

## Low Birth Weight Scenario In India: A Systematic Review And Meta-Analysis

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### ABSTRACT

**Background:** Low birth weight (LBW) is defined as a state when an infant is born with a weight less than 2.5 kg. It can be resulted due to various biological, social or environmental factors including nutritional status of household. According to UNICEF, from 2000-2015 about 20 million children were affected by LBW worldwide. Sub Saharan Africa and South Asia holds the major share among which India according to National Family Health Survey-4 report has 18% of its childbirth weight as LBW.

**Methodology:** This systematic review study was mainly conducted to evaluate to status of LBW among Indian population and how it is different among tribal and non-tribal population and what are the risk factors associated with it. All published papers are searched from standard databases. Then full text papers were screened and evaluated following PRISMA guideline. A total of 29 (non-tribe=19, Tribe=10) studies were found eligible and included in the present analyses.

**Result:** According to the present review result LBW among Indian population is 30.97%, Tribal population has greater percentage that is 41.96% LBW higher than the non-tribal population (25.73%). The Scheduled tribe mother had two times higher (OR: 2.06, 95% CI: 1.96-2.16) risk of delivering LBW babies. Some of the major risk factors which results into LBW among the

population and specially creates more distinction between tribal and non-tribal population are bio-social factors.

**Conclusion:** Mother's education about proper nutrition is very much needed along with public health interventions to have an overall focus on maternal health as well as social development and welfare programme considering tribal population.

**Keywords:** Low birth weight, Tribe, Malnutrition, India, Review

## INTRODUCTION:

Mother is the creator and protector of a child from the very first day of conception. During pregnancy with the growth of a child, mother's body undergoes through different phases. Wellbeing of a mother both physically and mentally is very much crucial for a healthy child during birth as it is the very basis for wellbeing of the child in further life. But a scenario is very much prevalent worldwide specially in developing countries that is Sub Saharan Africa and South Asian nations is that of LBW. As defined by World Health Organization, it is a state where an infant is born with a weight less than 2.5 kg or 5.5 pounds. LBW has many factors responsible for its cause and on the other hand it resulted into many severe consequences in the further life of the child. LBW can be resulted due to various maternal biological, social and environmental factors some of the most prominent are Intra uterine growth retardation, low weight and height of mother, low weight gain during pregnancy, poor nutritional status, poor socioeconomic status and early marriage among many others. LBW child can be born preterm or at term and can lead to subnormal growth, stunting, illness, neurodevelopment problems and even death in severe cases. Worldwide various studies have been done time to time to know the reasons behind low birth weight and different intervention steps have also been taken but the results are not as desired. According to UNESCO report, from 2000-2015, more than 20 million children that is 1 in 7 children are born with low birth weight [1]. The prevalence is mainly high in Sub Saharan Africa, South Asia because of poor nutritional status of women, early marriage, poor educational status of women, poor antenatal and postnatal care. World Health Assembly (WHA) in 2012 adopted Global Nutrition Targets in which it was decided that a target of 30% reduction in low birth weight will be achieved by 2025, however the progress has been full of challenges and is not upto the mark. Among the South Asian nations, India is a developing nation with a large population. Malnutrition has been a major problem from a long time inspite of achieving food security through agricultural revolution and various intervention programmes. Malnourished mother gives birth to malnourished, small sized infant which further leads to various morbidities. According to National Family Health Survey - 4 report the percentage of children born with low birth weight are 18% [2]. From the NFHS-1 conducted during 1992-93 to NFHS-4 conducted during 2014-15, in a time span of almost 2 decades the decline rate of LBW is 7% which is a little progress, but there are miles to go. In India, tribes are more nutritionally and socially underprivileged which consist of 8.6% of India's population. In one of the studies analysing the prevalence of LBW among tribal children from the NFHS-4 report stated that every fifth tribal children are born with LBW [3]. Thus, the assessment of LBW and its

associated factor is of utmost importance and especially how it is different among the tribal population is needed to reduce morbidity and mortality among children whose one of the main causes is LBW. In view of the above point present review was undertaken to evaluate the overall prevalence of LBW in India and to compare the prevalence of LBW children among tribal and non-tribal population of India.

## METHODOLOGY

Literature review is basically based upon collecting, evaluating and analyzing publications of secondary data from various sources such as earlier published articles, journals, book reviews. Systematic reviews give more detailed and rigorous research question. It's quantitative component is Meta analysis which means analysis of analysis. Forest plot is the graphical display of results from individual studies on a common scale. It is a part of meta-analysis. Presence of heterogeneity influences method of analysis. Therefore, two types of analysis are done to overcome heterogeneity biases i.e. Fixed effects model: if heterogeneity is absent and Random effects model: if heterogeneity is present. Test for existence of heterogeneity: Cochrane's Q-statistic based on chi-square and  $I^2$  statistic-score heterogeneity between 0% and 100% (25%-low heterogeneity, 50% - moderate heterogeneity; 75% high heterogeneity). In our study heterogeneity scores by  $I^2$  statistic was above 75% for combined as well as for separate studies for tribe and non-tribe also which shows high heterogeneity. So, we took random effect model for the analysis.

Study design: Cross sectional studies were included to find out the prevalence of LBW baby among the Indian population and how the scenario is different among tribal and non-tribal population.

Data searching: Computerized databases: Google, Pubmed (<https://pubmed.ncbi.nlm.nih.gov>), UNICEF, WHO (<https://www.who.int>), [www.thelancet.com](http://www.thelancet.com), Government reports such as NFHS, personal references and emails, web, conference programmes, dissertations, review articles, Government reports.

Key words used to conduct these searches are low birth weight, tribal, intrauterine growth retardation, preterm, malnutrition, India.

Time frame: Dec 2000 to June 2021. Altogether 29 studies were selected for meta-analysis (Figure 1).

Study area: Overall out of 29 studies, 6 were from eastern part of the country consisting states of West Bengal, Tripura, Assam, Jharkhand, 9 from the Western part consisting of Maharashtra, Gujarat, Goa, 8 from North Indian states of Uttar Pradesh, Delhi, Uttarakhand and the remaining 6 from Southern states of Kerala, Karnataka, Telangana, Andhra Pradesh.

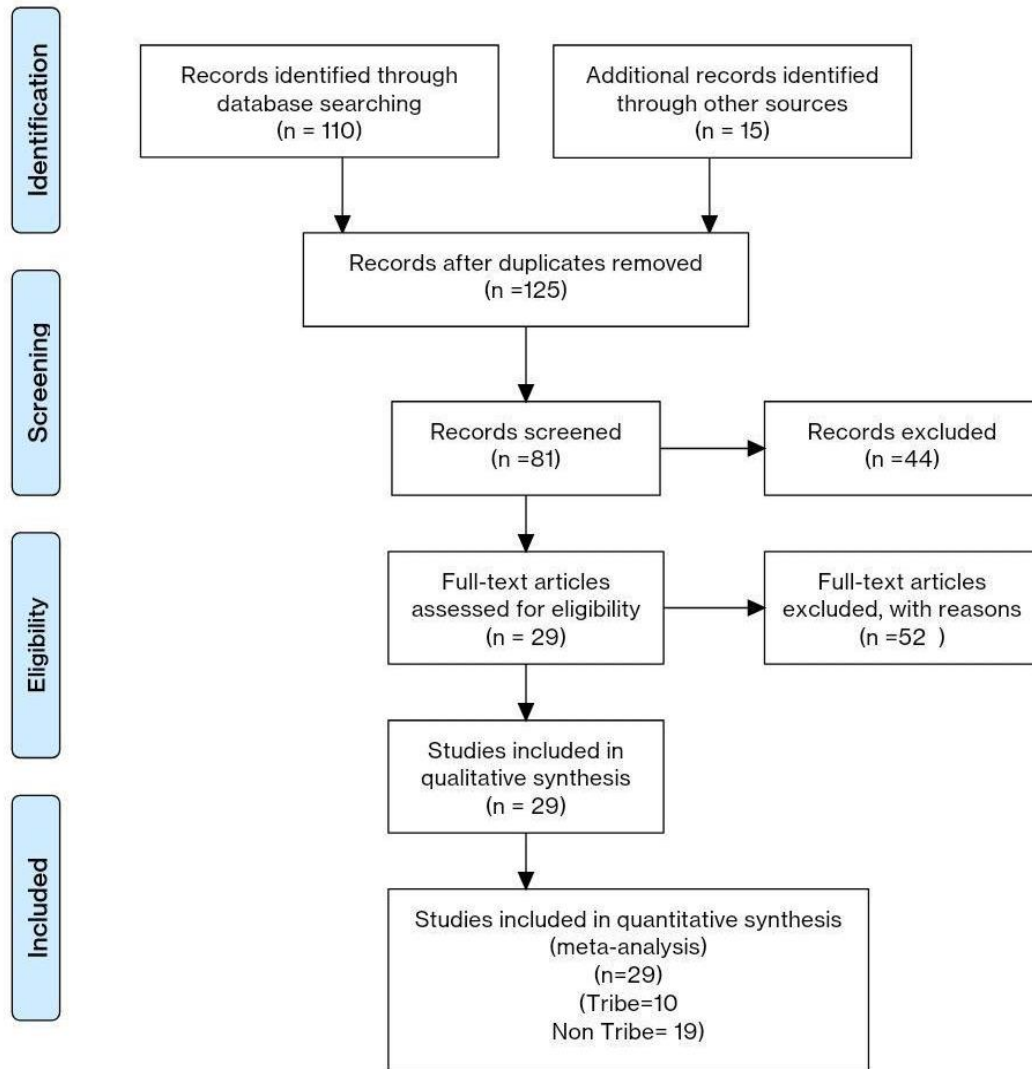


Fig 1: Flow chart for study selection

**RESULT**

Table 1 shows the selected studies on low birth weight among both tribal and non-tribal population. The criteria for LBW in this paper are that of stated by the WHO that is birth weight less than 2.5kg. Sample size varies from 10519 in the study by Desai et al. [4] to 48 in the study of Chande [5]. The overall prevalence rate is 30.98% (95% CI: 22.22 - 40.46) as depicted by random effect model. Publication bias is there as depicted by both Egger’s and Begg’s test.

Figure 2 shows the forest plot for the proportion of low birth weight among Indian population. Each horizontal line represents individual study, and the box shows the result with the line depicted 95% confidence interval of the result. Average of combined of all individual results are depicted by the diamond in the bottom. The figure indicates the prevalence of low birth weight was highest 87.50% (95% CI: 74.75 - 95.27) in the study Chande, [5] conducted among the tribal population while the lowest was 10. 612 (95% CI: 7.05 - 15.16) in the study Patel et al. conducted among non-tribal population [6].

Table 1: Prevalence of low birth weight among Indian population

Study	Sample size	Proportion LBW (%)	95% CI	Weight (%)	
				Fixed	Random
Agarwal et al, 2011	350	40.000	34.829 to 45.342	1.08	3.46
Agarwal et al, 2012	325	32.308	27.251 to 37.690	1.01	3.46
Ahankari et al, 2017	655	13.740	11.196 to 16.617	2.03	3.48
Bhattacharjya et al, 2015	305	23.934	19.256 to 29.127	0.95	3.46
Borah et al, 2016	450	21.778	18.049 to 25.882	1.39	3.47
Chande, 2016	48	87.500	74.754 to 95.272	0.15	3.27
Chhabra et al, 2004	435	39.080	34.468 to 43.842	1.35	3.47
Choudhary et al.,2013	290	36.207	30.669 to 42.029	0.90	3.45
Desai et al, 2017	10519	70.197	69.312 to 71.070	32.49	3.49
Gogoi and Ahmed, 2007	120	60.833	51.504 to 69.614	0.37	3.40
Joshi et al, 2005	233	34.335	28.258 to 40.816	0.72	3.44
Kumari et al, 2019	515	32.816	28.772 to 37.058	1.59	3.47
Lakshmi et al, 2018	185	25.405	19.303 to 32.314	0.57	3.43
Mumbare et al, 2012	2382	26.784	25.014 to 28.611	7.36	3.49

Mundlod & Thakkarwad, 2016	2915	13.413	12.196 14.704	to	9.01	3.49
Murshid & Krishnaprabha, 2018	50	18.000	8.576 31.437	to	0.16	3.28
Nair et al, 2000	2919	14.800	13.530 16.140	to	9.02	3.49
Narwade & More, 2018	1611	18.622	16.749 20.610	to	4.98	3.49
Narwade & More, 2018	1000	38.700	35.668 41.798	to	3.09	3.48
Padda et al, 2011	1341	34.676	32.127 37.292	to	4.15	3.48
Pal et al, 2016	720	36.806	33.274 40.446	to	2.23	3.48
Pal et al, 2020	2611	21.486	19.924 23.112	to	8.07	3.49
Patel et al, 2006	245	10.612	7.050 15.162	to	0.76	3.45
Sen et al, 2010	503	17.296	14.092 20.891	to	1.56	3.47
Shalini et al, 2010	256	37.500	31.550 43.743	to	0.79	3.45
Sharma et al, 2014	80	63.750	52.239 74.211	to	0.25	3.35
Tellapragada et al, 2016	710	11.408	9.164 13.979	to	2.20	3.48
Thakre et al, 2018	287	17.770	13.527 22.693	to	0.89	3.45
Vishwakarma et al, 2020	286	26.923	21.871 32.461	to	0.89	3.45
Total (fixed effects)	32346	37.469	36.942 37.999	to	100.00	100.00
Total (random effects)	32346	30.974	22.227 40.469	to	100.00	100.00

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- Total (fixed effects)
- Total (random effects)

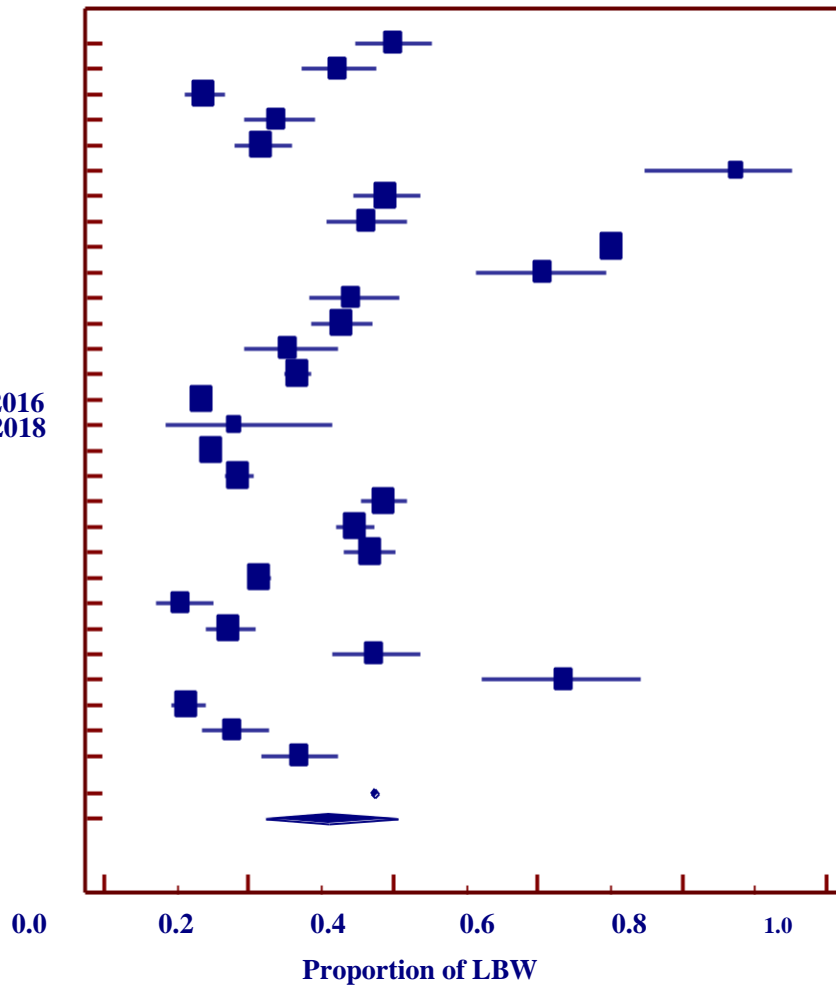


Fig 2: Forest plot for the proportion of low birth weight among Indian population

Table 2 shows prevalence of low birth weight among tribal population in India. The overall prevalence is 41.693 % (95% CI: 21.97 - 62.90) by random effect model. Figure 3 depicts the proportion of low birth weight among the tribal children in India. The figure indicates that the prevalence was highest 87.50% (95% CI: 74.75 - 95.27) in the study Chande [5] conducted in Bandana, Maharashtra whereas the prevalence was lowest 13.41 % (95% CI: 12.19 - 14.74) in the study Mundlod & Thakkarwad, [7] conducted among the tribes of Adilabad, Telangana.



Table 2: Prevalence of low birth weight among tribal population in India

Study	Sample size	Proportion of LBW (%)	95% CI	Weight (%)	
				Fixed	Random
Chande, 2016	48	87.500	74.754 to 95.272	0.28	9.72
Desai et al, 2017	10519	70.197	69.312 to 71.070	60.60	10.14
Gogoi and Ahmed, 2007	120	60.833	51.504 to 69.614	0.70	9.97
Mundlod & Thakkarwad, 2016	2915	13.413	12.196 to 14.704	16.80	10.13
Murshid & Krishnaprabha, 2018	50	18.000	8.576 to 31.437	0.29	9.74
Narwade & More, 2018	1611	18.622	16.749 to 20.610	9.29	10.13
Narwade & More, 2018	1000	38.700	35.668 to 41.798	5.77	10.12
Pal et al, 2016	720	36.806	33.274 to 40.446	4.15	10.11
Sharma et al, 2014	80	63.750	52.239 to 74.211	0.47	9.88
Thakre et al, 2018	287	17.770	13.527 to 22.693	1.66	10.07
Total (fixed effects)	17350	50.927	50.180 to 51.673	100.00	100.00
Total (random effects)	17350	41.693	21.979 to 62.904	100.00	100.00



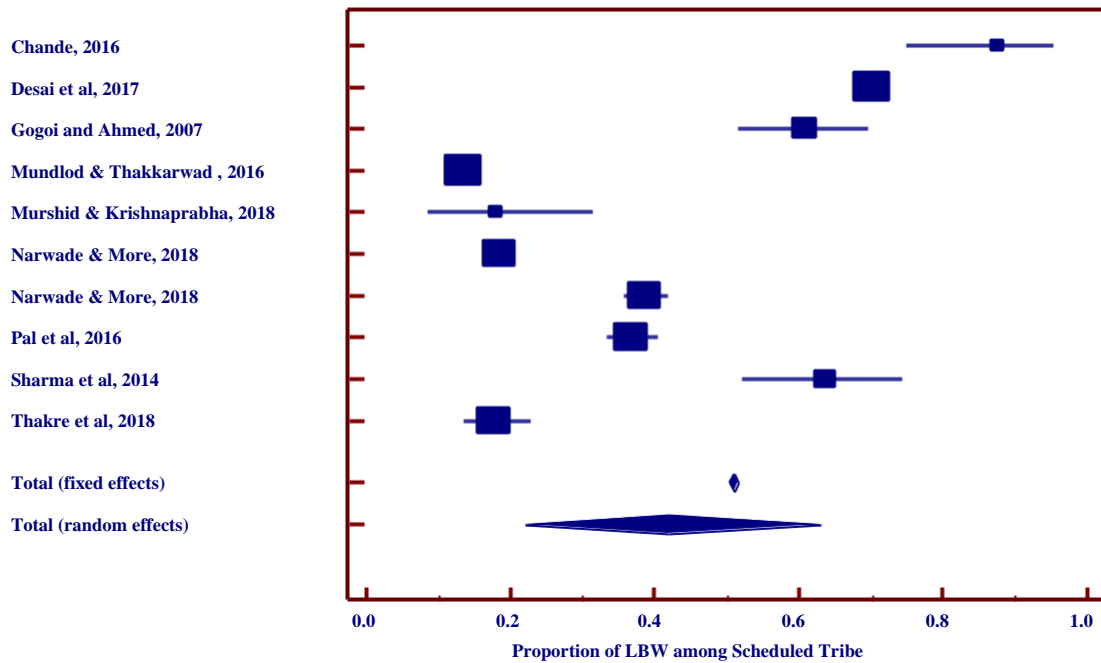


Figure 3: Forest plot showing proportion of low birth weight among tribal Indian population

Table 3 shows the selected studies on the proportion of low birth weight among non-tribal population in India. The overall prevalence is found to be 25.72 % (95% CI: 21.64 to 30.03) by random effect model in this study.

Figure 4 shows the forest plot for the proportion of low birth weight among non-tribal children. The figure indicates the prevalence was highest 40% (95% CI: 34.82 - 45.34) in the study Agarwal et al. [8] conducted in UP whereas the prevalence was lowest 10.61% (95% CI: 7.05 - 15.16) conducted in Goa by Patel et al. [6].

Table 3: Prevalence of low birth weight among non-tribal population

Study	Sample size	Proportion (%)	95% CI	Weight (%)	
				Fixed	Random
Agarwal et al, 2011	350	40.000	34.829 to 45.342	2.34	5.22
Agarwal et al, 2012	325	32.308	27.251 to 37.690	2.17	5.19
Ahankari et al, 2017	655	13.740	11.196 to 16.617	4.37	5.37
Bhattacharjya et al, 2015	305	23.934	19.256 to 29.127	2.04	5.17

Borah et al, 2016	450	21.778	18.049 25.882	to	3.00	5.29
Chhabra et al, 2004	435	39.080	34.468 43.842	to	2.90	5.28
Choudhary et al.,2013	290	36.207	30.669 42.029	to	1.94	5.15
Joshi et al, 2005	233	34.335	28.258 40.816	to	1.56	5.06
Kumari et al, 2019	515	32.816	28.772 37.058	to	3.44	5.32
Lakshmi et al, 2018	185	25.405	19.303 32.314	to	1.24	4.94
Mumbare et al, 2012	2382	26.784	25.014 28.611	to	15.87	5.51
Nair et al, 2000	2919	14.800	13.530 16.140	to	19.45	5.52
Padda et al, 2011	1341	34.676	32.127 37.292	to	8.94	5.46
Pal et al, 2020	2611	21.486	19.924 23.112	to	17.40	5.51
Patel et al, 2006	245	10.612	7.050 15.162	to	1.64	5.08
Sen et al, 2010	503	17.296	14.092 20.891	to	3.36	5.31
Shalini et al, 2010	256	37.500	31.550 43.743	to	1.71	5.10
Tellapragada et al.2016	710	11.408	9.164 13.979	to	4.74	5.38
Vishwakarma et al, 2020	286	26.923	21.871 32.461	to	1.91	5.14
Total (fixed effects)	14996	23.119	22.446 23.802	to	100.00	100.00
Total (random effects)	14996	25.726	21.644 30.032	to	100.00	100.00

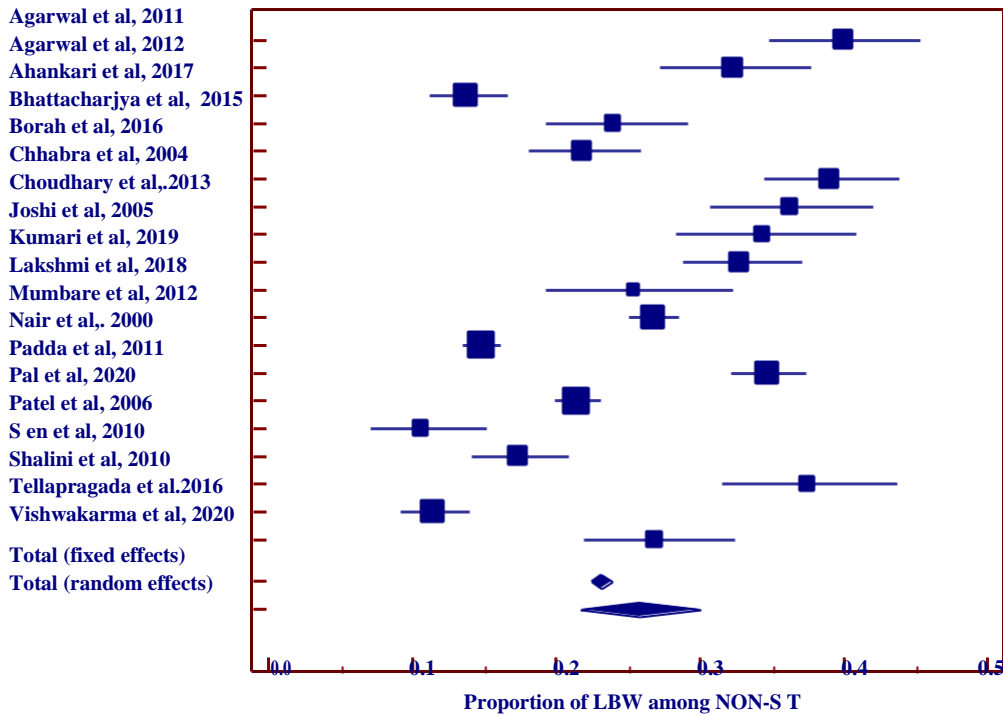


Figure 4: Forest plot showing proportion of low birth weight among non-tribal population

Table 4: Odds ratio of prevalence of low birth weight among tribal and non-tribal population

Prevalence of LBW	No of Study	Sample size	Prevalence of LBW	Chi-square P-value
ST population	10	17350	41.69	909.29 <0.0001
NON-ST population	19	14996	25.73	
Odds ratio	2.06 (95% CI: 1.96-2.16)			

Odds ratio of prevalence of low birth weight among tribal and non-tribal population is presented in table 4. The odds ratio shows that the prevalence of LBW was significantly more among tribal population in comparison to the non-tribal population ( $X^2=909.29$ ,  $p<0.0001$ ). The Scheduled tribe mother had two times higher (OR: 2.06, 95% CI: 1.96-2.16) risk of delivering LBW babies.

**DISCUSSION:**

The problem of LBW is a very crucial problem towards child development as it is responsible for long term problems such as stunting, morbidities and poor neurodevelopment in children and has been a serious problem for all time worldwide. LBW is mainly responsible for most of the neonatal deaths [9]. The prevalence of low birthweight varied widely across regions from 7.2% in developed regions to 17.3% in Asian countries. But in South Asia, the prevalence of low

Birth weight was 26.4% which is much higher than many parts of the world [9]. In this study the prevalence of low birth weight was found to be 30.97% (95% CI: 22.22 - 40.46). The pooled prevalence is higher than the current National level estimates which is 18% (NFHS-4) [2]. This study shows that the prevalence is much higher among the tribal population than in non-tribal population (Figure 5).

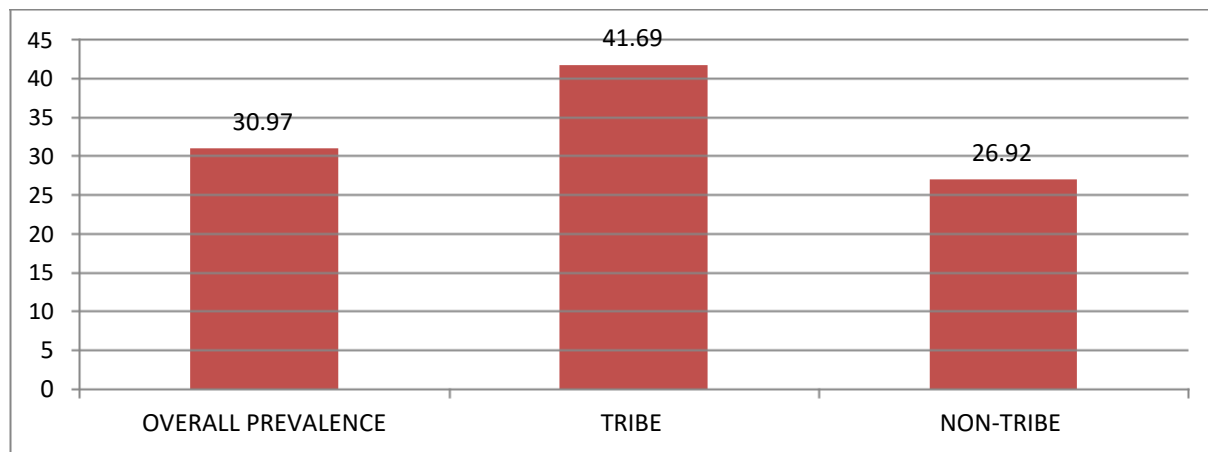


Figure 5. Prevalence of LBW by population.

The highest prevalence among tribal population is 87% while in non-tribal population the highest prevalence is 40% among the studies. Low birth weight is caused mainly by maternal biological, social and environmental factors. Most of the studies has reported for a long time that the major factors behind this is Preterm delivery and Intrauterine growth retardation (IUGR) which has also been reported by the UNICEF [1]. Among various maternal biological factors one of the factors mostly reported by most of the studies is maternal age. Mother whose age is less than 20 years and more than 35 years are at more risk and with increase in age after 20 years the birth weight also increases [11]. Adolescent mothers are neither physically nor psychologically well developed. Lower maternal weight that is less than 40kg and lesser weight gain during pregnancy is a very risk factor. When weight gain during pregnancy is less than 6 kg, complete weight gain of foetus doesn't take place [12] and mid pregnancy placental volume is associated with maternal weight which is an important for birth weight [13]. An underweight and stunted mother whose height is less than 1.50 m doesn't allow complete development and had a risk of preterm delivery [14]. Undernourished women, with lower BMI and lower haemoglobin level holds a high risk of child born with low birth weight [4]. Diet plays a great role in mother's nutritional status during pregnancy but is affected by socioeconomic status, food habit. Nutritional status of tribal women is mainly poor because of poor socioeconomic condition, food taboos and lower haemoglobin level is also found among them [15]. Intra uterine growth retardation which is one of the leading factors for low birth weight is caused mainly due to poor nutritional status of mother and poor sanitation. Many tribal women specially during pregnancy suffers from infectious diseases due to poor quality of sanitation and poor water quality [16]. Morbidities such as gestational hypertension and sickle cell anaemia have adverse effect on

foetal growth as depicted by some of the studies [4]. Women's physical activity during pregnancy matters a lot, though light physical activity is beneficial for the growth of foetus as it helps to maintain better hormonal balance and body fit, on the other hand excessive physical work can become harmful and lead to LBW [8]. Excessive physical work along with poor nutrition can even become worse as it will deplete the carbohydrate, energy level in the mother's body thus depleting level for the foetus also. Some reproductive practices and family planning also matters a lot, such as birth spacing. Birth spacing of less than 2 years leads to poor nutritional status of mother, poor milk quality and it can thus impact the next pregnancy because under nourished mother gives birth to undernourished and low birth child [18]. Some of the maternal social factors along with biological factor responsible for low birth weight reported by some of the studies are poor socioeconomic status specially people living below poverty and who have poor standard of living [19]. Socioeconomic status affects diet, nutritional status, psychological state, educational status among many others. In many studies it was noted that mother with poor educational status have LBW child [20], it can be because educated mother knows better utilization of resources, can take care of antenatal check-ups. Tribes mainly face the brunt of poor socioeconomic condition and thus the effects are more among them. The tribal girls are mainly married of earlier, during adolescence before full maturity which leads to undernourished mother and child. The reason for most of the mother and infant mortality is early marriage and early pregnancy. Another social factor which matters most is ante natal check-ups which is poor among tribal women [19]. The ante natal check-up follow up is not properly done by the pregnant women sometimes because of lower consciousness level about check-ups and sometimes because of availability and affordability. Female sex of the child and tobacco use by mother and father is also a risk factor for low birth weight as is reported by some of the studies [22]. Along with various biological and social factors, environmental factors do matter for low birth weight as is reported by some of the studies that during extreme cold and extreme hot, metabolic rate in mother's affecting nutrient uptake thus declining proper foetal growth and weight gain and rate of preterm delivery also increases [23].

## CONCLUSION:

Low birth weight is a worldwide scenario, but the developing nations are mainly affected by and India is no exception to it. In India due to disparity in socioeconomic condition, nutritional status, educational condition, food security tribes are mainly affected with low birth weight and malnutrition. As reported by governmental reports and by this study, rate of LBW is high in India and even double for tribes than non tribes. Various maternal biological, social and environmental factors are responsible for the prevalence of low birth weight. To improve the situation and achieve the goal set by World Health Assembly in 2012, an all-round public health intervention is needed for early detection and management of all round nutrition of pregnant women along with inclusion of social and economic development and social welfare. Good quality antenatal care along with women's education about proper nutrition during pregnancy and during lactation, late marriage and family planning is needed. Progress has been made to improve the condition of birth weight but there are miles to go as this is not the result of a single factor, but various factors intertwined together.

**REFERENCES:**

1. UNICEF, WHO, (2019). UNICEF, WHO-Report-low birth weight estimates. <https://www.unicef.org/reports/UNICEF-WHO-low-birthweight-estimates-2019#:~:text=Highlights,death%2C%20stunting%20and%20developmental%20difficulties>
2. International Institute for Population Sciences (IIPS) and ICF. (2017). National Family Health Survey (NFHS-4), 2015-16: India. Mumbai: IIPS.
3. Kumari, N., Algur, K., Chokhandre, P.K., Salve, P.S. (2021). “Low birth weight among tribal in India: evidence from National Family Health Survey-4”. *Clinical Epidemiology and Global Health*, 9: 360-366.
4. Desai, G., Anand, A., Shah. P., Shah, S., Dave, K., Bhatt, H., Desai, S., Modi, D. (2017). “Sickle cell disease and pregnancy outcomes: a study of the community-based hospital in a tribal block of Gujarat”. *Journal of Health Population Nutrition*, 36(1): 3.
5. Chande S. (2016). “Birth weight of tribal infants born to adolescent Mothers”. *International Journal of Home Sciences*, 2(1): 318-321.
6. Patel V, Prince M. (2006). “Maternal psychological morbidity and low birth weight in India”. *British Journal of Psychiatry*, 188(3): 284-285.
7. Mundlod S and Thakkarwad S. (2016). “Prevalence of Low Birth Weight & associated maternal risk factors in tribal medical college (RIMS) Adilabad (TS)”. *Ind J of Applied Research*, 6(10):195-196
8. Agarwal K, Agarwal A, Agarwal VK, Agarwal P, Chaudhary V. (2011). “Prevalence and determinants of low birth weight among institutional deliveries”. *Annals of Nigerian Medicine*, 5(2): 48
9. Shah BD, Dwivedi LK. (2011). “Causes of neonatal deaths among Tribal Women in Gujarat, India”. *Population research and Policy review*, 30(4): 517-536.
10. United Nations Children’s Fund (UNICEF), World Health Organization (WHO), UNICEF-WHO Low birthweight estimates: Levels and trends 2000-2015. Geneva: World Health Organization; 2019.
11. Narwade RG, More UB. (2018). “The effects of maternal age and parity on birth weight in a tribal community of Kinwat, Nanded, Maharashtra, India”. *Int J Reprod Contracept Obstet Gynecol*, 7(11):4451-4453.
12. Mumbare SS, Maindarkar G, Darade R, Yenge S, Tolani MK, Patole K. (2012). “Maternal risk factors associated with term low birth neonates: a matched pair case control”. *Indian Pediatrics*, 49(1): 25-28.



13. Kinare AS, Natekar AS, Chinhwadkar MC, Yajnik CS, Coyaji KJ, Fall CHD, Howe DT. (2000). "Low mid pregnancy placental volume in rural Indian women: A cause for low birth weight?". *American journal of obstetrics and gynecology*, 182(2): 443-448
14. Tellapragada C, Eshwara VK, Mukhopadhyay C. (2016). "Risk factors for preterm birth and low birth weight among pregnant Indian women: A hospital based prospective study". *Journal of preventive medicine & Public health*, 49:165-175.
15. Sharma M., Mishra S. (2014). "Effects of Maternal Health and Nutrition on Birth Weight of Infant". *Int J of Sci and Research*, 3(6): 855-858
16. Tanuja D, Karmakar V, Sampathkumar, S Jeyalakshmi , R Abel . (1995). "Nutritional status of tribal women in Bihar". *Man in India*, 75:209-214.
17. Agarwal K, Agarwal A, Agarwal VK, Agarwal P, Chaudhary V. (2011). "Prevalence and determinants of low birth weight among institutional deliveries". *Annals of Nigerian Medicine*, 5(2): 48
18. Raman T R, Devgan A, Sood SL, Gupta A, Ravidhander . (1998). "Low birth weight babies: incidence and risk factors". *Medical journal Armed forces India*, 54(3): 191-195.
19. Pal DK, Mondal T, Ghosh R. (2016). "A Study on the Factors Associated with low birth weight of tribal women in a rural area of West Bengal". *IOSR J Dental Medi Sci*, 15(2):78-79.
20. Kader M, Nirmala KP, Perera KP. (2014). "Socioeconomic and nutritional determinants of low birth weight in India". *North American journal of medical sciences*, 6(7): 302
21. Pal A, Manna S, Dhara P C. (2020). "The risk of low birth weight and associated factors in West Bengal, India: a community based cross sectional study". *Egyptian Pediatric Association Gazette*, 68: 27
22. Taywade ML, Pisudde PM. (2017). "Study of socio-demographic determinants of low birth weight in Wardha district, India". *Clinical epidemiology and global health*, 5(1): 14-20.
23. Mahon P, Harvey N, Crozier S. (2010). "Low maternal vitamin D status and fetal bone development: cohort study". *J Bone Miner Res*, 25: 14-19.