1.0 (ref.)		
Yes	74.94	45.44–123.61	**< 0.001**

OR – odds ratio; CI – confidence interval
Numbers in bold indicate statistically significant values.

primarily maternal education (OR = 2.98; 95% CI: 1.08–8.21; p = 0.034).

Many lifestyle factors have been associated with birth weight. While LBW in the developing world results mainly from the poor health and nutrition of the mother, cigarette smoking during pregnancy is one of the main causes of LBW in the developed world (2). In the European Longitudinal Study of the Pregnancy and Childhood (ELSPAC), which included 4,530 women from the Czech Republic, children of mothers who were moderately heavy/heavy smokers during pregnancy had an average of 245 g lower birth weight than non-smokers (29). Dejmek et al. (30) studied the impact of maternal exposure to environmental tobacco smoke on low birth weight in a sample of 6,866 singleton births. Maternal smoking during pregnancy increased the relative risk of LBW considerably. Crude odds ratios (ORs) were 2.81 (CI: 2.21–3.71) for moderate and 4.95 (CI: 4.95–8.06) for heavy active smoking mothers. In our study a statistically significant association between smoking during pregnancy and low birth weight persisted in the univariate analysis (OR = 5.05, 95% CI: 3.15–8.07, p < 0.001). Of all mothers included in our analyses, 79 (4.1%) reported that they had smoked during pregnancy. This is not comparable to the study by Johnson et al. (18) from the UK, they estimated that smoking in pregnancy was a factor in one in eight LBW births.

Only 4 (0.2%) mothers admitted use of drugs during pregnancy and 3 (0.2%) mothers admitted use of alcohol during pregnancy. Data on alcohol, tobacco and drugs appear to be strongly influenced by dissimulation and appear to be falsely lower than they actually are.

Prenatal care includes risk identification, prevention and management of pregnancy-related or concurrent disease, and health education and health promotion. Antenatal visits of the pregnant mothers are very important as they provide chances for monitoring the foetal wellbeing and allow timely intervention for foeto-maternal protection. The multivariate logistic regression from this study only showed that antenatal care had effect on LBW. In multivariate logistic regression analysis, factor associated with low birth weight was the number of prenatal care visits less than 8 (OR = 1.62, 95% CI: 1.01–2.61, p = 0.047).

Preterm birth was found to be a risk factor for low birth weight. It is clear that babies born prematurely before completing their term due to any gynaecological, medical or other causes are not completing their normal physical development in the womb and are at higher risk to have low weight at birth. In this regard, it could be important that any gynaecological, medical or other condition that could possibly cause premature delivery should be timely recognized and properly managed during pregnancy

(2, 27). In our study babies who were born preterm were almost 75 times more likely to have low birth weight as compared to those born at their full term (OR = 74.94, 95% CI: 45.44–123.61, $p < 0.001$). Jafari et al. reported risk of LBW babies in preterm birth as 40.45 time higher (27).

Limitations of the Study

Our cross-sectional study did not include all possible negative factors influencing pregnancy outcome. We did not follow the nutritional habits of pregnant females or possible effect of passive smoking as in other studies.

CONCLUSIONS

Since a large proportion of foetal mortality is associated with LBW and considering the fact that foetal development is a vulnerable process influenced by maternal risk factors, this study examined some maternal risk factors associated with LBW infants. The main objective of this study was then to determine the association between socio-demographic, maternal, medical and obstetric risk factors and low birth weight. In multivariate logistic regression analysis, factors that were associated with low birth weight were primarily maternal education, marital status single, number of prenatal care visits less than 8, and preterm birth.

Identification of factors, which carry risk of LBW, may help to attempt their correction and counselling when possible. This modification will help in decreasing perinatal mortality and morbidity. Furthermore, the good health and the favourable socioeconomic environment of the pregnant mother are also considered essential prerequisites for the mental and physical well-being of the infant. In addition, economic studies have demonstrated that reducing the burden of low birth weight would cause important cost savings both to the health system and to households. In conclusion, findings from this study may help hospitals develop proper, immediate and sustainable measures to improve maternal and child health.

The 2016 WHO recommendations for prenatal care recommend a minimum of eight antenatal visits for all women regardless of parity while an individual approach is essential. The current situation of the COVID 19 pandemic offers us an idea of further comparison of newborn indicators, mother care, including the number of visits at new prenatal counselling centres, before and during the pandemic.

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Conflict of Interests

None declared

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