Original article

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Contributing Factors for Low Birth Weight among Newborns in Maternity Hospital, Kathmandu

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ABSTRACT

Background: Low birth weight (LBW) is a major determinant of neonatal morbidity and mortality in developing countries. Its causes are multifactorial and not yet fully understood. Early identification and management of maternal and environmental risk factors can help to reduce the incidence and consequences of LBW. This study aimed to identify contributing factors of LBW among newborns delivered at a tertiary maternity hospital in Nepal.

Methods: A case-control study was conducted among postnatal mothers at Paropakar Maternity and Women's Hospital, Kathmandu. A total of 129 postnatal mothers (43 cases and 86 controls) were selected using a consecutive sampling for cases and simple random sampling for control. Data were collected through in-person interviews using a validated structured questionnaire and antenatal chart review. Data were analyzed using descriptive and inferential statistics, and a p-value <0.05 was considered statistically significant.

Results: The LBW was associated with short birth interval (<24 months) (*p* 0.044), severe nausea and vomiting (*p* 0.002), non-consumption of folic acid (*p* 0.027), non-consumption of calcium supplements (p 0.027), consumption of tobacco (*p* 0.006) and exposure to active or passive smoking (*p* 0.004). Preterm birth and inadequate daytime rest had strong association with LBW (*p values* <0.001).

Conclusion: Preterm birth and inadequate daytime rest are the strong contributors for LBW. These findings highlight the importance of timely and comprehensive prenatal monitoring to prevent preterm deliveries. Addressing these factors through targeted maternal health interventions might reduce the prevalence of low birth weight in Nepal.

Keywords: *Contributing factors, low birth weight, newborns, maternity hospital*

INTRODUCTION

Low birth weight (a birth weight of less than 2500 grams regardless of gestational age) affects over 20 million infants globally each year.[1] In Nepal, LBW prevalence has remained around 12% over the past five years.[3] Various cross-sectional studies in Nepal reported the prevalence of 15.5% to 23.1% and prematurity, maternal health, socioeconomic status, and maternal tobacco consumption as the common risk factors.[4-6]

LBW may result from prematurity, intrauterine growth restriction, or a combination of both.[1] LBW babies are vulnerable to perinatal asphyxia, respiratory distress, hypothermia, intracranial hemorrhage, and hypovolemia.[7] They are approximately 20 times more likely to die from complications compared to normal-weight infants,[1,8] with LBW contributing to nearly half of perinatal deaths and one-third of infant mortality.[9] Survivors are often vulnerable to malnutrition and infection. Early identification and management of maternal and fetal risk factors can substantially reduce LBW incidence and its long-term consequences, including hypertension, diabetes mellitus, and anemia.[10]

Compared with normal-weight infants, those with LBW or very low birth weight (VLBW) require inpatient care nearly four times more frequently, resulting in markedly higher healthcare costs during the first year of life.[11]

Reducing the incidence of LBW could therefore lessen its clinical and economic burden, benefiting both families and healthcare systems.[12] The importance of addressing LBW is further underscored by its association with human suffering, financial strain from specialized and intensive care, and links to socioeconomic underdevelopment.[9]

LBW infants not only face elevated risks of mortality but also long-term consequences such as stunted growth and chronic diseases. Global initiatives, including the World Health Assembly Nutrition Target to reduce LBW prevalence by 30% by 2025, and the Sustainable Development Goal (SDG) target to lower LBW rates to ≤14% by 2030,[3,13] highlight the urgency of this issue.

Addressing LBW requires comprehensive strategies encompassing maternal nutrition, improved antenatal care, and targeted education for mothers. Despite ongoing national efforts, Nepal continues to face challenges in achieving SDG targets, underscoring the need for continuous research and focused interventions to reduce LBW prevalence and improve neonatal outcomes. Understanding and addressing the multifactorial determinants of LBW are essential to developing evidence-based programs aimed at lowering newborn mortality in Nepal. Therefore, this study was conducted to identify the determinants of LBW among newborns delivered in a maternity hospital.

METHODS

A hospital based matched case control study was conducted among postnatal mothers, who delivered at Paropakar Maternity and Women's Hospital Thapathali, Kathmandu. This hospital is the only tertiary-level public maternity hospital in the country. Singleton live-born babies with birth weight <2500 grams were taken as case and birth weight ≥2500 grams were taken as control irrespective of gestational age, gravida, and delivery mode. Previous study conducted by Sutan et al., (2014) also included all weeks of gestational mothers in sample. Babies with weight >4000 gm, critically ill babies were excluded in this study. Furthermore, mothers who were critically ill were also excluded from the study.

Sample size was calculated taking power at 80%, confidence level as 95%, a ratio of control to case as 2:1, prevalence of gestational weight gain during second trimester among case (p1) = 74% and among control (p2) = 48% from the previous study. [14] The sample size was calculated by using formula $n = (z_{\alpha/2} + Z_{\beta})^2 \, p_1 (1-p_1) \, p_2 (1-p_2) / (p_1 - p_2)^2$. Total 32 cases were calculated and adding 10% nonresponse rate required sample size for cases was 36 and for control 72. Total 129 (43 cases and 86 control) samples were recruited for the study.[15]

All the available postnatal mothers eligible and willing to participate were recruited until fulfilment of the cases (consecutive sampling). For each case identified, potential controls were identified from women who delivered a live singleton newborn within 24 hours of the delivery in the hospital. If multiple eligible controls were available, two controls were selected randomly from the potential controls.

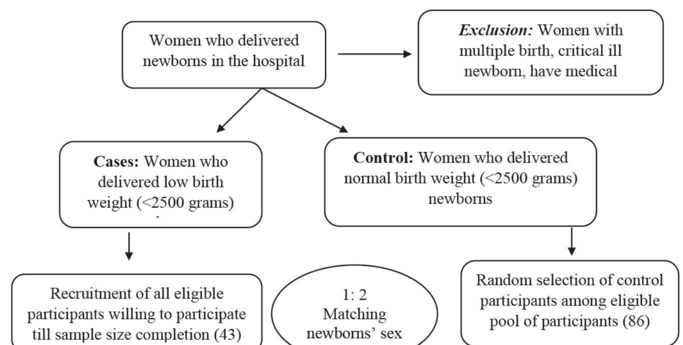

Fig. 1: Sampling strategy

Data collection instrument was developed based on available literature. Developed instrument was reviewed by the 6 subject matter experts and a research expert for content relevancy, adequacy, and clarity. Instrument was developed in English language and translated into Nepali language and back-translated into the English language. Validated Nepali language instrument was pretested among 15 postnatal mothers (5 cases & 10 controls) in Tribhuvan University Teaching Hospital and minor modifications were done in instrument.

Ethical approval was obtained from the Institutional Review Committee (IRC) of the Institute of Medicine (IOM) (Reg. No. 40/2022). Ethical and administrative approval was obtained from the study setting [PNWH (Reg No. 63/2613)]. After obtaining written informed consent from each respondent, in-person interviews were conducted in simple colloquial Nepali language using self-developed validated instrument. Interviews were conducted at postnatal wards. Confidentiality was maintained by using a screen while taking interview at the bedside. Antenatal card review was done to collect and verify information related to medical disorders during pregnancy, last menstrual period, hemoglobin level, maternal height and weight as well as last trimester hemoglobin of the mothers. To minimize the measurement bias, the same weighing machine was used to measure the weight of all newborns after zeroing the machine. Data collection was done during September to October 2024. Data were analyzed using both descriptive and inferential statistics. Frequency, percentage, mean, median, and standard deviation were calculated according to nature of the data. The Chi-square test was applied to examine associations of birth weight of babies with selected variables of mothers and babies. Bivariate analysis was performed to identify factors associated with the outcome variable. The logistic regression model was constructed using variables with $p < 0.05$ in bivariate analysis. Crude and adjusted odds ratios (ORs) with 95% confidence intervals (CIs) were computed, and statistical significance was set at $p < 0.05$. However, the multivariable logistic regression model showed poor goodness of fit might be due to small sample size. Therefore, adjusted estimates were not emphasized in the final analysis.

RESULTS

Socio-demographic characteristics of the respondents show that 83.7% cases & 88.4% controls belonged to 20-34 years with mean age of cases and controls were 25.2 ± 4.8 years & 25.3 ± 4.9 years respectively. Regarding ethnic background, 44.2% of cases and controls were Janajati (Indigenous) groups. Most of the cases and control (81.4% and 88.4%) resided in urban area and 76.7% and 83.7% of cases and controls belongs to Hindu religion. Regarding educational status, 37.2% and 38.4% of cases and controls were secondary level educated. The majority of respondents from cases (69.8%) and controls (70.9%) were homemakers. More than half (55.8% and 54.7%) of cases and controls belonged to single families (Table 1).

Table 1: Respondents' socio-demographic characteristics n= 129

Variables	Case (n=43) N (%)	Control (n=86) N (%)
Age		
<20 years	5 (11.6)	6 (7.0)
20-34 years	36 (83.7)	76 (88.4)
≥ 35 Years	2 (4.7)	4 (4.7)
Mean ± SD	25.2 ± 4.8 Years	25.3 ± 4.9 Years
Ranges	18-36 Years	18-39 Years
Ethnicity		
Janjati	19 (44.2)	38 (44.2)
Brahmin/Chhetri	18 (41.9)	36 (41.9)
Dalit	4 (9.3)	8 (9.3)
Madeshi	1 (2.3)	2 (2.3)
Muslim	1 (2.3)	2 (2.3)
Residence		
Urban	35 (81.4)	76 (88.4)
Rural	8 (18.6)	10 (11.6)
Religion		
Hinduism	33 (76.7)	72 (83.7)
Buddhism	6 (14.0)	9 (10.4)
Christianity	2 (4.7)	3 (3.5)
Kirat	1 (2.3)	1 (1.2)
Islam	1 (2.3)	1 (1.2)
Education		
No Formal Education	4 (9.3)	6 (7.0)
Basic Education	16 (37.2)	26 (32.6)
Secondary level education	16 (37.2)	30 (38.4)
Bachelor and above	7 (16.3)	12 (22.1)

Variables	Case (n=43) N (%)	Control (n=86) N (%)
Occupation		
Homemaker	30 (69.8)	61 (70.9)
Service holder	6 (13.9)	12 (14.0)
Business	4 (9.3)	7 (8.1)
Student	2 (4.7)	3 (3.5)
Daily wage earners	1 (2.3)	3 (3.5)
Family Type		
Single-family	24 (55.8)	47 (54.7)
Joint Family	8 (18.6)	16 (18.6)
Extended family	11 (25.6)	23 (26.7)

Among the newborns, most of the cases (90.7%) were low birth weight and cent percent (100.0%) of controls were normal birth weight newborns. More than half (58.1%) newborns were female. Whereas 48.9% and 88.4% of newborns in cases and control were full-term newborns (Table 2).

Table 2: Characteristics related to newborns of respondents n=129

Variables	Case (n=43) N(%)	Control (n=86) N (%)
Birth weight of newborn		
Low Birth Weight(< 1500gm to 2499gm)	39 (90.7)	-
Very Low Birth Weight (1100- 1499gm)	4 (9.3)	-
Normal Birth Weight (≥2500gm)		86 (100.0)
Sex of baby		
Male	18 (41.9)	36 (41.9)
Female	25 (58.1)	50 (58.1)
Gestational age at birth		
Extreme Preterm (<28 weeks)	1(2.3)	-
Very Preterm (28 to < 32 weeks)	4 (9.3)	-
Late Preterm (32 to<37 weeks)	17 (39.53)	10 (11.6)
Term (≥37 weeks)	21 (48.9)	76 (88.4)

There was significant association of birth weight of the babies with the birth interval <24 months among multigravida mothers (n=25 in cases and 49 in control) and having severe nausea and vomiting during first and second trimesters (*p values 0.044 and* 0.002) (Table 3, 4).

Table 3: Association of LBW with socio-demographic variables of respondents

Variables	Case (n=43) N(%)	Control(n=86) N(%)	*p* -value
Age			
20- 34 years	36 (83.7)	76 (88.4)	0.462
≥ 35years &< 20 years	7 (16.3)	10 (11.6)	
Residence			
Rural	8 (18.6)	10 (11.6)	0.281
Urban	35 (81.4)	76 (88.4)	
Education			
Below Secondary level	20 (46.5)	34 (39.5)	0.449
≥ Secondary level	23 (53.5)	52 (60.5)	
Family type			
Nuclear	24 (55.8)	47 (54.7)	0.900
Joint and extended	19 (44.2)	39 (45.3)	

** p-value significant at <0.05*

Table 4: Association of LBW with obstetric and health related variables of respondents n=129

Variables	Case (n=43) N(%)	Control(n=86) N(%)	*p*-value*
Gravida			
Primigravida	17 (39.5)	37 (43.0)	0.705
Multigravida	26 (60.5)	49 (57.0)	
Parity			
Primipara	18 (41.9)	38 (44.2)	0.802
Multipara	25 (58.1)	48 (55.8)	
Birth interval	**(n=26)**	**(n=49)**	
< 24 Months	11 (42.3)	10 (20.4)	
≥ 24 Months	15 (57.7)	39 (79.6)	0.044
Median=36 months, *IQR= (Q3- Q1), Range: 18-60 months)*			
Previous history of LBW newborn			
Yes	3 (13.7)	1 (2.3)	0.117*f*
No	23 (86.36)	48 (97.7)	
Presence of health problems			
Yes	25 (58.1)	39 (45.3)	0.171
No	18 (41.9)	47 (54.7)	
Severe nausea and vomiting during first and second trimester of pregnancy			
No	16 (64.0)	36 (92.3)	0.002*f*
Yes	9 (36.0)	3 (7.7)	

* *p-value significant at <0.05, f Fisher exact test*

Table 5: Association of LBW with antenatal care-related variables of respondents n=129

Variables	Case(n=43) N(%)	Control(n=86) N(%)	*p-value**
Antenatal visits as per protocol (≥ 8 visit)			
Yes	23 (53.5)	43 (50.0)	0.709
No	20 (46.5)	43 (50.0)	
Consumption of folic acid in first 3 months of pregnancy			
Yes	21 (48.8)	61 (70.9)	0.027
No	22 (51.2)	25 (29.1)	
Compliance with IFA tablets			
Yes (≥180 tablets)	32 (74.4)	61 (70.9)	0.677
No (<180 tablets)	11 (25.6)	25 (29.1)	
Consumption of calcium tablets			
Yes	35 (81.4)	86 (100.0)	0.001
No	8 (18.6)	-	
Food frequency per day			
< 3 times	2 (4.7)	2 (2.3)	0.600
≥ 3 times	41 (95.3)	84 (97.7)	
Type of food intake			
Vegetarians	8 (18.6)	12 (14.0)	0.491
Non- vegetarians	35 (81.4)	74 (86.0)	
Nighttime rest			
< 8 hours	9 (20.9)	11(12.8)	0.229
≥ 8 hours	34 (79.1)	75 (87.2)	

Variables	Case(n=43) N(%)	Control(n=86) N(%)	*p-value**
Day time rest			
< 2 hours and not taken rest	19 (44.2)	13 (15.1)	0.001
≥ 2hours	24 (55.8)	73 (84.9)	
Consumption of tobacco			
Yes	8 (18.6)	3 (3.5)	0.006*f*
No	35 (81.4)	83 (96.5)	
Presence of smoker in a family			
Yes	18 (41.9)	27 (31.4)	0.004
No	25 (58.1)	59 (68.6)	

** p-value significant at <0.05 level, f Fisher exact test*

There was a significant association of birth weight of the babies with consumption of folic acid & consumption of calcium tablets (*p* 0.027 and 0.001), daytime rest (*p* 0.001), tobacco use (*p* 0.006) & and history of passive smokers in the family (*p* 0.004) with LBW. However, there was insignificant association of LBW with antenatal variables, hemoglobin level in the last trimester of pregnancy and body mass index (BMI) with LBW (Table 5 and 6).

Table 6: Contributors for low birth weight among respondents n=129

Variables	Case(n=43) N (%)	Control(n=86) N(%)	COR	*p*-value	(95 %CI)
Birth interval#	**(n=26)**	**(n=49)**			
< 24 Months	11 (42.3)	10 (20.4)	2.860	0.044*	1.008 - 8.11
≥ 24 Months	15 (57.7)	39 (79.6)	Ref		
Severe nausea and vomiting during pregnancy	**(n=25)**	**(n=39)**			
Yes	9 (36.0)	3 (7.7)	7.324	0.002*	1.86 - 28.71
No	16 (64.0)	83 (92.3)	Ref		
Consumption of folic acid in first 3 months of pregnancy	**(n=43)**	**(n=86)**			
No	22 (51.2)	61 (70.9)	2.329	0.027*	1.09 - 4.96
Yes	21 (48.8)	25 (29.1)			
Rest at day time					
< 2 hours and not taken rest	19 (44.2)	13 (15.1)	4.446	<0.000*	1.91 - 10.32
≥ 2hours	24 (55.8)	73 (84.9)	Ref		
Consumption of tobacco					
Yes	8 (18.6)	3 (3.5)	6.324	0.006*	1.58 - 25.24
No	35 (81.4)	83 (96.5)	Ref		
History of presence of passive smoker in a family					
Yes	18 (41.9)	27 (31.4)	3.035	0.004*	1.42 - 6.47
No	25 (58.1)	59 (68.6)	Ref		
Gestational age at birth					
Preterm	22 (51.2)	10 (11.6)	7.962	<0.000*	3.26 - 19.39
Term	21 (48.8)	76 (88.4)	Ref		
Hemoglobin level in the last trimester					
≥11 gm/dl	41 (95.3)	79 (91.9)	1.05	0.91	0.48-2.28
<11gm/dl	2 (4.7)	7 (8.1)			
Body mass index(BMI)					
Underweight & overweight and obese #	23 (53.5)	37 (43.0)	0.98	0.58	0.92-1.05
Normal weight(< 18.5 to 24.9 kg/m^2)	20 (46.5)	49 (57.0)			

**=p -value significant at <0.05 level, # calculated only among Multipara Mothers, Ref = Reference*

Findings show that preterm birth showed a strong and highly significant association with low birth weight. Preterm infants had nearly eight times higher odds of being low birth weight compared to term infants (COR = 7.96; 95% CI: 3.26–19.39; p < 0.001). Whereas mothers who took less than two hours of rest during the daytime or did not take rest at all had significantly higher odds of low-birth-weight infants than those who rested for two hours or more (COR = 4.45; 95% CI: 1.91–10.32; p < 0.001).

The mothers having less than 24 months birth interval were nearly more than two-fold risk to have LBW babies compared to mothers having birth interval ≥24 months (COR=2.860,95%CI:1.008- 8.116). Similarly, mothers having severe nausea and vomiting during pregnancy were 7 times more risk of developing LBW (COR 7.324, 95%CI: 1.868-28.712). Regarding consumption of folic acid, there is two folds more chance of having LBW babies from mother who did not consume(COR 2.329, 95%CI:1.092-4.969). Likewise, the mothers who used to consume tobacco were nearly sixfold more prone to have LBW (COR 6.324, 95%CI:1.58-25.24).Likewise, there is a chance of delivering LBW newborns by mothers who had history of passive smokers in a family is also higher (COR 3.035, 95%CI:1.42-6.47) by 3 times.

There was no association of LBW and hemoglobin level (OR=1.05, 95% CI: 0.48-2.28, p=0.91) and BMI (OR=0.98, 95% CI: 0.92-1.05, p=0.58) of the mothers (Table 6)."

DISCUSSION

The present study showed significant association of birth weight with birth interval between pregnancies (COR=2.860, *p* 0.044). Findings are supported by prior studies conducted in various contexts.[116,17,18] Another study showed significant association of LBW with <1 year of birth interval.[19] However, this study's findings contradict with several study findings where there was insignificant relation (*p*= 0.071) between LBW and birth spacing.[20,21]

In this study, there was a statistically significant association between severe nausea and vomiting during the first and second trimesters of pregnancy and LBW (*p* 0.002). Finding is consistent with the study findings conducted by Kandel & Kafle (2017) where the findings revealed that 77 percent of mothers having severe hyperemesis gravidum during pregnancy were unlikely of developing LBW babies.[21] Consistent to a study finding from china[22], present study finding showed a significant association of LBW with of folic acid consumption (p 0.027).

In this study, not consuming calcium tablets was significantly associated with LBW among babies (p 0.001). Consistent to present study finding, a previous case-control study reported that mothers who did not consume calcium supplements were 3 times more likely to develop LBW compared to mothers who consumed calcium supplements.[23] Other prior studies also identified the similar findings [24,25].

In present study, there was a highly significant association between LBW and rest <2 hours/day. Previous study reported that the proportion of LBW was 4 times higher in mothers who took rest and slept less than 10 hours.[17] other study findings also found the association of LBW with hours of rest at day time.[5,26, 27]Present study findings also revealed a significant association of LBW with consumption of tobacco and history of passive smoking (*p* 0.009, 0.005) Findings of previous case-control and other studies supported the findings.[20, 28,29,17] Null findings for hemoglobin and BMI may reflect insufficient power (post-hoc power~0.2 for small effects) or low prevalence of anemia (mean HB=12.5 g/dL), contrary to expectations.

The current study showed that LBW has strong association with gestational age (*p*=0.002) (COR = 7.96; 95% CI: 3.26–19.39; p < 0.001). Findings was supported by the study conducted by K.C. et al., (2020) & Hailu & Kebede, (2018) where findings revealed that preterm birth (<37 weeks of gestation) was a determinants for LBW (aOR 2.9, 95% CI: 1.4 -6.1 & aOR 5.321; 95% CI: 2.959-9.567) respectively.[28,30] Previous studies reported significant association (*p*0.001) between gestational age (<37 weeks) and LBW[(26,4, 31,32)] According to Bansal et al., (2019), preterm birth has 9.07 times higher risk of having LBW babies compared to term-birth babies (OR=9.078, 95%CI: 4.148-19.869) which were consistent with present study. Furthermore, another study finding from Bangladesh also identified gestational age as the determinant for LBW.[32,33]

LIMITATION

This study has several limitations that should be considered when interpreting the findings. First, the case–control design limits the ability to establish causal relationships between the identified factors and low birth weight. Second, the relatively small sample size may have reduced the statistical power of the study and limited the precision of the estimated associations. Third, some variables, including maternal rest, tobacco exposure, and micronutrient intake, were based on self-reported information and may be subject to recall and social desirability bias. Additionally, as the study was conducted in a hospital setting, the findings may not be fully generalizable to the wider community. Despite these limitations, the study provides useful insights into modifiable maternal and behavioral factors associated with low birth weight in the Nepalese context.

CONCLUSION

The present study demonstrates a strong association between low birth weight and preterm birth as well as inadequate daytime rest. In addition, several maternal and behavioral factors were found to be associated with low birth weight, including short birth interval, poor compliance with micronutrient supplementation such as folic acid and calcium, and both active and passive exposure to tobacco. As these factors are largely modifiable, the findings underscore the importance of strengthening antenatal care services with focused awareness and behavior change interventions. Such interventions should emphasize appropriate birth spacing, adequate maternal nutrition and rest during pregnancy, and the prevention of both active and passive smoking to reduce the burden of low birth weight.

These findings emphasize the importance of timely and comprehensive prenatal monitoring to prevent pre-term deliveries whenever possible. Addressing these factors through targeted maternal health interventions can contribute significantly to improve neonatal outcomes and to reduce the prevalence of low birth weight among new borns in hospital settings.

CONFLICT OF INTEREST

Researchers have no conflict of interest.

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REFERENCES

1. World Health Organization. Preterm and low birth weight infants [Internet]. Geneva: World Health Organization; 2023 [cited 2024 Nov 21]. Available from: https://www.who.int/news-room/fact-sheets/detail/preterm-and-low-birth-weight-infants
2. UNICEF, World Health Organization. UNICEF-WHO low birth weight estimates: levels and trends 2000–2015 [Internet]. Geneva: UNICEF; 2019 [cited 2023 Jul 25]. Available from: https://www.unicef.org/reports/UNICEF-WHO-low-birthweight-estimates-2019.
3. Government of Nepal, Ministry of Health and Population, Department of Health Services. Annual report, Department of Health Services 2077/78 (2020/21) [Internet]. Kathmandu: Department of Health Services; 2022 [cited 2024 Nov 21]. Available from: file:///C:/Users/user/Downloads/DoHS-Annual-Report-FY-2077-78-date-5-July-2022-2022_FINAL%20(1).pdf
4. Prajapati R, Shrestha S, Bhandari N. Prevalence and associated factors of low birth weight among newborns in a tertiary level hospital in Nepal. Kathmandu Univ Med J. 2018 Mar; 61(1):49-52.https://www.kumj.com.np/issue/61/49-52.pdf
5. Koirala AK, Bhatta DN. Low-birth-weight babies among hospital deliveries in Nepal: a hospital-based study. International Journal of Women's Health. 2015 Jun 8:581-5. https://www.tandfonline.com/doi/abs/10.2147/IJWH.S84559
6. Thapa P, Poudyal A, Poudel R, Upadhyaya DP, Timalsina A, Bhandari R, Baral J, Bhandari R, Joshi PC, Thapa P, Adhikari N. Prevalence of low birth weight and its associated factors: Hospital based cross sectional study in Nepal. PLOS Global Public Health. 2022 Nov 2; 2(11):e0001220. Available from https://doi.org/10.1371/journal.pgph.0001220
7. Paul VK, Bagga A. Care of low birth weight babies. In: Paul VK, Bagga A, editors. Ghai essential pediatrics. 9th edition. New Delhi: CBS Publishers & Distributors; 2019. p. 149-50.
8. Sharma SR, Giri S, Timalsina U, Bhandari SS, Basyal B, Wagle K, Shrestha L. Low birth weight at term and its determinants in a tertiary hospital of Nepal: a case-control study. PloS one. 2015 Apr 8; 10(4):e0123962. Available from https://doi.org/10.1371/journal.pone.0123962
9. Park K. Preventive medicine in obstetrics, pediatrics, and geriatrics; nutrition and health. In: Park K, editor. Park's textbook of preventive and social medicine. 24th ed. Jabalpur: M/s Banarsidas Bhanot; 2017. p. 570-573, 676-596.
10. Reddy JM, Aravalli SP. A study on predictors of low birth weight. Int J Contemp Pediatr. 2021;8(4):689. Available from: https://doi.org/10.18203/2349-3291.ijcp20211078.
11. Rüdiger M, Heinrich L, Arnold K, Druschke D, Reichert J, Schmitt J. Impact of birthweight on health-care utilization during early childhood–a birth cohort study. BMC pediatrics. 2019 Dec;19:1-1.Available from https://doi.org/10.1186/s12887-019-1424-8

12. UNICEF. Low birth weight: A good start in life begins in the womb [Internet]. New York: UNICEF; 2023 [cited 2024 Nov 21]. Available from: https://data.unicef.org/topic/nutrition/low-birthweight.
13. Thapaliya R, Rai BK, Bhandari R, Rijal P, Gupta PP. The effect of birth interval on fetal outcomes. Health Renaissance. 2015; 13 (3):169-76. Available from https://www.researchgate.net/profile/Rabin-Bhandari-3/publication/318963756_
14. Charan J, Biswas T. How to calculate sample size for different study designs in medical research? Indian J Psychol Med. 2013 Apr., 35(2): 121-6. Doi: 10.4103/0253-7176.116232. PMID: 24049221; PMCID: PMC3775042. Available from How to Calculate Sample Size for Different Study Designs in Medical Research?
15. Sutan R, Mohtar M, Mahat AN, Tamil AM (2014). Determinant of low birth weight infants: a matched case control study. Open Journal of Preventive Medicine. 2014;4(3):91–99. Available from: https://www.scirp.org/html/1-1340268_43684.htm
16. Dubey M, Rout AJ, Ram R, Saha JB, Chakraborty M, Biswas N. Relationship between low birth weight of babies and antenatal care of mothers: A cross sectional study at a tertiary care hospital of Kishanganj, Bihar. Bihar. GJMEDPH. 2014; 4 (6) Available from https://scholar.archive.org/work/zizhudjzuneshiokfknw
17. Coutinho PR, Cecatti JG, Surita FG, Souza JP, Morais SS. Fatores associados a baixo peso ao nascer em uma série histórica de partos em Campinas, Brazil. Revista da Associacao Medica Brasileira. 2009; 55:692-9. Available from https://doi.org/10.1590/S0104-42302009000600013
18. Khan MW, Arbab M, Murad M, Khan MB, Abdullah S. Study of factors affecting and causing low birth weight. Journal of scientific research. 2014 Apr 25; 6 (2):387-94. Available from doi: http://dx.doi.org/10.3329/jsr.v6i2.17090
19. Shrestha M, Gupta SK, Sharmah BK, Baidya M. Socio economic and maternal reproductive factors affecting low birth weight babies in Central Nepal. Journal of Nepal Paediatric Society. 2016; 36 (3):277-83. Available from DOI: https://doi.org/10.3126/jnps.v36i3.16394
20. Kandel KP, Kafle S. Risk factors associated with low birth weight among deliveries at bharatpur hospital. Journal of Nepal Health Research Council. 2017 Sep 8; 15(2):169-73. Available from DOI: https://doi.org/10.33314/jnhrc.v15i2.1055
21. Liu Y, Li N, An H, Li Z, Zhang L, Li H, Zhang Y, Ye R. Impact of gestational hypertension and preeclampsia on low birth weight and small-for-gestational-age infants in China: A large prospective cohort study. The Journal of Clinical Hypertension. 2021 Apr; 23(4):835-42. Available from https://doi.org/10.1111/jch.14176
22. Yadav DK, Shukla GS, Gupta N, Shrestha N, Singh A, Kaphle HP. Maternal and obstetric factors associated with low birth weight. J Nepal Health Res Counc. 2020;17(4):443-450. Available from: https://doi.org/10.33314/jnhrc.v17i4.2263
23. Bhaskar RK, Deo KK, Neupane U, Bhaskar SC, Yadav BK, Pokharel HP, Pokharel PK. A case-control study on risk factors associated with low birth weight babies in Eastern Nepal. Int J Pediatr. 2015; 2015:1-7. Available from: https://doi.org/10.1155/2015/807373.
24. Joya AM, Fayyaz Masood T. Maternal Risk Factors Contributing for Low Birth Weight Babies at tertiary care hospitals of Lahore. Addiction. 2019; 14(346):3-8. Available from https://pjmhsonline.com/2019/july_sep/pdf/762.pdf
25. Bansal P, Garg S, Upadhyay HP. Prevalence of low birth weight babies and its association with socio-cultural and maternal risk factors among the institutional deliveries in Bharatpur, Nepal. Asian Journal of Medical Sciences. 2019;10(1):77-85. Available from DOI: https://doi.org/10.3126/ajms.v10i1.21665
26. Acharya D, Singh JK, Kadel R, Yoo SJ, Park JH, Lee K. Maternal factors and utilization of the antenatal care services during pregnancy associated with low birth weight in rural Nepal: analyses of the antenatal care and birth weight records of the MATRI-SUMAN trial. International journal of environmental research and public health. 2018 Nov;15(11):2450. Available from https://doi.org/10.3390/ijerph15112450
27. KC A, Basel PL, Singh S. Low birth weight and its associated risk factors: Health facility-based case-control study. PloS one. 2020 Jun 22;15(6):e0234907. Available from https://doi.org/10.1371/journal.pone.0234907
28. Patale PJ, Masare MS, BansodeGokhe SS. A study of epidemiological co-relates of low birth weight babies born in tertiary care hospital. Int J Res Med Sci. 2018 Mar;6(3):1006-10. Available from DOI: https://doi.org/10.18203/2320-6012.ijrms20180631
29. Girotra S, Mohan N, Malik M, Roy S, Basu S. Prevalence and determinants of low birth weight in India: Findings from a nationally representative cross-sectional survey (2019-21). Cureus. 2023 Mar;15(3). Available from PMCID: PMC10129903 PMID: 37123748
30. Hailu LD, Kebede DL. Determinants of low birth weight among deliveries at a referral Hospital in Northern Ethiopia. BioMed research international. 2018;2018(1):8169615. Available from https://doi.org/10.1155/2018/8169615
31. Agarwal K, Agarwal A, Agrawal VK, Agrawal P, Chaudhary V. Prevalence and determinants of "low birth weight" among institutional deliveries. Annals of Nigerian medicine. 2011 Jul 1;5(2):48. Available from DOI:%20https://doi.org/10.18203/2320-6012.ijrms20180631
32. Seid SS, Tolosa T, Adugna D. Prevalence of low birth weight and associated factor among neonate born at Jimma medical center (JMC), Jimma, South Western Ethiopia. Transl Biomed. 2019;10(1):156. Available from DOI: 10.21767/2172-0479.100156
33. Khan SI, Jhorna DE, Chakma A. Socio-demographic and nutritional determinants of birth weight. J Food Sci Nutr. 2018; 1 (1): 29-32. J Food Sci Nutr 2018 Volume 1 Issue. 2018 Feb 21;1.