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Maternal Nutrition and Other Factors Associated With Low Birth Weight (LBW) Among Indian Neonates

Emi Grace Mary Gowshika. R
M.Sc Food Service Management & Dietetics,
Independent Researcher, Tamil Nadu, India
emigracerajendran@gmail.com

Abstract- Low Birth Weight (LBW) in neonates is one of the most compromised pregnancy outcomes in India. This was found to have an everlasting effect on the baby even during adulthood. Maternal nutrition and other associated risk factors were the major predisposing reasons for LBW or Small for Gestational Age (SGA) among neonates. This descriptive review was carried out to collect literature pertaining to the relationship between maternal nutritional status, maternal nutrient deficiencies, maternal anthropometric indices and other maternal risk factors on LBW in their babies, which included previously, executed studies between 2016 to 2020 in India. This study was found to be essential in identifying the potential risk factors and to prevent them with a view to reduce LBW in our country. The selected 12 articles were found to highlight maternal nutrition and other risk factors like: maternal age at pregnancy, maternal weight gain and prenatal weight, maternal height, socio-economic status, maternal knowledge and education on pregnancy outcomes, nutritional deficiencies in mothers and abstaining from antenatal clinical visits (ANC) to be directly linked to them delivering LBW neonates in India. The potential risk factors identified will further enable to plan effective interventions like awareness among reproductive age girls and women and also providing prenatal, antenatal and postnatal care for mothers and babies will aid in reducing LBW in neonates and help in facilitating healthier fetal growth and development in Indian population.

Keywords: - Maternal Nutrition, Low Birth Weight, Pregnancy, Antenatal, Prenatal, SGA, LBW, Small for Gestational Age, Risk Factors.

I. INTRODUCTION

Maternal nutrition is known as the intake of either adequate or inadequate quantity or quality of nutrients in three important stages of prenatal period (before conception), Antenatal period (during pregnancy) and postnatal period (after delivery). Low Birth Weight (LBW) neonates are identified as those newborns whose weight is less than 2500g or 2.5kg as defined by the World Health Organization (WHO) [1]. This is mostly attributed to the Chronic Lack of Nutrition in the mothers or also as a result of Prematurely Born Babies. Premature neonates are those who are born before the complete nine months of Gestational Age. Meanwhile, Over-nutrition or Obesity in mothers leads to Macrosomia (big babies) who weigh more than 4000g or 4kg [2]. The most important human fetal growth regulator is considered to be as maternal health and nutrition status. Studies had proved the positive association of improved maternal nutrition and reduced adverse birth outcomes as well as an improvement in the overall fetal growth [3’4]. Various determinants can alter the nutritional requirements of the mother.

It can be associated with the age of the mother at pregnancy as this can affect both the nutritional status and breast milk composition between different ages which is especially worse in malnourished or adolescent mothers [5].

Morbid conditions in the poorly nourished mother due to poor socio-economic status, poor educational background or lack of knowledge and awareness about a balanced diet had led to severe Malnourishment and Anemia. This could further increase the chances of Toxemia in pregnancy.

The fetus satisfies their nutritional requirements through maternal nutrient stores. The development and growth of fetal tissues and other vital organs in the mother's womb, depends entirely on good nutrition for the expecting mother [6].

Therefore, when a mother's diet is either calorically or nutritionally inadequate, the adverse effects are evident among both the mother and the fetus which can lead to nutritional disorders [7]. LBW has been proved to be proportionally associated with adverse immediate and long-term well-being and development of the baby [8].

Ultimately, inadequate dietary practice can cause a mother to reproduce intrauterine growth retarded newborns having LBW with high chances of neonatal morbidity and mortality caused due to irreversible tissue damage in the babies [9].

There lies an overall serious challenge in reducing the LBW incidence in developing countries like India and in uplifting maternal and child health. Therefore, this review aims to identify the maternal nutrition and other factors associated with LBW among Neonates in India.

1. Need for the Study:

The major risk factor for neonate mortality and morbidity is LBW and it has also been identified as one of the most sensitive index to determine a Nation's Health and Development. This review is required to find the various maternal nutrition and other factors which can lead to potential LBW among neonates in-order to identify the potential risk factors causing LBW and thereby, preventing them with a motive to keep LBW at bay among Indian population.

2. Objectives:

To review literature related to:

- Establishing a relation between Maternal Nutritional Status and Birth Weight of neonates.
- Association between Maternal Nutrient Deficiencies at Pregnancy and LBW in neonates.
- Association between Maternal Anthropometric Indices and LBW in neonates.
- Association between other maternal risk factors and LBW in neonates.

II. METHODOLOGY

This review was done based on the search strategy adopted to identify published studies using keywords like: maternal nutrition, maternal risk factors, low birth weight infants and birth outcomes in India. The search was done on "PubMed", "Research Gate" and "Google Scholar" searches engines from April to May 2021.

The articles were also obtained from other peer-reviewed Indian and International Journals done among Indian population. The year limit was set to previous five years (2016 to 2020) to identify only the recent and accurate current data for this study. A total of 20 articles were obtained, out of which 12 articles were included in this study.

1. Study Design:

Quantitative Review: Descriptive Analysis

2. Study Participants:

Post-pregnancy women in rural or urban parts of India.

3. Inclusion Criteria:

- Cross-sectional, survey, review and mixed method studies were included from India between 2016 to 2020 which were published in English.
- Primary motive of the studies must be the association of maternal nutritional and other risk factors causing LBW in neonates from India.
- Post-pregnant women of any age in India were included in this study.

4. Exclusion Criteria:

- Interventional and Policy analysis studies were excluded.
- Other women were excluded.
- Studies done in foreign countries were not used for review.

III. REVIEW OF LITERATURE

1. Nutrition during Pregnancy:

Many researchers have conducted many studies which determined the association between maternal nutrition and the nourishment of the unborn child. The neonate is entirely dependent on the mother for both macro and micro nutrients which if not adequately present in the mother could lead to adverse growth failure leading to LBW in the neonates.

ICMR in 2010 guidelines for Recommended Dietary Allowances (RDA) for pregnant women in India had recommended an additional intake of 350 kcal/day of energy, 23 g/d of protein, 30 g/d of fats and other micronutrients like calcium 1200 mg/d, retinol (vitamin A) 800 µg/d and iron 35 mg/d [10].

Certain other International Organizations like FAO, WHO and UN had recommended that the increase in energy intake for pregnant women in first trimester must be 85 kcal/d, in the second trimester it should be 285 kcal/d and during the third trimester it should be increased by 475 kcal/d [11].

Micronutrient rich foods like green leafy vegetables, dairy products and fruits are reported to be consumed inadequately by poor women from rural and urban India [12, 13]. Milk consumption among women also had a direct association with the birth weight of the neonates [14].

1.1 Intake of Macronutrients: Women with a caloric intake of less than 70% of RDA and 60% less protein during third trimester had delivered LBW babies [15, 16]. Caloric supplements lead to improvement in birth weight and reduced the incidence of LBW in the newborns [17]. There was found to be a positive association between calorie, protein and calcium in the final trimester with birth weight of the neonates [18, 19]. Studies also proved that maternal fat intake was positively associated with gestational weight gain and length of the neonates [20]. High concentrations of Omega-6 fatty acids and low concentrations of Omega-3 fatty acids led to LBW in neonates [21, 22]. Low consumption of Fish or decreased intake of Eicosapentaenoic Acid (EPA) during the final trimester was also directly associated with LBW in the newborns [23].

1.2 Intake of Micronutrients: Majority of the pregnant women were found to be consuming less than 50% of the RDA for Iron, folic acid, zinc, magnesium and copper [24,25]. Few studies showed a positive correlation between micronutrient intake of mother and LBW than their macronutrient consumption. Iron intake through both foods and supplements showed to reduce LBW in infants which was very must prevalent among those who consumed Vitamin C along with iron [26]. Fetal skeletal development and bone formation and growth were directly linked to the optimal intake of calcium and vitamin D by the mother [27]. Increased levels of pantothenic acid, biotin, magnesium and vitamin D had positive birth weight outcomes [28]. Certain studies proved that a higher than RDA intake of protein had negative association with birth weight of the neonates but did not significantly result in LBW [29].

2. Antenatal Micronutrient Deficiencies:

2.1 Anemia: Maternal anemia was the major cause for perinatal mortality, LBW, neonatal mortality and preterm infants as proved by many studies which were conducted in both low and middle income countries [30]. Maternal hemoglobin levels was one of the determinants for birth weight of the neonates as well as the type of delivery that woman would experience [31]. The low levels of transfer in saturation, cord serum iron and ferritin concentrations had relationship with maternal hemoglobin leading to adverse iron status in the mother as well as depleted iron stores in the neonates [32]. Iron supplementation proved to be beneficial in increasing mother's iron stores and reducing risk of delivering LBW babies [33]. Iron deficient mothers were known to giving birth to iron deficient newborns when compared with healthy mothers [34, 35].

2.2 Vitamin B12 Deficiency: Antenatal vitamin B12 consumption had a positive association with birth weight in Indian neonates. Depleted vitamin B12 stores in the mother during all of the three trimesters had a significant impact on delivering an Intrauterine Growth Retarded (IUGR) [36] or LBW [37] baby than those mothers with adequate vitamin B12 stores.

2.3 Zinc Deficiency: Complications of pregnancy and delivery (retarded growth, retarded neuro behavioral and immunologic development and other congenital abnormalities) was associated with zinc in very few studies [38]. Zinc supplementation for mothers proved to have a positive effect on birth

weight of the neonate [39]. The birth weight was also associated with maternal serum iron, zinc and calcium concentrations [40].

2.4 Iodine Deficiency: Pregnancy outcomes such as mental retardation, increased pregnancy loss, preterm delivery and cretinism which was the result of severe iodine deficiency [38]. Maternal urinary iodine concentration increase was related to healthy birth weight and length of the neonates.

2.5 Other Minerals and Trace Elements Deficiency: Complications relating to fetal development, pregnancy and delivery was also linked with deficiency of other vital minerals like calcium, magnesium, copper and selenium [38]. Continuation of magnesium deficiency throughout pregnancy up to lactation and weaning decreased the weight of the infant after birth [41]. Neonates born with LBW were found to feature decreased presence of minerals like iron, zinc and calcium in their umbilical cord blood than those neonates born with healthy weight [40].

3. Maternal Anthropometry:
Maternal nutrition status has a direct association with weight and height of the infant. A prolonged poor nutrition in the woman before and during pregnancy has a higher chance of producing LBW neonates and can also cause stunting after birth [42].

Usually anthropometric indices are used as a diagnostic tool for identification of poor weight gain and nutritional status of a mother, which can be corrected with proper dietary advices and practices once identified [43]. Maternal height, weight and Body Mass Index (BMI) were directly linked to LBW in neonates [44].

3.1 Maternal Weight: Prenatal maternal weight and weight gain during 6 to 9 months are found to be positively determined with birth length and growth between 3 to 6 months of gestation [45]. LBW (between 48 to 248 g) was increased among mothers indicating low weight gain during the second trimester (below 5.7 kg weight gain) [46].
3.2 Maternal Height: The chance of being stunted in children whose mother was less than 145 cm has high compared to those women with an increased height [47].

3.3 Maternal mid Upper Arm Circumference (MUAC): A mother with MUAC levels below 22 cm was found to reproduce LBW neonates as per African and Indian scenarios [48].

3.4 Maternal Body Mass Index (BMI): Mothers who were underweight (below 18.5 kg/m2) were found to be at an increased risk of giving birth to LBW neonates [49]. Energy (calorie) deficient mothers were associated with delivering LBW babies three times more than normal group mothers [50]. On the contrary, maternal obesity and overweight had been reportedly increasing and were prone to pregnancy and postpartum complications. They were four times more prevalent to be diagnosed with gestational diabetes and two times more prone to develop pre-eclampsia when compared to normal BMI mothers [51].

4. Socio-Economic Status (SES):
This is another major pregnancy outcomes predictor as women belonging to lower income groups, lack of education, unemployment and large families can increase the risk of LBW of babies born to them [52]. Though there is no direct link between SES and LBW in neonates, it is one of the factor for poor nutrition and inadequate knowledge on preventive factors to raise healthy babies.

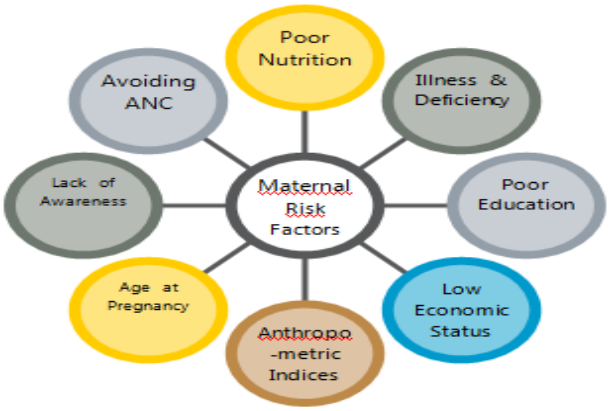

Fig 1. Maternal Risk Factors associated with Low Birth Weight (LBW) in neonates.

IV. RESULTS AND DISCUSSIONS

In an observational study conducted by Mudhaliar, et al., in 2017 [53], they aimed to update the information of pregnant women's nutrition and their infant's outcomes in order to help in the development of protocols for health care. They conducted the study for 6 months which included the assessment of 220 pregnant women regarding their nutritional status.

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They obtained anthropometric measurements, dietary habits through clinical visits. WHO Nutri Survey 2007 calculator was used as a statistical tool. They found that majority (80.45%) women were between 20 to 30 years of age and the rate of illiterate women were 35.45%. anemia was diagnosed among 78.19% pregnant women and their BMI range between 18.5 to 25 (normal) was found in 60.45% pregnant women.

LBW prevalence during study was 87.43%.the study concluded that LBW in India was mostly due to under-nutrition in mothers and that more clear understanding of the relationship between birth size of the newborn and the nutrition of the mother was essential in order to plan effective interventions with a motive to improve pregnancy outcomes and birth weight of Indian babies.

Deka, et al., [54] in the year 2018 conducted a cross sectional study to study various maternal factors which were linked to LBW in newborns. The study was done for a year which included 400 babies selected randomly and was further found that 165 of them were LBW and the remaining 235 were Normal Birth Weight (NBW) babies.

Maternal determinants like age, dietary patterns, weight, height and hemoglobin levels were obtained and was analyzed using Graph Pad Instat Software. Out of many maternal determinants for association with LBW in infants, maternal age, weight and anemia (hemoglobin levels) were found to be significantly associated. The study concluded that the maternal factors were modifiable and can be prevented if medical, economical, educational and social measures were provided to improve the overall health and nutrition status of mothers in order to reduce LBW in India.

A literature review was conducted by Tyagi, et al., [55] in 2017 which aimed to establish a relationship between nutrition status of the mother and LBW in their newborns. It was concluded from the search which included 101 studies that, maternal dietary pattern was one of the major cause attributing to LBW in neonates. Both macro and micro nutrients were found to be playing a crucial role in determining the birth weight of the baby and the pregnancy outcomes in a mother. High risk groups were found to be women with less than 45kg weight, less than 18.5kg/m2BMI and less than 145cm height. Lower socio-economic status along with poor education had indirect association with LBW. Therefore, maternal nutrition was drastically found to be affecting the fetal growth and development which was also attributed due to various other cultural, social and demographic characters.

Zaveri, et al., [56] conducted a cross-sectional study in 2020 on maternal factors associated with LBW in India with data from National Family Health Survey (NFHS-4) in 2015-2016. Stratified two-stage technique was used to assess the maternal risk factors in LBW infants. 17.5% out of 147762 children were found to be LBW. Maternal dietary pattern had a preventive effect on LBW in babies.

Mothers conditions like anemia and underweight were at a higher chance of causing LBW in babies. Iron tablets or syrup was found to be consumed by 95% of the mothers during their antenatal visits to the clinic. Socio-demographic factors like education, caste, religion, income status, geographical region, place of residence were also found to be linked to LBW of neonates.

The study concluded stating that interventions during antenatal visits, supplementation supply, monitoring of dietary patterns had to be done during antenatal clinical visits. Economically backward women must be provided with special care and attention to prevent adverse pregnancy complications and outcomes.

Trivedi, et al., [57] in 2016, conducted a cohort study among 121 mother-baby pairs regarding the association of antenatal nutrition status of the mother on the neonatal development measure during the first thirty days. Nutritional status determination tests like serum total protein, hemoglobin and albumin tests were performed to assess their nutritional status. APGAR sores, birth weight, cord blood albumin and gestational age were evaluated in the neonates and their overall development in the initial 30 days was also noted.

LBW was reported among 39.67% of the neonates and was concluded to be higher among female babies and those who were small for gestational age. It was reported that LBW was more prevalent among poorly nourished mothers and the neonates had lower cord blood albumin levels and also an

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increased health associated problems. Therefore, mother's nutritional status was found to be a major determining factor for influencing the overall development and growth of the infant in the initial 30 days. Optimal nutrition must be promoted in order to reduce chronic diseases in adulthood from fetal development.

A hospital dependent prospective study was done by Shariff & Prakash [58] in 2019 to determine the relationship between antenatal nutrition of the mother on birth weight of the neonates. 50 males and 58 female babies were included in the study. Positive correlation was established in relationship between maternal BMI and birth weight of infants. Hemoglobin levels of mothers did not have a significant association with LBW among male babies. The study thus confirmed the positive correlation of nutritional status of the mother and birth weight of their babies.

A prospective study including 1034 pregnant women in their 28th week of pregnancy was done by Verma & Shrivastava [59] in 2016, which was done for a year and it assessed the nutritional status of those pregnant women through pretested and structured questionnaire along with determination of their hemoglobin levels in a laboratory and they were followed for denoting the outcome in terms of birth weight of the babies until delivery. It was found that majority of the women (51.47%) were found to be consuming 1601 to 1800 kcals and their protein intake was between 51 to 60g. there hemoglobin assessment determined that most of them (44.49%) had hemoglobin levels between 9.1 to 10gm%.

Those consuming between 1401 to 1600kcal/d (61.90%) was found to deliver babies weighing less than or equal to 2000g, on the contrary, those consuming more than 1800kcal/d delivered babies weighing more than 3000g those who consumed protein (4.87%) about 70g had found to deliver babies weighing less than or equal to 2000g while, those consuming 35.48% of those belonging to the same group delivered babies weighing more than 3000g women with hemoglobin levels less than or equal to 7.0gm% delivered babies weighing less than or equal to 2000g but, those having Hb levels more than 10.0gm% delivered babies weighing more than 3000g. This study concluded that, there was a direct link between maternal nutrition and the birth weight of their babies.

Bangal, et al., [60] 2017, conducted a retrospective analysis on rural India's changing birth weight patterns among 45,000 births between the years 2008-2017 from a Tertiary Care Hospital. There was a decline in low birth weight from 47% to 35% over the past decade. The elevation in birth weights noted among male and female babies were 176g and 151g respectively.

They also proved an association between improved socio-economic status of the mother, delay in marriage age, high antenatal weight gain and improved prenatal nutritional status of the mothers having a positive correlation with increased optimal birth weight of the neonates. The study thus proved that there was a sharp decline in LBW in infants in the previous decade and that improved maternal nutrition, health and good quality antenatal care would enhance optimal birth weights in infants born to them.

A comparative, exploratory cohort study was done by Salunkhe, et al., [61] in 2018 which aimed to correlate maternal nutritional status with birth weight of the neonates. A structure interview collecting dietary 24hr recall from 380 mothers randomly selected were obtained. A significant correlation was noticed among maternal nutritional status and birth weight of their neonates. Mothers consuming less than 70% protein (32.2%) were found to be delivering LBW babies. Calcium and Iron intakes were also found to be associated with LBW in infants. Therefore, consumption of quality calories, calcium, protein and iron in appropriate quantities had a strong influence on birth weight of neonates. Maternal weight gain was a strongest anthropometric predictor for LBW in babies.

A tribal study based on National Family Health Survey 4 (NFHS-4) was done by Kumari, et al., [62] in 2021 on 1,93,345 children aged 0-5 years to identify the factors related to LBW. In 165 districts included every fifth child was born with low birth weight and 232 districts recorded high LBW than average in India. Maternal age during pregnancy, education, antenatal care clinical visits and economic index had a direct association with LBW in babies. Therefore it was proved that LBW was highly prevalent among Tribal communities and the major associated factors must be sorted to prevent LBW further in that population. The concern on these tribal communities

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from the government would help in intervening and developing policies to reduce LBW in their population.

A review was done on the relationship between low birth weight and maternal anthropometry indices. It was done by Devaki & Shobha [63] in the year 2018. Maternal prenatal BMI, height, prenatal weight, antenatal weight gain and many other anthropometric indices was directly associated with LBW in their infants.

Pal, et al., [64] in 2020 conducted a cross-sectional study among 2611 pregnant women on highlighting the risk of LBW and other associated factors in West Bengal. Mothers who were pregnant before 20 years and having a BMI of less than 18.5 kg/m2 had higher risk than others. Women weighing less than 45kg and less than 150 cm height were more prevalent to deliver LBW infants. Anemia and Hypertension were also associated with LBW the determinants were found to be preterm delivery and other chronic illness among women. Those abstaining from antenatal clinical visits were also more vulnerable along with women who had not consumed iron folic acid (IFA) tablets and a proper healthy diet during pregnancy.

Lower socio-economic status, illiteracy and rural residence were also other major contributing factors. Therefore, scientific recommendations were provided for prenatal period in order to benefit their term of pregnancy through optimal health and diet and awareness on existing maternal welfare services was also required to reduce LBW in infants.

V. CONCLUSION

From the review done on the above 12 Indian articles on determining the maternal nutrition and other risk factors associated with LBW in neonates, it is found that maternal Nutritional status prenatal, antenatal and postnatal drastically associates with LBW and other developmental factors after birth.

Other potential risk factors associated were (Fig1):

- Any deficiencies or Illnesses in the mother,
- Poor Knowledge and Education of the mother,
- Mothers belonging to lower Socio-economic Status,
- Mothers indicating abnormal Anthropometric Indices,
- Women marrying at earlier age and age at Pregnancy,
- Lack of awareness on health, diet and association with pregnancy outcomes especially LBW in their babies and
- Avoiding Antenatal Clinical Visits (ANC) for monitoring and implementation of interventions during pregnancy.

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