Chapter I

Introduction and Review of Literature
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1.1 Introduction

The present chapter deals with low birth weight (LBW), its causes, effects, prevalence, and method of reporting, heaping, mother’s nutritional level and its determinants across various state and regions of India. The related literatures on LBW were reviewed.

Low Birth Weight (birth weight < 2.5kg) has been a problem of constant worry in the world, especially in developing countries like India (Aparajita Dasgupta et al., 2011). Low birth weight infant remains at much higher risk of mortality than the infant with normal weight at birth. Low birth weight is a strong predictor of an infant survival. Infant mortality is a major public health problem in India.

Low birth weight is a key indicator of the health trajectory of a child. In addition, to being an intrinsic endpoint, low birth weight is associated with numerous adverse health outcomes in childhood and adulthood. The problem of LBW is multidimensional, and its need an integrated approach incorporating medical, social, economical and educational measures to address issue (Metgud CS, et al., 2012). The major challenge in the field of public health is to identify the factors influencing low birth weight (Rahul HD et al., 2014).

Children’s health is tomorrow’s wealth is one of World Health Organization (WHO)’s slogans in recent years (WHO, 2015). Birth weight is an important indicator of a child’s vulnerability to the risk of childhood illness and chances of survival. The incidence of LBW has been selected as an important indicator for monitoring major health goals by the World Summit for Children (UN, 2002).

1.1.1 Low birth weight, its cause and effects

Low birth weight infants are vulnerable for early growth retardation, inflated with infectious disease and also considered to be the death during infancy and childhood (WHO, 2015). Here LBW is the dominating risk factor for infant morbidity and mortality. The literature suggested that LBW infants are more likely than normal
birth weight infants to have neuro developmental complications and congenital abnormalities. The risk increases both by lower gestational age and weight (Sidhu et al., 2009). Moreover, LBW babies are more likely to suffer from the disabilities in form of developmental delay, poor growth and mental disabilities. It is also postulated that the most common cause of morbidity and mortality are associated with low birth weight babies (Maheswari et al., 2014).

The World Health Organization (WHO) defines the term Low Birth Weight (LBW) as birth weight less than 2500 grams. Nearly, 50% of neonatal deaths occur among LBW babies. The survivors remaining 50% are at a high risk of being malnourished and prone for recurrent infections and neuro developmental handicaps and congenital abnormalities (Col Singh et al., 2009). The study conducted by Gosavi SV et al., 2011 reports that teenage pregnancies and primiparous women are higher risk of LBW. Certain maternal characteristics like smoking during pregnancy are also associated with LBW. Mothers who continue to smoke in the second half of pregnancy is higher baby's risk of LBW (Chan DL, et al., 2008).

Birth weight determines the future mental and physical development of the newborn (Alexander GR, et al., 2007). There are multiple causes of low birth weight, including early induction of labour or caesarean birth (for medical or non-medical reasons), multiple pregnancies, infections and chronic conditions such as diabetes and high blood pressure (Kim D et al., 2013). Age effect is through pregnancy complications that lead to preterm delivery and LBW. Prospective parents may inform about the higher risk for neonatal morbidity associated with delayed childbearing. Health care providers may aware of the impact of delayed childbearing on health care resources (Tough SC, et al., 2002).

1.1.2 Pattern of reporting birth weight

In developing countries, majority of birth occurs outside health facilities. This phenomenon causes difficulty in obtaining precise data on birth weight (Channon et al., 2011). Many infants are not weighed at the time of birth; these difficulties are in the form of unavailability of formal record of birth weight and birth certificate (Channon, 2011). The method of recording birth weight data can affect birth weight estimates in developing countries.
Low birth weight is internationally recognized indicator for the predictor of an individual baby's survival. Birth weight is an important variable both for policy and research, but accurate birth weight data from the developing countries is lacking (Rekha, et al., 2014). The data on birth weights are assimilated through Cross-sectional surveys. They enable to arrive for national estimate of mean birth weight and its prevalence. In case of availability of large sample size, regional estimates within a country are also possible (Boerma JT, et al., 1996). Hence, accurate reporting of prevalence of low birth weight is important for monitoring health of a population. Health systems in poor countries should initiate efforts to systematically monitor the recording of birth weight data ensuring for both quality and comparability at the international levels (Channon et al., 2011).

There are many facets of LBW like problem of heaping and maternal assessment of birth size. Heaping is an important concern in reporting a birth weight. LBW is often underestimated in developing countries due to heaping of the data at 2500 grams. Heaping represents misclassification that arises when measured birth weights are rounded to the nearer grams and grouped into weight classes. There is a need to possible biases from misclassification may be carefully evaluated (Umbach DM et al., 2000). Birth weights reported by mothers are “heaped” on multiples of 500 grams (Ann K. Blanc et al., 2005). The validity and reliability of maternally reported pregnancy and delivery information may differ with the nature of the factor of interest, but is affected little by time from birth or case-control status (Olson, et al., 1997).

In many developing countries the majority of infants were not weighed at birth. Health cards displayed less clustering on certain digits than memory recalled weights. Heaping of birth weight data on multiples of 500 grams was observed in method of reporting. The method of recording birth weight data can affect birth weight estimates in developing countries (AAR Channon et al., 2011).

The estimates of low birth weight derived from survey in developing countries are likely to portray an overly optimistic picture of children’s and women health status. More information about the underlying source of these data are needed not only to provide additional insight into the degree of error characterizing existing
estimate, but also improve data collection strategies in future health interview surveys (Arodys Robles et al., 1999).

In situations where the exact birth weights are not available, the maternal assessments of birth size are taken into considerations. However, such assessments serve as poor proxy indicators of birth weight, as they underestimates the actual prevalence (E. Eggleston et al., 2000) and infants for whom birth weights are missing may not be comparable to those for whom weight is reported. Consequently, there is higher likelihood of such birth weight to be low birth weight. Thus, relying solely on reports of numeric birth weight will underestimate the prevalence of low birth weight.

Infants with missing birth weight records are more likely to be low birth weight (LBW). As infants with missing birth weight data have different characteristics from those with recorded birth weight, estimates of LBW depending solely on available birth weight records will produce a biased prevalence. Health personnel should record actual birth weight without rounding. They may inform mothers of the birth weight and advise them to retain health cards for future reference (MM Islam, 2014).

1.1.3 Prevalence of Low Birth Weight

Worldwide more than 15-30 million infants are born annually, of which one fifth births are low birth weight. The developing countries account for major burden 96% (Rekha et al., 2014). Prevalence of LBW represents the scenario of infant’s health risk in the country. The level of low birth weight in developing countries (16.5 per cent) is more than double the level in developed regions 7% (UNICEF, 2004). According to UNICEF, in developing world 15% of infants or more than 1 in 7, weighs less than 2500 gram at birth.

India has highest number of low birth weight babies each year approximately 7.4 million and percentage of infants with low birth weight is 28% (UNICEF, 2011). India accounts for 40% of low birth weight births in Asia (PS Thomre et al., 2012). The importance of empowering women in India to combat the high prevalence of LBW (Chakraborty et al., 2011).
The goal is to achieve a 30% reduction of the number of infants born with a weight lower than 2500 grams by the year 2025 (WHO, Geneva, 2012). This would translate into a 3.9% relative reduction per year between 2012 and 2025 and a reduction from approximately 20 million to about 14 million infants with low weight at birth.

1.1.4 Effects of Mother Nutrition’s on Low Birth Weight

The prevalence of low birth weight (LBW) is higher in Asian countries than elsewhere, predominantly because of under nutrition of the mother prior to and during pregnancy (Sumithra et al., 2009). Mother’s with low body mass index pre-vulnerable for complications during pregnancy and also at time of delivery. Such complications may lead to preterm birth, lower birth weight and even risk of neonate mortality (Kalk et.al, 2009).

Mothers’ nutritional status is the most important determinant of newborn children’s birth weight. Mothers’ BMI impact was more pervasive across India than the impact of other factors on birth weight (A. Dharmalingam, 2010). Intake of healthy diet providing before conception and throughout pregnancy have no overall effect on birth weight (Potdar, et al., 2014). Adequate and quality dietary intake by mother is an important determinant for the birth weight of the newborn (KK Sahu et al., 2015).

Low birth weight proportion is reported to be higher in teenage pregnancies and primiparous women, therefore, along with teenage pregnancies and primiparous mothers need special attention during the antenatal check-ups (Gosavi SV et al., 2014). It is essential to provide proper diet and nutritional care of mothers during pregnancy. Increased education of mothers through programmes in TV and newspapers articles have significant roles to play in reducing LBW in India (Bharti P et al., 2011). Overweight is found to have a protective effect in short-statured mothers, indicating that a surplus of energy may diminish the risk of LBW. Short-statured younger mothers, but not taller ones, showed higher risk of LBW. The mother being underweight, regardless of stature, is associated with LBW (Britto et al., 2013). Reducing the prevalence of low birth weight, public health strategy needs to focus attention on better maternal nutrition and education (Agarwal et al., 2012).
1.1.5 Determinants of Low Birth Weight

Birth weight is an important variable for measuring the quality of the prenatal medical and social environment, as well as predicting future individual health outcomes (Malavika et al., 2010). The study by (Choudhary et al., 2014) detected association of LBW with the socio-demographic and maternal characteristics. The authors found that mother's with inadequate ANC service utilization and unwanted pregnancies are more vulnerable for low birth weight deliveries (Negassi et al., 2014). The maternal smoking is another risk factor for LBW, as this may lead to intrauterine growth retardation, rather than preterm delivery (Horta BL et al., 1997). The increase in preterm deliveries and multiple gestations were found to be the important factors with regard to the increase in LBW infants in Japan on the contrary; prevalence of maternal smoking was not substantially associated with the increase in LBW infants (Takimoto H et al., 2005).

There are many other contextual risk factors contributing to increasing prevalence of LBW infants. The prevalence was detected to be higher among mother's of rural settings, living in a community with a high concentration of poverty and a low coverage of safe water supply. Hence implementing appropriate community-based intervention programmes are likely to reduce the occurrence of LBW infants (Kayode GA et al., 2014). Moreover, women who give birth in a hospital are probably of a higher socioeconomic status than women who deliver at home and thus are less likely to give birth to LBW babies (Moreno et al., 1990; Boerma et al., 1996). Therefore, pregnant women should be encouraged for institutional deliveries.

In addition to socio-demographic and maternal characteristics, certain amenable maternal factors also affect birth weight. The education of mothers, socioeconomic status, anemia and parity and spacing period were the influential factors on birth weight of child, in a study by AK Jawarkar et al., 2012. In another study, factors associated with LBW were maternal education, stature, age at delivery; short inter pregnancy interval, inadequate antenatal care, and per capita income of family (Joshi H.S. et al., 2010).
The LBW impose major public health burden in the developing country, hence strategies such as pre-pregnancy screening, early antenatal booking and proper identification of high risk-mother needs to be strengthened. Targeted interventions in the form of health education, socioeconomic development, maternal nutrition, and increasing the use of health services during pregnancy may minimize the occurrence of LBW (Bendhari et al., 2015). The prevalence of LBW can also be reduced by increasing the gestational age, regular antenatal checkup, and balanced diet during antenatal period, adequate rest during antenatal period and avoiding the tobacco chewing (Agarwal et al., 2015). Health care during pregnancy and management of high-risk factors for LBW may reduce the incidence of LBW and the death rate of LBW infants (Chen et al., 2013). Devising interventions targeted at improvement in maternal education and nutrition status, thereby reducing anemia; increasing availability of contraception to delay age at first pregnancy; prolonging intervals between births; and ensuring appropriate care for mothers at greatest risk of delivering a LBW (Hirve SS et al., 1994), can be effective means to address the problem of LBW more effectively.

1.1.6 Region Specific Low Birth Weight in India

The review of literature on the epidemiological aspects of LBW in India, suggests that nearly one fifth of newborns have LBW (Bharati et al., 2011), with preponderance among females. Mother’s education; access to TV; nuclear family; and intake of iron tablets are the most important socio-economic parameters influencing the birth weight in India. From time to time the phenomena of LBW have been the topic for research from various parts of India.

The 'North' and 'North-East' zone of India has respectively the highest and lowest prevalence. In the northern region, prevalence of LBW is 40% and LBW babies are more likely to have developmental delay, poor growth and mental disabilities (Agarwal et al., 2012). A study in border district of Uttar Pradesh identified, birth order, mode of delivery, parity and gestational period as the major risk factor of LBW, with prevalence of 38% (Kaushal SK et al., 2012). In another study from rural area of Uttar Pradesh, higher prevalence of LBW (Mavalankar DV et al., 1992), was revealed and reported significant association with maternal weight; hemoglobin level; energy intake by the mother and average gain in weight in third
trimester, with birth weight of the neonates. In another study by Arohi Dalal et al. 2014, from Ahmadabad that reducing teen age pregnancy; improving nutrition during adolescence; increasing coverage of antenatal visits; encouraging wider birth interval and avoiding tobacco chewing, can serve as an important strategies for reducing the LBW. In yet another study from northern India, Ahmadabad, found that a substantial proportion of term and preterm LBW births may be averted by improving maternal nutritional status, anemia and antenatal care. A study in rural area of Uttar Pradesh revealed that still the prevalence of LBW is on higher side (KK Sahu et al., 2015). One hospital based study from central region of India, Madhya Pradesh, estimated prevalence of LBW as 36.8%, and depicted gestational and parity as important maternal parameter influencing the birth weight of child (Noor et al., 2015).

Study in rural area of western Maharashtra is identified that a large number of mothers are either not or inadequately utilizing antenatal care services. Many risks factors for LBW can be identified, prior to occurrence of pregnancy. Health education, socio-economic development, maternal Nutrition, and increasing the use of health services during pregnancy, are all important for reducing LBW (Deshpande Jayant D et al., 2011). In western India it was found that high risk pregnancies and mothers with ≤2 years of birth spacing predicted chances of LBW (Patel et al., 2015). A study from Tamil Nadu emphasized the need for improving maternal health, quality and utilization of antenatal care, weight gain during pregnancies, prevention, and proper management of risk factors such as anemia, along with improving socioeconomic and educational status of mothers (Kandhasamy et al., 2015). A study in Bihar among labor class, estimated prevalence of 70%, and revealed linkage of maternal factors like age, socio-economic status, religion and occupation and with LBW (Shahnawaz et al., 2014).

A study of the Primary health centre of north Karnataka focused the attention on health education of prospective mothers and discouraging teenage pregnancy. Programmes directed at girls and women much before pregnancy are needed. Women and girl child education should be given the desired attention as showed strong correlation with risk of LBW, with prevalence of LBW as 8.3% (Rakesh et al., 2013).
A longitudinal study in a rural block of Assam discovered that LBW babies had higher rate of weight gain during the first 6 months of age, but remained significantly lighter than the NBW infants (Madhur et al., 2014). In subsequent year, during the follow up, incidence of morbidities like acute respiratory infection, diarrhea, skin disorders, fever and ear disorders were higher among the LBW babies compared to NBW babies (Madhur et al., 2015). A community based cross-sectional study in a rural block of Assam, reported the prevalence of 21.8% and highlighted the need for information, education and communication (IEC) activity in intensified manner for determining LBW, and at the same time lowering its level (Madhur Borah et al., 2014).

In summary, keeping in view of the findings recorded under the studies mentioned above, globally, 15-30 million infants are born annually, of which one fifth births are LBW. In developing countries most of the birth occur outside of the health facility, so proper reporting of birth weight is lacking and thus prevalence of LBW gets under estimated. The available studies identified numerous risk factors for LBW at state and regional levels in India. Furthermore, prevalence of LBW gets under estimated due to pattern of birth weight reporting through health card or mother memory recall (birth weight or birth size) and prevailing of heaping. There exits regional variability in the prevalence of LBW from as low as 8.3% from southern region to as high as 40% from northern regions. Hence, there is need to conduct studies in India from time to time for updated epidemiological understanding behind the occurrence of LBW. Such studies enables in providing better evidence and clues to plan future public health programs.

1.2 Need of the Study

The review of literature divulges major public health burden associated with the LBW. Still there is dearth of studies aimed at providing ample evidence in the reporting of LBW, the regional variability across India and their determinants. As evident from the available literature, very few study attempted at utilizing the available large scale quality data like NFHS to carry out systematic analysis of existing burden of LBW and related epidemiological models. Thus there is need for enhancement in the epidemiological information on LBW in India. With these views
in mind the present study has been carried out to answer some of the pertinent questions like (i) why recording of birth weight in India is still very poor, as per NFHS-3, only 34.1% of children had birth weight recording; (ii) what are the alternative way to overcome the problem of LBW, for example, to assess the burden of LBW, data on mother’s reporting on size of the children may be used; (iii) what can be the methodological benefit of comparing the reporting of LBW and maternal assessments of birth size. Such studies from time to time will substantiate the epidemiological evidence on LBW, and also provide insight for planning appropriate interventions. Epidemiological model on LBW for the country as whole as well as for specific region may provide additional clues for the policy planners. Realizing the burden of LBW and the public health problem that it imposes, the subject has been investigated deeply.

1.2.1 Research Questions of thesis

Keeping in view of the existing literature, the roll provide ample evidence on the etiology of LBW, however many relevant questions still remains unanswered like (i) what is the extent of birth weight reporting and quality of the data? Is there any solution to the problem of non-recording of birth weight in India? (ii) What is the burden of low birth weight in India? (iii) Whether this burden varies across the states/regions? (iv) Do the women with poor nutritional status (measured in terms of body mass index and anemia) are more likely to produce children of low birth weight?

1.2.2 Objectives of the thesis

The objectives under the present study are as; (i) to assess the data quality and compare two methods of data collection on low birth weight in India. (ii) to provide revised estimates of low birth weight for India and states after adjusting weight heaping at certain digits. (iii) to develop epidemiological model investigating the association between mothers nutritional status and low birth weight in India. (iv) to develop regional models assessing region specific determinants of low birth weight in India.

1.3 Outline of the Thesis
The present investigation under the entitled “An Epidemiological Study of Low Birth Weight in India: Bio-statistical Appraisal” is organized into seven chapters as follow.

**Chapter I: Introduction and Literature Review**

The chapter contains a brief introduction of the topic including review of literature. Further, the need for undertaking the particular research problem and the objectives of the thesis are mentioned.

**Chapter II: Materials and Methods**

The study is based on the secondary data obtained through; third round of National Family Health Survey (NFHS-3) data. The analyses are carried out for different background characteristics like education of mother, place of residence, caste of mother, birth order, religion, region and wealth quintile index, etc. Statistical techniques and analytical methods are explained in details.

**Chapter III: Measurement issues of Low Birth Weight in India**

This chapter deals with the measurement issue of birth weight in India and its states. The chapter covers the pattern of reporting system of birth weight in India and its states and also examined the heaping at certain digits in reporting of birth weight in India and regions by mother memory recall and health card. The agreement analysis was performed to find the accuracy between birth weight and birth size at the time of data reporting.

**Chapter IV: Prevalence of Low Birth Weight in India**

The prevalence of low birth weight with adjustment of birth weight heaping and its association with various covariates in India. Part of the present chapter form, Ratio method was used for calculating the revised estimate of low birth weight in India. Adjusted low birth weight mentioned in place of revised estimate of low birth weight in the result. It was calculated for different background characteristics in India and its states.

**Chapter V: Mother's Nutritional Status and Low Birth Weight in India**
This chapter deals with the association between mother's nutritional status and low birth weight in India and its states. Nutritional level of mothers has assessed using BMI and Anemia level. Body Mass Index (BMI) was defined as weight in kilograms divided by height in meters squared (kg/m2). A cut-off point of <18.5 is used to define thinness or underweight, 18.5 to <25 is used to define Normal weight and a BMI of 25 or above indicates overweight or obesity (NFHS, 2005-06). Anemia level was divide into two categories for analysis purpose: anemic and not anemic.

Chapter VI: Determinants of Low Birth Weight in Different Regions of India

This chapter deals in based on the results are obtained by analyzing the regional issues and determinants of low birth weight in India. The key factors affecting in various regions of the country has also studied in this chapter. India is divided into six regions in the data set as East; West; North; South; Northeast and Central regions. Basically, we have considered reporting and prevalence of low birth weight in different regions.

Chapter VII: Summary and Conclusions

This chapter includes a brief discussion on policy recommendation emerging from the study.