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LOW BIRTH WEIGHT AND ASSOCIATED RISK FACTORS: AN INVESTIGATION FROM THE BIRTH REGISTER OF DISTRICT HOSPITAL SAGAR, MADHYA PRADESH, INDIA

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ABSTRACT

Low birth weight is a major cause of infant mortality. In a country like India, to reduce the prevalence of low birth weight is still a challenge due to wide spread socio-economic disparity. The major objective of this hospital based investigation was to find out the prevalence of low birth weight babies and associated factors in Sagar, Madhya Pradesh. The sample consists of 1003 mothers, who delivered in District Hospital, Sagar during Jan-Feb 2018. In this study, 70.8 % of the children were born with normal birth weight, 29.2 % of the children were having LBW. The average birth weight of male and female child was 2.9 and 2.5 kg, respectively. The value of R^2 for the female literacy was 0.163(p=0.015). It was found that 15.6 % of wasting is a result of LBW (R^2=0.156, p= 0.017). The results indicate that female illiteracy is one of the determinants of LBW and it is resulting into wasting. To reduce the overall burden of LBW, the education of girls should also be prioritized.

Keywords: *Infant mortality, low birth weight, wasting, Madhya Pradesh*

INTRODUCTION

Birth weight is the single strongest predictor of infant survival. However, its position in the causal pathway is unclear (Wilcox and Skcerven, 1992). Low Birth Weight (LBW) is the dominating risk factor for infant morbidity and mortality, resulting in 36% of all mortality in children <5 years of age, constituting about 4 million deaths per year (Singh et al., 2019). A review of past studies indicates that biological factors, like gestational age, maternal health, education, parity of mother, sex of delivered child, influence the birth weight (Ade and Patil, 2016; Kumar et al., 2018; Muula et al., 2013; Shrivastava and Shrivastava, 2013; Singh et al., 2017; Sullivan, 2016). The major causes of newborn mortality

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in India are pre-maturity/preterm (35%), neonatal infections (33%), intra-partum related complications/ birth asphyxia (20%), and congenital malformations (9%) (UNICEF India, 2017). LBW is the single most important factor determining the survival chances of the child. Many of them die during the first year. The infant mortality rate is about 20 times greater for all LBW babies than for other babies (Ade and Patil, 2016). LBW has shown a direct relationship with immediate, long-term development and overall well-being. There are suggestions that prevalence of LBW to some extent may be overcome by delaying in child bearing age among adolescents, taking sufficient bed rest during the pregnancy and improving female literacy. The present study was planned to find out the low birth weight and associated risk factors in Sagar area of Madhya Pradesh State.

MATERIALS AND METHODS

The study was carried out at Sagar District Hospital, which had well-equipped labor room and operation theatre. The hospital was also fully equipped to do caesarean sections and to perform all types of obstetric, gynecological operations and surgeries. Approximately, over 750 deliveries were being conducted in the District Hospital every month. The target population for the present study was women of reproductive age group of 19-40 years who came to the District Hospital for delivery during the study period (January to February, 2018). Data was collected from the birth register of the hospital. Age, parity, complexity during childbirth, gestational period, delivery result, Hb % of mother, blood group, sex and weight of child were collected from the birth register of the hospital. State wise data on LBW, female literacy rate, under 5 mortality rate (U5MR), prevalence of institutional deliveries, Infant mortality rate (IMR) and prevalence of wasting were obtained for 36 states and union territories from census of India 2011 and NFHS- III and IV, to understand the determinants of LBW and for comparison purpose. The data were analysed and tabulated using MS Excel and SPSS Version 16.0.

RESULTS

In the present study, only 2.09 % mothers experienced any kind of complications (viz., malaria, typhoid, PIH, jaundice and diabetes) during pregnancy. Maximum number of mothers (81.1%) had normal delivery, while only 18.9% were delivered by caesarean section. The average birth weight of the male child was found to be 2.9 kg. On the other hand, the average birth weight of female child was recorded as 2.5 kg. The gender difference in mean birth weight was found to be statistically insignificant ($t=0.421, p=0.745$). The distribution of newly born babies of District Hospital Sagar (MP), according to their body weight, is presented in Table-1. It is evident from the Table that 24.8 % babies were having LBW ($\leq$ 2.5 kg). The LBW babies were further divided into two sub-categories, viz. very low birth weight (VLBW, $\leq$1.5 kg) and extremely low birth weight (ELBW, $\leq$1.0 kg). Among LBW babies, 3.7% were having very low birth weight and 0.4%

had extremely low birth weight. Remaining 70.8 % babies were having normal birth weight. It is apparent from Figure-1 that the prevalence of LBW for all the categories was higher among the females as compare to males. Normal birth weight was also higher among the males as compared to females.

The distribution of new born babies, as per their body weight, along with the age of mothers is presented in Table-2. It is evident from the table that highest percentage of LBW (33.3 %) was found among the mother of age group of 18-21 years followed by mothers of 22-25 (26.8%), 26- 29 (31%), and 30^{+} years of age (25.2%). The highest percentage (74.8%) of babies, having appropriate body weight, was found to be born to the mother of age 30^{+} followed by 22-25, 26-29, and 18-21 years of age (i.e., 73.2%, 69% and 66.7%, respectively).

Distribution of newly born babies as per anemic condition of mothers can be seen in Table-3, which reveals that anemia is not a determinant factor for LBW. It is apparent that a total of 53.7% mothers were normal (Hb $\leq$9.0), whereas 77 (7.6%) mothers were anemic. However, low hemoglobin level of mother is a risk factor during childbirth. This may be because of the fact that maternal anemia limits maternal oxygen intake, decreases oxygen supply to fetus and consequently leads to fetal growth restriction, especially for mothers of advanced maternal age and teenage pregnancy, which do not corroborate with other studies conducted in India and abroad (Brabin, et al., 2001; Kumar et al., 2017; Kumari et al., 2019; Shrivastava and Shrivastava, 2013; Sifakis and Pharmakides, 1939; Steer, 2000; Susanti et al., 2017; Toteja et al., 2006; Weldekidan, et al., 2018). National Nutritional Anemia Prophylaxis Program (NNAPP) was introduced in 1970 under this program; tablets of iron and folic acid are distributed among pregnant women in India.

Table-4 reveals that Hb of mothers of younger age was normal. The highest percent of mothers having normal Hb levels were found to be belonging to 21-22 (23.9%) years of age. In the present study, it was found that age of mother had no impact on their level of hemoglobin percentage. In order to understand the impact of age of mother on hemoglobin, chi-square test was performed which was found to be insignificant (x^2 =5.19, df=6, p>0.05) for LBW.

Linear regression analysis was performed, keeping LBW as dependent variable and female literacy rate, prevalence of institutional deliveries, U5MR, IMR and prevalence of wasting as independent variables. The findings of regression analysis are presented in the Table-5. It is apparent that the female literacy rate and the prevalence of wasting have significant regression on the prevalence of LBW. The value of R^2 for the female literacy is 0.163 (p=0.015), it can be inferred that 16.3% LBW is determined by the education of the mothers, whereas 15.6 % of wasting is a result of LBW (R^2=*0.156, p= 0.017*). The strong correlation between birth weight and mothers' education is empirically well-documented (Ade et al., 2016; Gage et al., 2013; Muula et al., 2011).

Table 1: Distribution of newly born babies as per their body weight in district Sagar (MP)

Birth weight Category (kg)	Male		Birth weight MEAN±SD	Female		Birth weight MEAN±SD	Total	
	N	%		N	%		N	%
NBW(≥2.5)	385	74.1	2.8±0.59	326	67.3	2.8±0.58	711	70.8
LBW(≤2.5)	116	22.3	2.1±0.49	133	27.4	2.1±0.49	249	24.8
VLBW(≤1.5)	16	3.0	1.4±0.49	22	4.5	1.4±0.50	38	3.7
ELBW(≤1)	2	0.3	0.7±0.14	3	0.6	0.8±0.51	5	0.4
Total	519	100		484	100		1003	100

Figure-1: Distribution of LBW categories among the male and female newborns of district Sagar

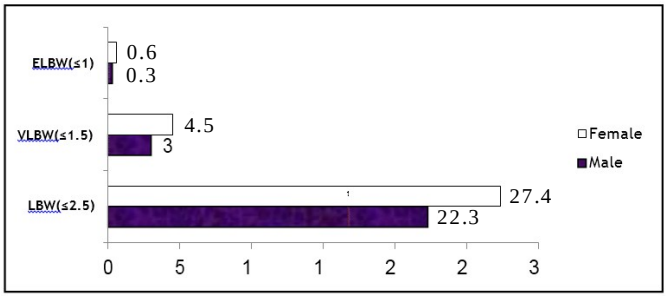


Table-2: Distribution of newly born babies as per their body weight and age of mother of Sagar

Age of mother	LBW (≤2.5 kg)			NBW (≥2.5 kg)			Total		
	M	F	Total(%)	M	F	Total(%)	M	F	Total
18-21	44	48	92(33.3)	95	90	185(66.7)	139	138	277
22-25	58	68	126(26.8)	180	164	344(73.2)	238	232	470
26-29	18	32	50(31)	75	36	111(69)	93	68	161
30+	15	9	24(25.2)	43	28	71(74.8)	58	37	95
Total	135	157	**292**	393	318	**711**	528	475	**1003**

Table 3: Distribution of newly born babies as per anemic condition of mothers of Sagar

Level Hb of mother	LBW		NBW		Total
	M (%)	F (%)	M (%)	F (%)	
Normal mothers (≥9.1)	133(82.6)	148(91.3)	145(89.5)	113(86.2)	**539 (87.5)**
Anemic mothers (≤9.0)	28(17.4)	14(8.7)	17(10.5)	18(13.7)	**77(12.5)**
Total	161(100)	162 (100)	162 (100)	131 (100)	**616 (100)**
Not available					387
Grand Total					1003

Table-4: Age of mothers with anemia in district Sagar

Age of mother	Hemoglobin (gm/dl) Anemic mothers (≤9.0)		Normal mothers (>9.1)		**Total**	
	N	%	N	%	N	%
19-20	70	14.2	95	18.6	165	16.5
21-22	117	23.7	122	23.9	239	23.8
23-24	108	21.9	99	19.4	207	20.6
25-26	96	19.4	97	19.0	193	19.2
27-28	40	8.2	45	8.8	85	8.5
29-30	36	7.3	31	6.1	67	6.7
30+	26	5.3	21	4.1	47	4.7
Total	493	100	510	100	1003	100

Source: NFHS 2015-16

Figure 2: Prevalence of LBW and Female Literacy Rate among Indian states

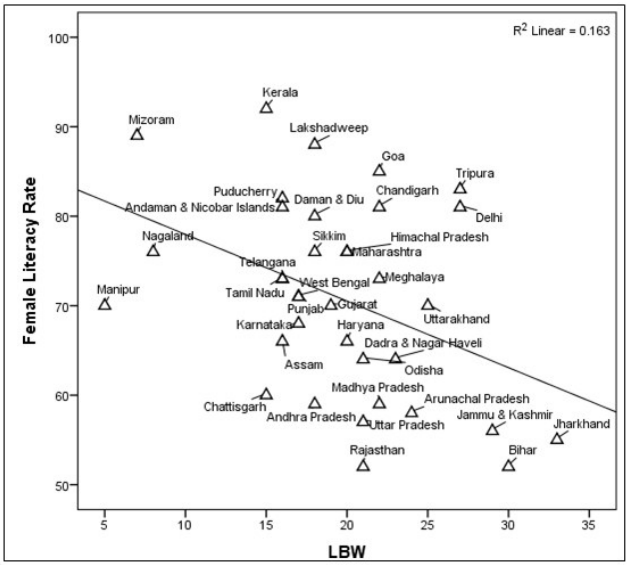
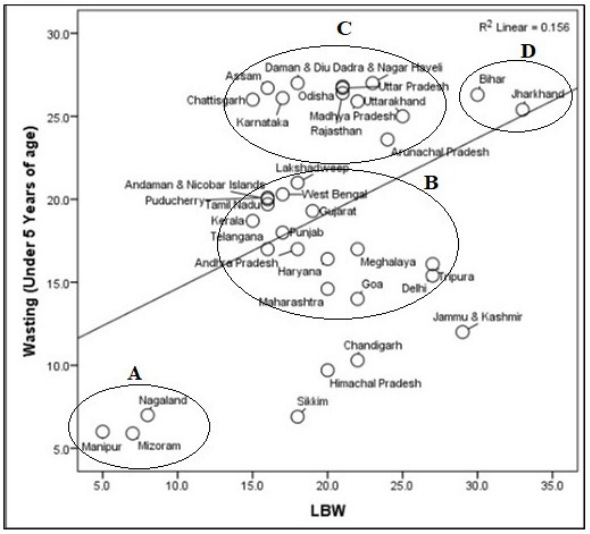


Table-5: Regression coefficient and F statistics keeping LBW as dependent variable

Independent Variables	Coefficients of Regression				F Statistics		
	R	R^2	*β*	*SE*	*t-value*	*F change*	*P-value*
Female Literacy	0.404	0.163	-0.404	6.103	5.735	6.623	0.015
Institutional Delivery	0.053	0.003	-0.053	5.368	3.934	0.097	0.757
U5MR	0.249	0.062	0.249	5.799	3.332	2.254	0.142
IMR	0.257	0.066	0.257	4.710	2.615	2.409	0.130
Wasting (under 5 years)	0.395	0.156	0.395	2.761	2.509	6.297	0.017

Figure-3: Prevalence of LBW and Wasting (under 5 years of age) among Indian states



DISCUSSION

The young (≤19 years) and advanced (≥35 years) maternal age during pregnancy has been linked to adverse fetal and birth outcomes. The proportion of birth weight weighing less than 2.5 kilogram is slightly higher in rural areas (23 %) than in urban areas (19 %). It is evident that 29.2 % of the children born in District Hospital Sagar are of less than the appropriate birth weight. The prevalence of LBW is higher in District Sagar. According to NFHS-IV (2015-16), the prevalence of LBW in Madhya Pradesh is 21.9%, which reveals that the prevalence of LBW is higher in the District as compared to average of the state. The cause of LBW may be due to their socio-economic condition and genetics. According to NFHS-IV, proportion of wasting is highest in Madhya Pradesh (28%) and the prevalence of LBW was higher among the females (32.7%) than the males (25.9%). Neonatal mortality rate (NMR) was observed to be 7.97 and IUCD (Intra-uterine child death) were 19 per thousand. A significant impact of education level of mothers has been observed in this study (Figure 2), which corroborates with findings of other studies (Christian et al., 2013a; Elshibly and Schmalisch, 2008; Gebremedhin, et al., 2015; Shrivastava and Shrivastava, 2013; Weldekidan et al., 2018).

It is apparent from the scattered plot diagram (Figure 3) that there is a positive correlation between wasting and LBW. Some of the northeastern states (Manipur, Mizoram and Nagaland) in the circle A are the states where the prevalence of wasting and LBW is very less, the states in the circle B have moderate wasting and LBW, circle C shows a cluster of states having moderate prevalence of LBW and very high prevalence of wasting. Proportion of LBW in the urban health center of Rajasthan is 27.1% with mean birth weight 2.2 ± 0.22 kg and normal birth weight babies accounted for 72.9% of the birth outcomes (Shrivastava and Shrivastava, 2013).States like Bihar and Jharkhand are the only states where the prevalence of wasting as well as LBW is very high. The present-day states of Chhattisgarh, Jharkhand and Uttarakhand, which were part of Madhya Pradesh (C), Bihar (D) and Uttar Pradesh (C), respectively, are also known as BIMARU (sick). A major reason for separating these states was development but still they are lagging behind.

Gestational age is a major contributor to birth weight (Christian et al., 2013a; Elshibly and Schmalisch, 2008). In the present study, 95.5% of the total deliveries were full term and only 4.5 % of pre-term deliveries were observed. Out of total preterm deliveries 65.2 % are LBW and the remaining 34.8 % of newborn were found to be having normal birth weight. It has been argued that gestational age is not merely age itself, but a strongly correlated phenomenon of growth and maturation (Bang, et al., 2005; Gupta, et al., 2019). In the present sample, maximum numbers of women who delivered were age in the group of 21-22 years while the number of 31+ women was least.

In 2015, an estimated 14.6% of all babies born globally were LBW. A total of 28 % babies born in India were LBW. Population of India is equivalent to 17.7% of the total population of the world. These babies were more likely to die during their first month of life and those who survive would face lifelong consequences including a higher risk of stunted growth. The states of Uttar Pradesh, Madhya Pradesh, Rajasthan and Bihar contribute to more than half of newborn and under-five deaths in India. The incidence of LBW in the present study was higher as compared to Sub-Saharan Africa (13%), Latin America and Caribbean (9%), South Asia (28%) and least developed countries (13%) (O'Brien and Dundon, 2014), Nepal (15%) (Singh, 2017), Bhutan (25.3%) (Pokhrel et al., 2019), Sri Lanka (19.2%) (Guruge, et al., 2018) Maldives (22%) Pakistan (19%) (UNICEF and WHO - United Nations Children's Fund and World Health Organization, 2004), and Afghanistan (15.5%) (Gupta et al., 2019). The LBW was also found higher in Bangladesh (30%) Sudan (31%), Yemen (32%) (UNICEF and WHO, 2004) and Nepal (31%) (Mutha et al., 2008).The prevalence of LBW found in the present study is less than UNICEF ICMR report, which shown 39.3% incidence of LBW in the three slums in Chennai, Madras and Calcutta and rural areas near Chandigarh, Varanasi and Hyderabad.

CONCLUSIONS

The present findings revealed that the prevalence of LBW was 29.2%, which is quite high. Here an attempt was made to find out the determinants of LBW. The regression analysis was performed which shows that education of the mothers had significant relationship with LBW (R^2= *0.163, p=0.015*). Additionally, the LBW and wasting also had significant correlation which leads to infer that the LBW is resulting into the higher prevalence of wasting. LBW still remains one of the major public health problems in most of the low and middle income countries in the world (Black et al., 2013; Blencowe et al., 2019; Christian et al., 2013b; Kuzawa et al., 2012; Sudfeld et al., 2015). It is recommended to improve maternal health through strengthening of the existing maternal service at the district hospital level. Prevalence of LBW can be reduced by increasing the education of girls as well as elevating the socio-economic condition in general.

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References

Ade, A., Brunda, N.K., and R. Patil, 2016. A Retrospective Study of Birth Weight and Their Risk Factors among Rural Women. *International Journal of Health Sciences and Research (Www.Ijhsr.Org)*, *6*(8), 19-23. Retrieved from www.ijhsr.org

Ade, A., Brunda, N.K., Patil, R., Manna, D. N., Shrivastava, S., Shrivastava, P., D. Badkur, (2016). Kangaroo mother care to reduce morbidity and mortality and improve growth in low-birth- weight infants. *Cochrane Database of Systematic Reviews*, *4*(8), 1–153. https://doi.org/10.1002/14651858.CD002771.pub4.www.cochranelibrary.com

Bang, A. T., Reddy, H. M., Bang, R. A. and M. D. Deshmukh, 2005. Why do neonates die in rural Gadchiroli, India? (Part II): Estimating population attributable risks and contribution of multiple morbidities for identifying a strategy to prevent deaths. *Journal of Perinatology*, *25*(SUPPL. 1), 35–43. https://doi.org/10.1038/sj.jp.7211270

Black, R. E., Victora, C. G., Walker, S. P., Bhutta, Z. A., Christian, P., De Onis, M., R. Uauy, 2013. Maternal and child undernutrition and overweight in low-income and middle-income countries. *The Lancet*, *382*(9890), 427–451. https://doi.org/10.1016/S0140-6736(13)60937-X

Blencowe, H., Krasevec, J., de Onis, M., Black, R. E., An, X., Stevens, G. A., Borghi, E.,Hayashi, C., Estevez, D., Cegolon, L., Shiekh, S., Hardy, V.P., Lawn, J.E., Cousens, S., 2019. National, regional, and worldwide estimates of low birthweight in 2015, with trends from 2000: a systematic analysis. *The Lancet Global Health*, *7*(7), e849–e860. https://doi.org/10.1016/S2214-109X(18)30565-5

Brabin, B. J., Hakimi, M. and Pelletier, D., 2001. An Analysis of Anemia and Pregnancy-Related Maternal Mortality. *The Journal of Nutrition*, *131*(2), 604S-615S. https://doi.org/10.1093/jn/131.2.604s

Chevalier, A. and V. O'Sullivan, 2007. "Mother's Education and Birth Weight," IZA Discussion Papers 2640, Institute of Labor Economics (IZA).

Christian, P., Lee, S. E., Angel, M. D., Adair, L. S., Arifeen, S. E., Ashorn, P., … R. E. Black, 2013a. Risk of childhood undernutrition related to small-for-gestational age and preterm birth in low- and middle-income countries. *International Journal of Epidemiology*, *42*(5), 1340–1355. https://doi.org/10.1093/ije/dyt109

Christian, P., Lee, S. E., Angel, M. D., Adair, L. S., Arifeen, S. E., Ashorn, P., … R. E. Black, 2013b. Risk of childhood undernutrition related to small-for-gestational age and preterm birth in low- and middle-income countries. *International Journal of Epidemiology*, *42*(5), 1340–1355. https://doi.org/10.1093/ije/dyt109

Elshibly, E. M. and Schmalisch, G., 2008. The effect of maternal anthropometric characteristics and social factors on gestational age and birth weight in Sudanese newborn infants. *BMC Public Health*, *8*, 1–7. https://doi.org/10.1186/1471-2458-8-244

Gage, T. B., Fang, F., O'Neill, E. and G. DiRienzo, 2013. Maternal Education, Birth Weight, and Infant Mortality. *Demography*, *50*(2), 615–635. https://doi.org/10.1007/s10955-011-0269-9.

Gebremedhin, M., Ambaw, F., Admassu, E. and H. Berhane, 2015. Maternal associated factors of low birth weight: A hospital based cross-sectional mixed study in Tigray, Northern Ethiopia. *BMC Pregnancy and Childbirth*, *15*(1), 1–8. https://doi.org/10.1186/s12884-015- 0658-1.

Gupta, R. D., Swasey, K., Burrowes, V., Hashan, M. R. and G. M. Al Kibria, 2019. Factors associated with low birth weight in Afghanistan: A cross-sectional analysis of the demographic and health survey 2015. *BMJ Open*, *9*(5), 1–8. https://doi.org/10.1136/bmjopen-2018-025715

Guruge, N. D. G., Dharmaratne, S. D. and M. Wasantha Gunathunga, 2018. Effectiveness of a "health promotional" intervention in enabling lay communities to change determinants of low birth weight. *Sri Lanka Journal of Child Health*, *47*(3), 233–241. https://doi.org/10.4038/sljch.v47i3.8546

Kumar, M., Verma, R., Khanna, P., Bhalla, K., Kumar, R., Dhaka, R. and V. Chayal, 2017.

Prevalence and associate factors of low birth weight in North Indian babies: a rural based study. *International Journal Of Community Medicine And Public Health*, *4*(9), 3212. https://doi.org/10.18203/2394-6040.ijcmph20173815

Kumar, S., Kumar, R., Tewari, M., Narayan Chakraborty, S., Kumar Som, T. and D. Kumar, 2018. Prevalence and Determinants of Low Birth Weight: An Experience from a Secondary Referral Unit Of Burdwan District, West Bengal (India). *IOSR Journal of Dental and Medical Sciences (IOSR-JDMS) e-ISSN*, *17*, 54–59. https://doi.org/10.9790/0853-1703015459

Kumari, S., Garg, N., Kumar, A., Guru, P. K. I., Ansari, S., Anwar, S., … M. Sohail, 2019. Maternal and severe anaemia in delivering women is associated with risk of preterm and low birth weight: A cross sectional study from Jharkhand, India. *One Health*, *8*(August), 100098. https://doi.org/10.1016/j.onehlt.2019.100098

Kuzawa, C. W., Hallal, P. C., Adair, L., Bhargava, S. K., Fall, C. H. D., Lee, N., Norris,S.A., Osmond,C., Ramirez-Zea, M., Sachdev, H.S., Stein,A.D., Victora,C.G., COHORTS Group, 2012. Birth weight, postnatal weight gain, and adult body composition in five low and middle income countries. *American Journal of Human Biology*, *24*(1), 5–13. https://doi.org/10.1002/ajhb.21227

Muula, A. S., Siziya, S. and E. Rudatsikira, 2011. Parity and maternal education are associated with low birth weight in Malawi. *African Health Sciences*, *11*(1), 65–71.

Muula, A. S., Siziya, S., Rudatsikira, E., Silvestrin, S., Da Silva, C. H., Hirakata, V. N., … G. DiRienzo, 2013. Maternal education level and low birth weight: A meta-analysis. *African Health Sciences*, *50*(4), 615–635. https://doi.org/10.1007/s10955-011-0269- 9.

O'Brien, N. G. and S. P. Dundon, 2014. Low Birth Weight. *British Medical Journal*, *4*(5737), 745. https://doi.org/10.1136/bmj.4.5737.745-b

Pokhrel, H. P., Gyeltshen, D., . T., Sharma, T. R., Tshewang, P., Dorji, K. and D. Yangzom, 2019. Determinants of Infant Mortality in Samdrup Jongkhar District, Bhutan.

International Journal of Innovative Research in Medical Science, *4*(02). https://doi.org/10.23958/ijirms/vol04-i02/584

Pratik, K. M., Robert, L. and K. Y. H. Sainburg, 2008. Impact of Newborn Skin-Cleansing With Chlorhexidine on Neonatal Mortality in Southern Nepal: A Community-Based, Cluster- Randomized Trial. *Pediatrics*, *23*(1), 1–7.

Shrivastava, S. and P. Shrivastava, 2013. A longitudinal study of maternal and socioeconomic factors influencing neonatal birth weight in pregnant women attending an urban health center. *Saudi Journal for Health Sciences*, *2*(2), 87. https://doi.org/10.4103/2278-0521.117912

Sifakis, S. and G. Pharmakides, 1939. Anemia in pregnancy. *Southern Medical Journal*, *32*(1), 90–91. https://doi.org/10.1097/00007611-193901000-00023

Singh, G., Chouhan, R. and K. Sidhu, 2009. Maternal Factors for Low Birth Weight Babies. *Medical Journal Armed Forces India*, *65*(1), 10–12. https://doi.org/10.1016/S0377-1237(09)80045-2

Singh, S., Deshpande, K., Chouhan, D. S. and D. Badkur, 2017. A Hospital Based Study on Complications of Childbirth and Associated Risk Factors at Ujjain, Madhya Pradesh. In *Ntl J Community Med* (Vol. 8). Retrieved from www.njcmindia.org

Singh, U., Ueranantasun, A. and M. Kuning, 2017. Factors associated with low birth weight in Nepal using multiple imputation. *BMC Pregnancy and Childbirth*. https://doi.org/10.1186/s12884-017-1252-5

Steer, P. J., 2000. Maternal hemoglobin concentration and birth weight. *American Journal of Clinical Nutrition*. https://doi.org/10.1093/ajcn/71.5.1285s

Sudfeld, C. R., McCoy, D. C., Danaei, G., Fink, G., Ezzati, M., Andrews, K. G., and W. W. Fawzi, 2015. Linear growth and child development in low- and middle-income countries: A meta-analysis. *Pediatrics*, *135*(5), e1266–e1275. https://doi.org/10.1542/peds.2014-3111

Susanti, A. I., Sahiratmadja, E., Winarno, G., Sugianli, A. K., Susanto, H. and R. Panigoro, 2017. Low Hemoglobin among Pregnant Women in Midwives Practice of Primary Health Care, Jatinangor, Indonesia: Iron Deficiency Anemia or â-Thalassemia Trait? *Anemia*, *2017*. https://doi.org/10.1155/2017/6935648

Toteja, G. S., Singh, P., Dhillon, B. S., Saxena, B. N., Ahmed, F. U., Singh, R. P., … U. Mohan, 2006. Prevalence of anemia among pregnant women and adolescent girls in 16 districts of India. *Food and Nutrition Bulletin*, *27*(4), 311–315. https://doi.org/10.1177/156482650602700405

UNICEF and WHO, 2004. Low Birthweight: Country, regional and global estimates. United Nations Children's Fund and World Health Organization. New York:UNICEF.

Retrieved from http://www.unicef.org/publications/index_24840.h

UNICEF India, 2017. *Neonatal Health | UNICEF*. Retrieved from http://unicef.in/Whatwedo/2/Neonatal-Health-

Weldekidan, F., Kote, M., Girma, M., Boti, N. and T.Gultie, 2018. Determinants of Anemia among Pregnant Women Attending Antenatal Clinic in Public Health Facilities at Durame Town: Unmatched Case Control Study. *Anemia*, *2018*. https://doi.org/10.1155/2018/8938307

Wilcox, A. J. and R. Skcerven, 1992. Birth Weight and Perinatal Mortality/ : The Effect of Gestational Age. *Am J Public Health*, 82(3): 378-382. *Gestational Age*. *82*(3).