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Predictors of Low Birth Weight Infants in the North West Province of Iran: a Case-control Study

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Abstract

Background: Ninety-five percent of low birth weight infants are born in developing countries. This study was aimed to assess the predictors of low birth in East Azerbaijan, North-west province of Iran.

Materials and Methods: The study was conducted through a hospital based case–control design involving 49 women delivering low birth weight infants and 98 delivering normal weight infants. The data analysis was using SPSS-13 software with bivariate and multivariate methods.

Results: There was a significant positive association between maternal chronological and marriage ages with low birth weight infants (P <0.05). Additionally, there was negative association between maternal weight prior to pregnancy and low birth weight (P <0.05). Interestingly, larger families of more than four members had higher probability for low birth weight infants in comparison to the families with less than four members (OR = 2.86, 95% CI: 1.09-7.47; P-value: 0.032). According to the multivariate logistic regression independent factors associated with low birth weight include higher maternal chronological age (OR = 1.88, 95% CI: 1.29 - 2.75; P-value: 0.001) and marriage age (OR = 4.97, 95% CI: 1.97 - 12.50; P-value: 0.001) and increase in maternal weight prior to pregnancy (OR = 0.60, 95% CI: 0.42 - 0.86; P-value: 0.006).

Conclusion: Major risk predictors of low birth weight in the Iranian female population were maternal age other than 25-30 at delivery, young maternal marriage age and lower maternal weight before pregnancy.

Key Words: Case-control study, Epidemiology, Low birth weight, Iran, Risk factors.

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1. INTRODUCTION

According to World Health Organization, low birth weight (LBW) is defined as weight of an infant less than 2,500 g at the time of birth (1). It is estimated that worldwide, annually 15.5% of infants are born with LBW and more than 95 percent of these are born in developing countries. About 72% of LBW infants are born in Asia and 8% in the Eastern Mediterranean region including Iran (2-4). Worldwide majority of LBW infants (70%) are preterm (< 37 weeks) and only 30% are full term (> 37 weeks)(5-7). Birth weight is one of the most important predictors of physical and mental development associated with patterns of illnesses and disabilities in the future (8-10). Moreover, mortality of LBW children is forty times higher than normal weight ones, and this remarkably affects the health indices of countries (9, 11, 12).

To an extent prevention, reduction in mortality rate and associated disabilities, care and maintenance costs of LBW children is attainable through identification of risk predictors. Recent literature stated that many factors are associated with LBW including demographics, prenatal conditions, pregnancy and behavioral factors. However most of the risk predictors are specific to that particular region or country, hence not transferable(1). Therefore, region specific epidemiological studies are essential to determine the local risk predictors involved. Also, to the best of our knowledge, only few studies have assessed the predictors of LBW infants in Iran. So, the aim of this study was to identify the most important predictors of LBW in East Azerbaijan, North West of Iran.

2. MATERIALS AND METHODS

The study was conducted through a hospital based case–control design, in a period of 3 months during 2014 across one private and two public hospitals affiliated with Tabriz University of Medical Sciences. Importantly, these public hospitals admitted patients including referrals from different areas of East Azerbaijan. All the subjects were selected according to the control selection principals for case–control studies (13-15). To ensure common source populations for cases and controls, subjects were selected accordingly. Due to differences in the socio-economic status between patients of public and private hospitals, case and control groups were individually matched on hospital type; so that two controls were selected per one case from the same hospital. . Moreover, cases and controls involved in the study were admitted on the same day.

2-1. **Case group**

In this study, the cases involved were 49 women who delivered LBW infants (<2.500g) in the period June to August 2014 in Tabriz hospitals.

2-2. Control group

The controls involved were 98 women who delivered infants with a normal birth weight (>2.500g). In this study the ratio of cases to controls was 1:2 and the following inclusion and exclusion criteria was considered for recruitment of subjects:

2-3. Inclusion criteria

- Women from East Azerbaijan who had their deliveries in the selected hospitals;
- Deliveries in the period of June to August 2014;
- Full term infants (37 weeks) only were enrolled;
- Willing to participate in the study.

2-4. Exclusion criteria

- Women not from East Azerbaijan;
- Preterm deliveries;
- Not willing to participate in the study;

- Women giving birth to twins or triplets or so on.

2-5. Variables assessed in this study

Variables assessed in this study, include factors relating to maternal, paternal, current pregnancy information, mother and infant anthropometry. All the information from case and control groups, were collected using a self-induced questionnaire consisting of 5 sections including: maternal, paternal, current pregnancy information, maternal and infant anthropometry. All the questionnaires were completed by the interviewer during the interview process. In order to ensure lower interviewer variability, interviews were conducted by one trained nutritionist. All of the interviews was conducted during the hospitalization when the patient became stable. All stages of analysis involve determination of suitable scales for variables and model building as outlined in Jewell in Statistics for Epidemiology(16).

2-6. Ethics

All protocols used in this study were approved by Ethics Committee of Tabriz University of Medical Sciences and the research was conducted in compliance with the Helsinki Declaration.

2-7. Statistical analysis and sample size

The variables used in this study were analyzed using both bivariate and multivariate methods. The sample size was calculated according to the study conducted in Iran by Eshraghian et al. in 2008 with help of statistical software package Stata (Release 13. College station, TX: Stata Corp LP.) (17). The maternal age was considered as main exposure variable between case and controls and sample size was calculated based on this variable. The mean and standard deviation (SD) for case and control groups were 54.9 (10.7) and 59.9 (9.7), respectively. Type I and type II errors were considered 0.05 and 0.2, respectively. Finally with considering the allocation ration 2 (controls to case) sample size was determined. This statistical software package was also used for analysis of data; and the significance was set with a P-value<0.05 (two tailed test). An independent samples t-test was used to compare the means of normally distributed numeric independent variables for both control and case groups. The Mann–Whitney U test was used as a non-parametric analog to the independent samples t-test when there was no normality assumption. In order to assess the association between two categorical variables, Chi-squared test was applied. Fisher's exact test was used when the expected count limit assumption was achieved. Crude odds ratios were calculated and their 95% confidence intervals were reported. Variables with associations with a P-value < 0.1 were adjusted in multivariate conditional logistic regression analysis. The adjusted odds ratios along with their 95% confidence intervals were kept in the final model.

3. RESULTS

The present study showed that mean of maternal age between the case and controls were 28.69±6.83 and 27.96±5.49, respectively. Also, marriage age between the cases and controls were 19.16±4.76 and 20.59±4.35, respectively. For further details comparing case and control groups refer to (**Table.1**). Bivariate analysis, showed that the probability of low birth weight infants increased remarkably among mothers aged ≤ 20 yrs and >35 yrs, but these associations was not statistically significant (P>0.05). Also, it was found that marriage age was significantly associated with the probability of low birth weight infants (P<0.05); so that the probability of low birth weight infants increased by 2.25 times in mothers with marriage age less than 20 years compared to mothers who have marriage age higher than 20 years. Body mass index (BMI) was also found to be significantly associated with low birth weight infants (P<0.05); such that the probability of it was decreased by 70 percent among overweight mothers compared to normal weight ones (OR= 0.30; 95% CI: 0.12 - 0.74; P-value: 0.014).

This study was also found that the probability of low birth weight infants was considerably decreased among mothers with weight of 70-80 kg (OR= 0.17; 95% CI: 0.04 - 0.68; P-value: 0.012) and 60-70 kg (OR= 0.24; 95% CI: 0.0.08 - 0.74; P-value: 0.013) compared to mothers with weight of 40-50 kilograms (**Table.2**).

One of the important findings of this study stated that with increasing the maternal age by five years, the probability of LBW increased by 88%, after adjusting maternal marriage age and maternal weight before pregnancy. In addition to this, maternal marriage age and weight before pregnancy showed independent significant associations with probability of low birth weight infants (P<0.05) (**Table.3**). All the measures or scales used for the assessed predictors are listed in (**appendix.1**).

Appendix 1: Measures of predictors of low birth weight.
Maternal age: (Five years age groups from 15 to 45 years old).
Maternal marriage age: (>20 years *vs.* ≤20 years).
Maternal education: University *vs.* High school; or High school *vs.* Secondary school.
Paternal education: University *vs.* High school; or High school *vs.* Secondary school.
Family dimension: ≤4 *vs.* >4 N.
Birth order: Last vs. Middle; or Middle *vs.* First.
History of abortion: (yes *vs.* no).
History of LBW: (yes *vs.* no).
History of preterm child: (yes *vs.* no).
Contraceptive use: (yes *vs.* no).
Maternal weight before pregnancy: Five groups from 40 to 90 kg.
Maternal height: 170-180 *vs.* 160-170; or 160-170 *vs.* 150-160; or 150-160 *vs.* 140-150 cm.
Weight gain: 20-25 *vs.* 15-20; or 15-20 *vs.* 10-15; or 10-15 *vs.* 5-10; or 5-10 *vs.* 0-5 kg weight gain.

Table 1: Demographic characteristics of cases (n = 49) and controls (n = 98).

Variables	Groups		
	Case	Control	Total, n (%)
Maternal education, N (%)			
Illiterate	0(0)	2 (2.04)	2 (1.36)
Primary school	14 (28.57)	22 (22.45)	36 (24.49)
Secondary school	17 (34.69)	22 (22.45)	39 (26.53)
High school graduate	14 (28.57)	34 (34.69)	48 (32.65)
University	4 (8.16)	18 (18.37)	22 (14.97)
Maternal job, N (%)			
Housewives	46 (93.88)	85 (86.73)	131 (89.12)
Employed	3 (6.12)	13 (13.27)	16 (10.88)
Family dimension, N (%)			
Equal or less than 4	38 (77.55)	89 (90.82)	127 (86.39)
More than 4	11 (22.45)	9 (9.18)	20 (13.61)
Paternal education, N (%)			
Illiterate	3 (6.12)	1 (1.02)	4 (2.72)
Primary school	8 (16.33)	25 (25.51)	33 (22.45)

Secondary school	15 (30.61)	27 (27.55)	42 (28.57)
High school graduate	14 (28.57)	29 (29.59)	43 (29.25)
University	9 (18.37)	16 (16.33)	25 (17.01)
Paternal job, N (%)			
Employee	7 (14.29)	17 (17.35)	24 (16.33)
Worker	14 (28.57)	21 (21.43)	35 (23.81)
Self employed	27 (55.10)	49 (50)	76 (51.70)
Other	1 (2.04)	11 (11.22)	12 (8.16)
Birth order, N (%)			
First Children	14 (29.79)	39 (39.80)	53 (36.55)
Middle Children	18 (38.30)	37 (37.76)	55 (37.93)
Last Children	15 (31.91)	22 (22.45)	37 (25.52)
Mean ± SD of maternal age	28.69 ± 6.83	27.96 ± 5.49	28.21 ± 5.96
Mean ± SD of maternal marriage age	19.16 ± 4.76	20.59 ± 4.35	20.11 ± 4.52

Table 2: Bivariate logistic regression model of predictors for low birth weight (case group, n= 49; control group, n = 98)

Variables	Chi- square value	P-value	Odds ratio (95% CI)
Overall associations			
Maternal age(year)			
15-20	13.30	0.019	Ref group
20-25			1.86 (0.55 - 6.32)
25-30			0.56 (0.17 - 1.88)
30-35			1.03 (0.32 - 3.35)
35-40			4.08 (0.86 - 19.37)
40-45			7.00 (0.59 - 81.63)
Maternal marriage age(year)			
>20	4.64	0.031	Ref group
≤20			2.25 (1.06 - 4.77)
BMI			
Underweight (<18.5)	8.89	0.030	0.91 (0.20 - 4.10)
Normal weight (18.5-24.9)			Ref group
Overweight (25-29.9)			0.30 (0.12 - 0.74)
Obesity (>30)			1.34 (0.47 - 3.90)
History of abortion	0.75	0.385	1.44 (0.62 - 3.29)
History of LBW	1.33	0.248	1.87 (0.63 - 5.51)
History of preterm child	0.21	0.732	1.36 (0.36 - 5.07)
Contraceptive use	0.12	0.726	1.14 (0.53 - 2.42)
Gestational interval (year)			
0-2	4.52	0.104	Ref group
2-4			0.34 (0.07 - 1.67)
>4			1.37 (0.44 - 4.24)
Maternal weight before pregnancy(kg)			
40-50	12.67	0.018	Ref group
50-60			0.64 (0.22-1.85)
60-70			0.24 (0.08 - 0.74)
70-80			0.17 (0.04 - 0.68)
80-90			0.90 (0.17 - 4.63)
90-100			0.90 (0.10 - 7.71)
Linear associations			
Maternal education	-	0.122	0.76 (0.55 - 1.07)*
Paternal education	-	0.915	1.01 (0.74 - 1.39)*
Family dimension	-	0.032	2.86 (1.09 - 7.47)*
Birth order	-	0.161	1.37 (0.87 - 2.15)*
Maternal height	-	0.043	0.58 (0.34 - 0.98)*
Weight gain in pregnancy	-	0.319	0.83 (0.58 - 1.18)*

[a] Fisher’s exact test, if the expected number was less than 5.
X^2 indicates *overall* association
* indicates *linear* association
- Based on the Likelihood Ratio Test, in some items, linear association was used rather than overall one.

Table 3: Multivariate logistic regression model of predictors for low birth weight (case group, n= 49; control group, n = 98)

Variables	Crude Odds ratio (95% CI)	P-value	Adjusted Odds ratio (95% CI)	P-value
Maternal age(year) 15-20 20-25 25-30 30-35 35-40 40-45	1.19(0.90 - 1.58)	0.206	1.88 (1.29 - 2.75)	0.001
Maternal marriage age (year) >20 ≤20	2.25 (1.06 - 4.77)	0.033	4.97 (1.97 - 12.50)	0.001
Maternal weight before pregnancy(kg) 40-50 50-60 60-70 70-80 80-90 90-100	0.78 (0.57 - 1.05)	0.106	0.60 (0.42 - 0.86)	0.006

- Based on the Goodness of Fit Test, independently significant variables were recruited as linear in the final multivariate model.

4. DISCUSSION

From this study, it was evident that family size, maternal chronological and marriage age and maternal weight prior to pregnancy were valuable predictors which showed significant association with LBW.According to present study, mothers aged 25-30 years old had significantly lower probability for LBW in comparison to mothers aged 15-20 years old. It can be concluded that age groups lower than 25 and higher than 35 years old, the probability for LBW infants increased considerably. This study confirms previous studies so that probability of LBW infants is higher among mothers aged 35 years and over (18) and 20 years and under(19).

It was also found that, maternal marriage age below 20 years had significantly higher probability of LBW infants. Interestingly, maternal age of marriage and maternal age of pregnancy are independently associated with LBW. It is evident that, maternal age of marriage below 20 years is susceptible to LBW infant’s pregnancy, despite their pregnancy occurring among the age groups with lower risks. Furthermore, maternal marriage age below 20 years is also associated with low incomes, inadequate prenatal care and lower antenatal maternal weight (20).

To the best of our knowledge, there is no evidence in the literature regarding the independent assessment of maternal age of pregnancy and marriage (19, 21). Interestingly it was found that, mothers weighing 60-70 and 70-80 kg had significant lower probability for LBW in comparison to mothers weighing 40-50kg. There was no significant difference in the probability of LBW between the mothers weighing below 50 kg and mothers weighing 50-60, 80-90, and 90-100 kg. Previous studies undertaken across different regions support our findings that underweight (<50 Kg), overweight (BMI> 25) and obese mothers (BMI>30) are more susceptible to deliver LBW neonates (19, 22-26). This study revealed that, larger families were likely to have a relative increase in the probability of LBW infants by 3 times per additional family member. These findings was confirmed by study conducted by Yadav et al. in 2011 (27).

Additionally, the present study found that maternal height was significantly associated with LBW, such that, with ten centimeter increase in the height, probability of LBW decreased by 42 %. This particular finding was supported by few past studies including Agarwal et al. (2011) (28) and opposed by Choudhary et al. (2013), Solanki et al. (2012) and Badshah et al. in 2008 (18, 29, 30).

Interestingly it was found that, with 5kg increase in weight during pregnancy, the probability of LBW decreased by 17%. However, this association was not statistically significant. On the contrary, other studies by Al-Hinai et al. (2013) and Munim et al. (2012) found a significant negative association between the gestational weight and LBW (22, 23).

From this study it was demonstrated that there is a negative association between maternal education and LBW infants which was non-significant. This was due to many factors such as sample size, subject selection and information bias all of which are responsible for significant associations. It is important to note that if a set of variables have no significant associations, it doesn’t necessarily means that there is no association between the two. However, further studies may be required to prove this (31). Interestingly few previous studies which were done by Choudhary et al. (2013) and Janjua et al. (2009) supported our findings where they found negative non-significant associations (18, 21). On the other hand some studies which were done by Bener et al. (2013), Yadav et al. (2011) and Badshah et al. (2008) found significant negative associations (25, 27, 30). These controversial results may be due to the use of different scales for the assessment of maternal educational level.

According to the present study, paternal illiteracy rate was higher in the case group in comparison to the control groups. However there was no significant association between paternal education level and LBW infants. This finding was confirmed by few previous studies have been done by Janjua et al.(2009) and Dandekar et al. (2014) (21, 32), but other studies opposed the outcomes as they found significant association between the two variables(30). The present study also found that, with one unit increment in the birth order, the probability of LBW infants increased by 37%, but this association was not significant, similar to the findings from previous studies have been done by Agarwal et al. (2011) and Narayanamurthy et al. (2013) (28, 33).

Furthermore, it was demonstrated that, gestational interval was one of the factors associated with LBW infants such that the probability of LBW decreases by 66 % in mothers with 2-4 years gestational interval in comparison to the mothers with 0-2 years gestational interval. Interestingly, the probability of LBW infants increases in mothers with gestational interval higher than 4 years in comparison to mothers with lower than 2 years. It is likely that this increment may not be independent, but simply due to higher gestational age. Hence, further studies will be required to confirm these findings. Conclusively, major risk predictors of LBW infants in the north-west province of Iran were: large families, mothers lower than 25 and higher than 35 years of age, adolescent marriages, stunted maternal height, underweight (< 60 kg) and overweight (>80 kg) mothers before pregnancy.

4-1. Limitation of study

All the case and control subjects involved in the study had similar socioeconomic status, thereby preventing from assessing this particular variable.

5- CONCLUSION

The present study showed that low birth weight infants predictors in an Iranian female population. It was concluded that maternal age other than 25-30 at delivery increased the probability of low birth weigh infants. Also, young marriage age was also considered as one of its risk factors. Finally, this study showed that with increasing maternal weight prior to pregnancy, the probability of low birth weight infants decreased.

6- AUTHORS' CONTRIBUTION

The study design: Nahid Karamzad, Mehrangiz Ebrahimi-Mameghani and Saeid Safiri; clinical recommendations: Mehrangiz Ebrahimi-Mameghani; writing the first draft: Nahid Karamzad, Saeid Safiri, Mahmood Moosazadeh and Abbas Abbasi-Ghahramanloo; management the data collection: Nahid Karamzad and Samira Amiri; analysis of the data: Saeid Safiri and Mostafa Qorbani; visiting and evaluating all patients: Nahid Karamzad and Samira Amiri; the project coordinator and responsible for data collection: Nahid Karamzad; revising of English version: Naeema Syedi.

7- FINANCIAL DISCLOSURE

There were no conflicts of interest among the authors of the study.

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11- REFERENCES

1. Kramer MS. Determinants of low birth weight: methodological assessment and meta-analysis. Bulletin of the World Health Organization. 1987;65(5):663.
2. Wardlaw TM. Low Birthweight: Country, regional and global estimates: UNICEF; 2004.
3. Vahdaninia M, Tavafian SS, Montazeri A. Correlates of low birth weight in term pregnancies: a retrospective study from Iran. BMC pregnancy and childbirth. 2008;8(1):12.
4. Khazaei S, Ayubi E, Nematollahi S, Khazaei S. Variations of Infant and Under-five Child Mortality Rates around the World, the Role of Human Development Index (HDI). International Journal of Pediatrics. 2016;4(5):1671-7.
5. Wadhwa PD, Sandman CA, Porto M, Dunkel-Schetter C, Garite TJ. The association between prenatal stress and infant birth weight and gestational age at birth: a prospective investigation. American journal of obstetrics and gynecology. 1993;169(4):858-65.
6. Carlo WA. The high-risk infant. Nelson textbook of pediatrics 19th ed Philadelphia, PA: Saunders. 2011;552.
7. Vakili R, Emami Moghadam Z, Khademi G, Vakili S, Saeidi M. Child Mortality at Different World Regions: A Comparison Review. International Journal of Pediatrics. 2015;3(4.2):809-16.
8. Alexander G, Wingate M, Mor J, Boulet S. Birth outcomes of Asian-Indian-Americans. International Journal of Gynecology & Obstetrics. 2007;97(3):215-20.
9. Kramer MS, Barros FC, Demissie K, Liu S, Kiely J, Joseph K. Does reducing infant mortality depend on preventing low birthweight? An analysis of temporal trends in the Americas. Paediatric and perinatal epidemiology. 2005;19(6):445-51.
10. Mansour E, Eissa A, Nofal L, Kharboush I, Reda A. Morbidity and mortality of low-birth-weight infants in Egypt. East Mediterr Health J. 2005;11(4):723-31.
11. Roudbari M, Yaghmaei M, Soheili M. Prevalence and risk factors of low-birth-weight infants in Zahedan, Islamic Republic of Iran. Eastern Mediterranean Health Journal. 2007;13(4):838-45.
12. Khodaee GH, Khademi G, Saeidi M. Under-five Mortality in the World (1900-

2015). International Journal of Pediatrics. 2015;3(6.1):1093-5.
13. Wacholder S, McLaughlin JK, Silverman DT, Mandel JS. Selection of controls in case-control studies. I. Principles. Am J Epidemiol. 1992 May 1;135(9):1019-28.
14. Wacholder S, Silverman DT, McLaughlin JK, Mandel JS. Selection of controls in case-control studies: III. Design options. American journal of epidemiology. 1992;135(9):1042-50.
15. Wacholder S, Silverman DT, McLaughlin JK, Mandel JS. Selection of controls in case-control studies: II. Types of controls. American journal of epidemiology. 1992;135(9):1029-41.
16. Jewell NP. Statistics for epidemiology: CRC Press; 2003.
17. Eshraghian M, ABOU AJ, GHAFARI Z, RAJAEI S. THE EFFECTS OF RISKFACTOR OF PREGNANCY PERIOD ON INFANT'S WEIGHT. 2008.
18. Choudhary A, Choudhary A, Tiwari S, Dwivedi R. Factors associated with low birth weight among newborns in an urban slum community in Bhopal. Indian journal of public health. 2013;57(1):20.
19. Kumar SG, Kumar HH, Jayaram S, Kotian M. Determinants of low birth weight: a case control study in a district hospital in Karnataka. The Indian Journal of Pediatrics. 2010;77(1):87-9.
20. Valero de Bernabé J, Soriano T, Albaladejo R, Juarranz M, Calle MaE, Martínez D, et al. Risk factors for low birth weight: a review. European Journal of Obstetrics & Gynecology and Reproductive Biology. 2004;116(1):3-15.
21. Janjua NZ, Delzell E, Larson RR, Meleth S, Kristensen S, Kabagambe E, et al. Determinants of low birth weight in urban Pakistan. Public health nutrition. 2009;12(06):789-98.
22. Al-Hinai M, Al-Muqbali M, Al-Moqbali A, Gowri V, Al-Maniri A. Effects of Pre-Pregnancy Body Mass Index and Gestational Weight Gain on Low Birth Weight in Omani Infants: A case-control study. Sultan Qaboos Univ Med J. 2013 Aug;13(3):386-91.
23. Munim S, Maheen H. Association of gestational weight gain and pre-pregnancy body mass index with adverse pregnancy outcome. J Coll Physicians Surg Pak. 2012;22:694-8.
24. Han Z, Mulla S, Beyene J, Liao G, McDonald SD. Maternal underweight and the risk of preterm birth and low birth weight: a systematic review and meta-analyses. Int J Epidemiol. 2011 Feb;40(1):65-101.
25. Bener A, Saleh NM, Salameh KM, Basha B, Joseph S, Al Buz R. Socio-demographic and consanguinity risk factors associated with low birthweight. J Pak Med Assoc. 2013 May;63(5):598-603.
26. McDonald SD, Han Z, Mulla S, Beyene J. Overweight and obesity in mothers and risk of preterm birth and low birth weight infants: systematic review and meta-analyses. BMJ. 2010;341:c3428.
27. Yadav D, Chaudhary U, Shrestha N. Risk Factors Associated with Low Birth Weight. Journal of Nepal Health Research Council. 2011;9(19):159-64.
28. Agarwal K, Agarwal A, Agrawal V, Agrawal P, Chaudhary V. Prevalence and determinants of" low birth weight" among institutional deliveries. Annals of Nigerian Medicine. 2011;5(2):48.
29. Solanki N, Kavishwar A, Chaudhari V, Chhasatiya N. The effect of maternal anthropometric characteristics and social factors on birth weight of child in small town hospital of Gandevi block of Navsari district. Int J Med Sci Public Health. 2012;1(2):32-7.
30. Badshah S, Mason L, McKelvie K, Payne R, Lisboa PJ. Risk factors for low birthweight in the public-hospitals at Peshawar, NWFP-Pakistan. BMC Public Health. 2008;8(1):197.
31. Rothman KJ, Greenland S, Lash TL. Modern epidemiology. Third ed: Lippincott Williams & Wilkins; 2008.
32. Dandekar RH, Shafee M, Sinha SP. Prevalence and risk factors affecting low birth weight in a district hospital at Perambalur, Tamilnadu. 2014;3(2):1-5.
33. Narayanamurthy M, Siddalingappa H, Kulkarni P, Ashok N. Prevalence and Determinants of Low Birth Weight in Rural Mysore. International Journal of Health Sciences and Research 2013;3(8):35-9.