Influences of Intrauterine Exposures Propelling Low Birth Weight: The Chagrin of Babies in the Developing World

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Abstract- Low birth weight (LBW) is one of the major challenges in achievement of the Millennium Development Goals particularly in low and middle-income countries, the incidence in India being reported to be around 28 percent. The risk of a poor outcome in the LBW infants is increased in a background of poor nutrition, both of the mother and the infant. Recent estimates suggest that stunting, wasting, and intrauterine growth restriction are responsible for 2.2 million deaths and 21% of disability-adjusted life years lost among children younger than 5 years [1]. The LBW infant is faced with rapid rate of anabolic processes and brain growth but has poor reserves. Thus the infant's need for optimal nutrition and special care is critical. Deficient nutrition and improper care lead to fatal outcome. LBW is universally the single most important determinant of the chance of newborn to survive and experience healthy growth and development. LBW as a health indicator is very sensitive to socio-economic factors, in particular to adverse conditions such as hunger, draught, infections and physical stress which specifically affect the poorest segment of population. Determinants of LBW need to be studied in order to identify potentially modifiable risk factors. This brief review explores the available epidemiologic data to investigate the questions of what are the causes and consequences of LBW.

Index Terms- Low birthweight, intrauterine growth retardation, nutrition, causes, consequences

I. INTRODUCTION

Low birth weight (LBW) has been defined by the World Health Organization [2] as weight at birth, irrespective of gestation age, of less than 2500 grams. During the period of 2000-2009, the incidence of LBW was reported to be 15 percent globally, 24 percent in the South East Asia region and 28 percent in India [3]. Recent research on child and maternal undernutrition emphasizes a 1000-day window of opportunity from gestation to 24 months of age, as a period of rapid growth [4]. It has been reiterated that damage during this period can potentially be permanent and impacts not only child growth and nutrition, but also cognitive development [5]. However, controversy abounds regarding the potential for LBW infants to catch-up to the typical growth pattern of the normal birth weight term infants of the same age. LBW is an important contributor to a range of poor health outcomes and is also an important predictor of clinical complications during this crucial age.

II. METHODS

The MEDLINE and EMBASE databases were searched for English-language papers published between 1990 and 2014 using a search expression including "low birth weight", "intra uterine growth retardation", "neonatal nutrition" etc. Apart from this journals were accessed at National Medical Library, Delhi. There were 354 papers located in the initial search of which 51 were selected which clearly related to the area of study.
Desk review of research publications in several national and international journals was undertaken. Journals referred to included Journal of Nutrition, European Journal of Clinical Nutrition, Food and Nutrition Bulletin, Lancet, International Journal of Public Health, Public Health Nutrition, Indian Pediatrics etc. Guidelines and reports from various international organizations including World Health Organization, UNICEF and Indian Academy of Pediatrics were reviewed.

Selected articles were reviewed to synthesize evidence from developing countries about the causes and consequences of low birth weight generated from various primary and secondary research.

III. FINDINGS

1. Dynamics involved in determining LBW

LBW, resulting from restricted fetal growth, preterm birth, or both, is a persistent problem in disadvantaged populations of developing countries like India. Intertwined arrays of factors are involved in predicting LBW deliveries during the intrauterine period. Poor nutrition is a known cause of LBW, especially in developing countries.

Table 1: Global and Regional Estimate of LBW (52)

	% LBW infants	Number of LBW infants (1000s)
World	15.5	20, 629
More developed	7.0	916
Less developed	16.5	19, 713
Least developed countries	18.6	4, 968
Africa	14.3	4, 320
Asia	18.3	14, 195
Europe	6.4	460
Latin America & Caribbean	10.0	1, 171
North America	7.7	343
Oceania	10.5	27

1.1 Socioeconomic status: The relative risk for LBW is significantly higher for lower socioeconomic status and primiparity [6]. Subramanyam et al reported that children are less likely to be born with LBW if they have mothers with a higher education (>12 years) compared to low educational levels (1-5 years) [7]. Poor access to good quality antenatal care is a significant risk factor for LBW deliveries [11].

1.2 Age at conception, parity, inter-pregnancy interval and gestational age:According to Raj et al, undernourished girls in developing countries who become pregnant in the growing adolescent phase are at much higher risk of delivering LBW infants [8]. Lenders et al noted that among adolescents, LBW deliveries were found to be more than twice as common as in adult pregnancies and the neonatal mortality rate was almost 3 times higher [9]. The proportion of such women who begin child bearing below 18 years was as high as 16 percent in India as determined by the third National Family Health Survey [10].Conversely, primus, elderly mothers were found to be at risk of delivering LBW babies [11]. Zhu et al observed that women with an inter-pregnancy interval of less than 6 months are 50% percentwere more likely to have an LBW infant [12]. Short gestational age is has also been identified a strong risk factor for LBW [13].

1.3 Maternal Nutritional Status: Maternal height and weight are significant indicators of LBW. Women with low pre-pregnancy BMI, have substantial attributable risk for LBW deliveries [14]. A study among south Indian population identified pre-pregnancy maternal weight less than 45 kg and, anemia during pregnancy as significant risk factors for LBW among term babies [6]. Maternal height has an influence on birth weight, with a height below 145 cm increasing the incidence of LBW [15]. Poor gestational weight gain is also associated with the risk of LBW [14, 16]. Total weight gain of less than 8kg significantly increases the risk of LBW and SGA infants [17, 18].

1.4 Maternal Nutritional Intake: Poor nutrition is a known cause of LBW, especially in developing countries.The diet of women in the pre-conception period and throughout most of pregnancy has a significant effect on birth weight. Intrauterine growth restriction is also associated with poor food availability during pregnancy [1, 20]. In many developing countries, pregnant women often eat less for the fear of the baby becoming too big and causing problems during labour thus giving birth to a LBW baby. Pregnant women are denied good food due to false beliefs. Papaya, a rich source of β-carotene (vitamin A) is considered to be an abortificient and is banned. Banana eating is believed to produce single child infertility, since the banana tree fruits only once [19].

Intrauterine growth restriction is also associated with poor food availability during pregnancy [1, 20]. Intake of macronutrients such as energy [1,21] and protein [22], before and during pregnancy, have the greatest positive influence. Also, higher fat intake during second trimester of pregnancy is associated with improved neonatal length, birth weight and tricep skinfold thickness [23]. Sabour et al found significant correlations between adequate maternal calcium and vitamin D intake and birth weight [24]. Ramakrishnan et al reported that pre-natal docosahexanoic acid (DHA) supplementation of primigravid women resulted in increased birth size in a population where dietary DHA intakes are very low [25]. Birth size has also been strongly associated with the consumption of milk during the second trimester, and green leafy vegetables and fruits during the last trimester of pregnancy [23].

Strong evidence exists for an association between maternal hemoglobin concentration and birth weight with minimal values for LBW occurring at maternal hemoglobin concentrations below the current cut-off value for anemia during pregnancy [26]. At delivery, malarial infection has been associated with severe anemia and a reduction in mean birth weight [27]. Palma et al reported iron supplementation during pregnancy to be effective in reducing the risk of all kinds of LBW babies [28]. Inadequate maternal folate status has been linked to LBW by Molloy et al [29]. Birth size is also strongly associated with the consumption of milk during the second trimester, and green leafy vegetables and fruits during the last trimester of pregnancy [23]. Addressing multiple micronutrient deficiencies during pregnancy in mothers has been found to increase birth weight [30, 31]. Poor access to good quality antenatal care is a significant risk factor for LBW deliveries [11].

1.5 Smoking: Smoking has been observed to be the strongest lifestyle related predictor of LBW. Evidence exists for the influence of environmental tobacco smoke exposure and risk for LBW babies [33]. Direct dose response relationship exists between the number of cigarettes smoked and the risk of fetal growth retardation. Women whose partners' smoke are also at a higher risk of having a child with growth retardation. The effect of maternal smoking on LBW seems to be attributable to IUGR rather than preterm delivery [34]. In a cohort study, maternal smoking during early pregnancy was found to be a risk factor for LBW with small for gestational age (SGA) outcome and for LBW with full term birth [35].

1.6 Stress: In a few studies, poor maternal mental health has mediated the link between domestic violence and LBW [36]. Increased physical stress due to increased workload during harvest seasons has been associated with worsening in maternal nutrition status and LBW in a study from India [37].

1.7 Seasonality: Several studies have documented seasonal variation in birth weight, but results are far from homogeneous. In most epidemiological studies, summer has been associated with relatively lower birth weight, possibly because of exposure to cold temperature during early or mid-pregnancy, and babies born in fall or winter have relatively higher birth weights [38].

2.Implications of LBW

Over 18 million babies are estimated to be born with LBWs every year of which half are in south Asia [39]. Many of these neonates tend to suffer from increased risk of adverse outcomes during infancy such as increased morbidity and mortality, physical growth retardation and cognitive impairment, along with an increased risk of adult chronic diseases.

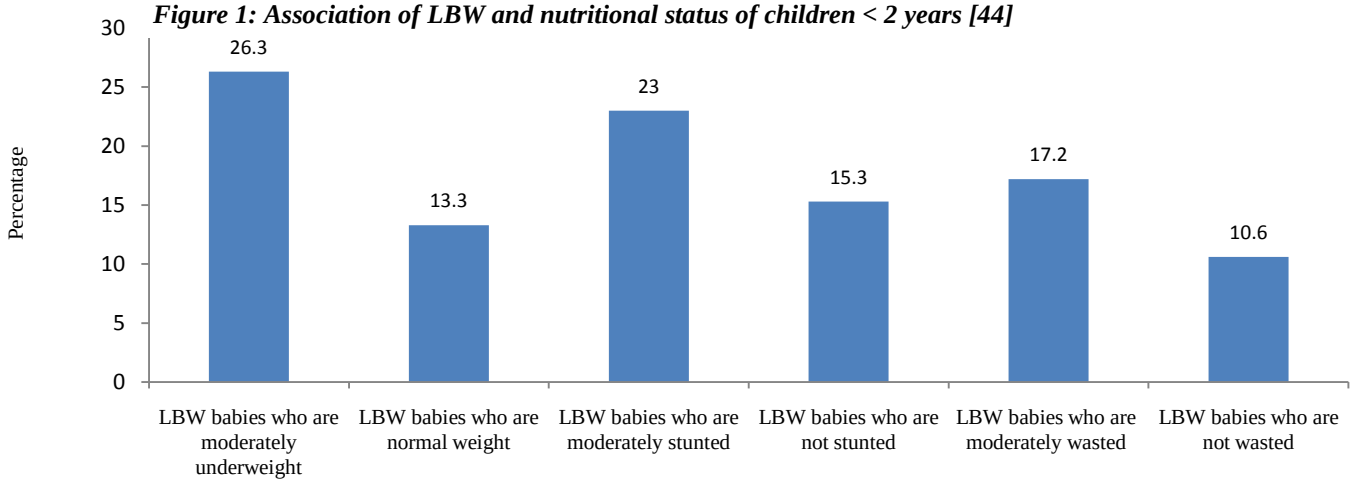
2.1 Infant mortality and morbidity: Infants born with LBW at term weighing 1500-1999 grams are 8.1 times more likely to die and those weighing 2000-2099 are 2.8 times more likely to die from all causes during the neonatal period than are those weighing 2499 gram at birth.

Globally, a neonatal mortality rate (NMR) of 24 per 1000 live births has been reported. In India, more than two-thirds of infant deaths happen in the first 28 days of life [3] of which nearly 82 percent occur among LBW infants, which is the highest in the world [40]. It has been shown that LBW plays an important role in almost 60 percent of neonatal deaths occurring due to birth asphyxia and infections [1, 41].

The scenario in India is detrimental. The infant mortality rate (IMR) in India continues to remain high at 50 per 1000 live births. The total number of deaths of children under five years, fell from 12.4 million in 1990 to 8.1 million in 2009 worldwide [3]. However, with an under five mortality rate of 66, India's position is detrimental in comparison to even the South East Asia region average of 59. Prematurity and LBW (14%), diarrhea (13%) and pneumonia (20%) have emerged out as the major causes of death in the under-five age group in India [42].

Reduced weight, poor immunity and a poor insulation because of lack of fat as the source of energy makes LBW babies susceptible to the risk of frequent infection, hypothermia, and poor growth, impact of which is maximum during the neonatal period. LBW is also implicated as a contributor to impaired immune function, which may be sustained throughout childhood [43].

Figure 1: Association of LBW and nutritional status of children < 2 years [44]



2.2 Undernutrition as a silent killer: Infants born with LBW suffer from underweight, stunting or wasting beginning in the neonatal period through childhood. The proportion of children who are moderately underweight or moderately stunted is higher in LBW babies [44]. As per NFHS-3, a third of the LBW infants in India have wasting and a fifth are stunted at birth and within the first 6 months of life [10]. High prevalence of postnatal malnutrition in LBW infants has been linked to lower gestation, poor intrauterine growth, lower birth weight, infant sickness and poor post-discharge weight gain [45].

The growth pattern for weight and length show good catch-up growth in babies with birth weight of more than 1.25 kg, reaching almost the same level as infants born with weight appropriate for gestational age by 1 year of age. Babies with birth weight less than 1.25 kg show late and poor catch-up growth, with considerable lag persisting at 1 year of age [46].

2.3 Psychomotor and Cognitive Development: Term LBW is associated with cognitive and behavioral deficits in children and adults [47]. There are few studies of the development of term LBW infants in developing countries in which LBW is usually associated with poverty and inadequate stimulation in the home as well as poor postnatal growth. These disadvantages may increase the children's risk of poor development [48].

Neonatal complications may have a larger detrimental effect on long term cognitive development of LBW infants [49]. A study by LatanHajnal et al among LBW infants [50] found that at two years of age, children who did not catch-up in growth had lower psychomotor development than those who experienced catch-up growth.

IV. CONCLUSION

The National Plan of Action for Children 2005 [51] committed India to reducing LBW and malnutrition and LBW in children (age <5 years) by half from 2005 to 2010. Needless to say, this still remains a formidable challenge due to high incidence of LBW and poor care of this disadvantaged population thereafter. In the last few decades, increasing numbers of smaller babies

have survived due to technological advances and exhibit much more health, growth and developmental disabilities than normal birth weight babies.

Globally many studies have been carried out to assess the magnitude and determinants of LBW. It is now acknowledged that many factors can influence the occurrence of LBW including some important ones like maternal nutritional status both at the time of conception and during pregnancy; socio demographic variables such as age, education and occupation of mother; and access to health care. There is still considerable confusion and controversy about the factors that have independent effects on LBW as well as the quantitative importance of these effects. One of the reasons is that many of the potential determinants are highly associated and their effects are thus mutually confounded. The study of LBW is all the more important since sub-optimal birth weight may have consequences in the perinatal period, during infancy, and even in adulthood. In the first place, perinatal morbidity and mortality are more frequent in LBW infants than in normal infants. Infants who survive suffer from impaired physical growth and psychomotor development. Finally, several epidemiological studies have suggested that infants born with IUGR have a higher risk of developing metabolic syndrome in adulthood.

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