# PREDICTORS OF BIRTH WEIGHT: A PROSPECTIVE STUDY AT TERTIARY CARE HOSPITAL OF BELGAUM, KARNATAKA, INDIA

**Thesis Submitted to**

THE KLE ACADEMY OF HIGHER EDUCATION AND RESEARCH

(KLE UNIVERSITY), BELGAUM

[Declared as Deemed-to-be-University u/s of the UGC Act, 1956 Vide Govt. of India Notification No.F.9-19/2000- U.3 (A)]

**(Accredited 'A' Grade by NAAC)** **(Placed in 'A' Category by MHRD, GOI)**


**For the Award of the Degree of Doctor of Philosophy**

**In the Faculty of Medicine**

**(Discipline: Public Health)**

By

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**JULY, 2014**

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# ACKNOWLEDGEMENT

It is my privilege to extend the sincere thanks to those personalities who remain precursors on my academic growth and supplemental to enrich professionals skills. In this regard, I am indebted to **THE KLE ACADEMY OF HIGHER EDUCATION AND RESEARCH (KLE UNIVERSITY), BELGAUM, KARNATAKA** for providing an excellent platform to study the Doctor of Philosophy; and the executives of **POKHARA UNIVERSITY, KASKI, NEPAL** for endorsing leave for the Ph.D. study.

It is an immense contentment for me to express my deepest sense of gratitude to **Dr. Vijaya A. Naik,** Professor and Head, Department of Public Health, Jawaharlal Nehru Medical College, Belgaum for her selfless encouragement, commitment and dedication in supervising my research work. Similarly, my special thanks go to **Dr. B. R. Nilgar**, Professor, Department of Obstetrics and Gynecology, Jawaharlal Nehru Medical College, Belgaum and the Controller of Examinations, KLE University whose guidance and support made me to advance the research skills. The continuous guidance of Professor Naik and Professor Nilgar during the study was crucial to materialize the conceptual blocks into the well furnished intellectual property. Their focus on "building the concepts", "digging into deep" and "translating into objective terms" throughout the analysis and report writing has advanced my analytical and critical research skills.

My sincere thanks go to **Mr. M.D. Mallapur**, Assistant Professor, Department of Biostatistics and Epidemiology, Jawaharlal Nehru Medical College, Belgaum and **Dr. S.B. Javali**, Associate Professor, Department of Community Medicine, USM-KLE

International Medical Programme, Belgaum who have enlighten me through statistical knowledge, skills and applications. Their conscientious and judicious guidance made me to translate the rough data into meaningful results. Similarly, I am extremely thankful to **Dr. Chandra S. Metgud**, Professor, Department of Community Medicine and **Dr. Anita Dalal**, Professor, Department of Obstetrics and Gynecology, Jawaharlal Nehru Medical College, Belgaum for their technical guidance.

It is my privilege to acknowledge **Dr. Chandrakant Kokate**, Honorable Vice-Chancellor, KLE University, **Dr. V. D. Patil,** Registrar, KLE University and **Dr. A.S. Godhi**, Dean, Faculty of Medicine, KLE University for their administrative support and academic encouragement. Likewise, I am grateful to **Dr. S.G. Karadesai**, Director Academic Affairs, **Dr. K.R. Alagawadi,** Assistant Registrar (Academics), KLE University; **Dr. R.S. Mudhol,** Medical Superintendent, KLE's Dr. Prabhakar Kore Charitable Hospital, Belgaum; **Dr. B. R. Desai**, Professor and Ex-Head, Department of Obstetrics and Gynecology, Jawaharlal Nehru Medical College, Belgaum and **Dr. N.S. Mahantshetti**, Vice-Principal, Jawaharlal Nehru Medical College, Belgaum, who permitted me to persue the research in their jurisdiction.

I thankfully acknowledge to **Dr. B.S. Kodkany**, Director, KLE's Health Research Foundation, **Dr. P.A. Patil**, Professor, USM-KLE International Medical Programme, **Dr. G. S. Pilli**, Professor and Head, Department of Pathology, Jawaharlal Nehru Medical College, Belgaum, **Dr. Subarna Roy**, Scientist E, Regional Medical Research Centre,

Indian Council of Medical Research, Belgaum for their technical assistance and constructive feedbacks.

I am extremely thankful to Mrs. Sunanda Patil, Renuka, Surekha, Mahadevi G. Gadekar, Department of Obstetrics and Gynecology, Dr. Prabhakar Kore Charitable Hospital, Belgaum; Meena Paudel, KLE's Institute of Nursing, Belgaum; Mr. Sanjay Kumar Yadav and Ram Kumar Sah, Department of Public Health, Jawaharlal Nehru Medical College, Belgaum, KLE University who have genuinely collected data despite their busy schedule of work. I am highly indebted to the study participants who have consented and cooperated during the study. Without their cooperation and genuine information, this study might not have completed.

I am thankful to the faculty members and administrative staffs of Department of Public Health and Department of Obstetrics and Gynecology, Jawaharlal Nehru Medical College, Belgaum. Similarly, I extremely acknowledge the support extended by Chief of the Medical Record Section, Mrs. S.M. Sankapal, Dietician In-charge of Dr. Prabhakar Kore Charitable Hospital, Belgaum for their coordinative supports.

I would like to thank my colleagues Mr. Tika Ram Gurung, Kiran Deshpande, Mahesh Biradi, Dr. Kapil Amgain and Mukesh Dhital who have helped enormously during my study period. Likewise, I acknowledge to Mrs. Sasmita Paudel, Mr. Gyanendra Jha, Ashutosh Shtrestha, Laxman KC and Bijendra Banjade. I am very much thankful to Mr. Dillee Prasad Paudel, Ph.D Scholar, KLE University who had been there

with me throughout the study period. His presence was the stimulant for me to advance research knowledge.

I am grateful to my parents and parent in-laws who remain the source of inspiration. I am also grateful to my brothers namely Mr. Krishna Raj Paneru, Bhuwan Paneru, Umakant Paneru and Pusp Raj Paneru; Kapil Gyawali and Kamal Gyawali (Brother In-laws) whose suggestions and cooperation remain instrumental in accomplishing this task. I am extremely thankful to my beloved wife Mrs. Kalpana Janwali-Paneru who has created congenial academic environment through moral and material supports. Further, I thank to my son Divyesh Paneru for his patience and cooperation. Finally, big thanks to Mr. Anand and Arun of JNMC main Library Xerox Centre, Belgaum for the extensive help in the formatting, printing and binding of the thesis.

At last but not least, I am indebted to all those known and unknown personalities who have contributed directly or indirectly to furnish my research.

**Date:** **Damaru Prasad Paneru**

**Place:** **Research Scholar**

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# LIST OF ACRONYMS

| | |
|---|---|
| AGA | Appropriate for Gestational Age |
| ANC | Antenatal Care |
| AUC | Area under Curve |
| AOR | Adjusted Odds Ratio |
| APH | Antepartum Hemorrhage |
| ART | Artificial Reproductive Technique |
| BMI | Body Mass Index |
| BP | Blood Pressure |
| CI | Confidence Interval |
| C/S | Cesarean Section |
| DM | Diabetes Mellitus |
| EDD | Expected Date of Delivery |
| ELBW | Extremely Low Birth Weight |
| ETS | Environmental Tobacco Smoke |
| GDM | Gestational Diabetes Mellitus |
| Hb | Hemoglobin |
| HBsAg | Hepatitis B surface Antigen |
| ICMR | Indian Council of Medical Research |
| IFA | Iron and Folic Acid |
| IOM | Institute of Medicine |
| IUGR | Intra Uterine Growth Restriction |
| Kcal | Kilocalorie |

| | |
|---|---|
| LBW | Low Birth Weight |
| LMP | Last Menstrual Period |
| MCH | Maternal and Child Health |
| MDG | Millennium Development Goals |
| NBW | Normal Birth weight |
| ND | Neonatal Death |
| NFHS | National Family Health Survey |
| NG | Natural Gas |
| No | Number |
| OECD | Organization for Economic Co-operation and Development |
| OPD | Out Patient Department |
| OR | Odds Ratio |
| PHC | Primary Health Center |
| P value | Probability value |
| PIH | Pregnancy Induced Hypertension |
| ROC | Receiver's Operating Characteristics curve |
| RR | Relative risk |
| SB | Stillbirth |
| SES | Socioeconomic Status |
| SGA | Small for Gestational Age |
| SPSS | Statistical Package for Social Sciences |
| SSLC | Secondary School Leaving Certificate |
| UK | United Kingdom |

| | |
|---|---|
| UNICEF | United Nation’s Children Fund |
| UTI | Urinary Tract Infection |
| VDRL | Venereal Disease Research Laboratory |
| VLBW | Very Low Birth Weight |
| WHO | World Health Organization |

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# ABSTRACT

**Background:** Low Birth Weight (LBW) continues to be the multi-factorial public health problem in India. India alone accounts for 40 percent of LBW babies of Developing World and more than 50 percent of those born in Asia. Although, reducing the prevalence of LBW less than 10 percent was one of the targets to be achieved by 2000AD, there has been small reduction in its prevalence since 1995. Several inconsistent, inconclusive and controversial associations have been reported between birth weight and several predictors. Hence, this study was carried out to identify the predictors of birth weight and to develop an antenatal risk scoring tool to identify the maternal risk of delivering babies with LBW.

**Methodology**: This prospective study was conducted at Dr. Prabhakar Kore Charitable Hospital, Belgaum during July 2012 to August 2013. A total of 1044 non-diabetic consenting pregnant women, attending antenatal clinic with less than 20 weeks of gestation and who had planned to deliver in the study hospital were included the study. After obtaining administrative and ethical clearance, enrolled study pregnant women were followed till delivery. Trained study personnel collected the data using structured pretested questionnaire and delivery records. To develop an antenatal risk scoring tool, risk scores were assigned to each of the significant predictors based on the Adjusted Odds Ratio. Birth weight was measured immediately within half an hour after delivery. Data were analyzed using SPSS 20.0 version. Percentage, mean median and standard deviations were calculated. Chi-square test, t test, multivariate linear and logistic

regressions were applied. Validity of the risk scoring tool was assessed by calculating the sensitivity and specificity. P value <0.05 was considered significant.

**Results:** Present study revealed that 57.2 percent of the pregnant women were of 20-24 years old, 61.5 percent had secondary education and 67.7 percent belonged to IV $^{th}$ and V$^{th}$ Socioeconomic class. Almost one third (32.5%) of the pregnant women had 150-155cms height with mean height being 152.7±5.3cms. Almost 11.0 percent were preterm births and 24.7 percent newborns had birth weight <2500gms. Mean weight of newborns was 2720.28±475.9gms. After controlling confounding factors, a total of 22 predictors of LBW were identified in the present study. These are sex of the baby (AOR:2.35), maternal height <145cms (AOR: 60.1) and 145-154.9cms (AOR:4.73); father's height ≤157.5cms (AOR: 14.49) and 157.5-162.5cms (AOR: 2.82); young mothers <20 years of age (AOR: 21.7), father's occupation (drivers-AOR: 4.54 & laborers-AOR:2.94), primigravida (AOR: 6.59), premature births (AOR: 22.3), artificial reproduction (AOR: 3.3), history of preterm delivery (AOR: 3.99), low birth weight (AOR: 5.31) and neonatal death (AOR: 6.47); daily calorie intake <69 percent of RDA (AOR:14.32) and protein intake <89 percent of RDA (AOR: 4.11) during pregnancy; presence of 1-2 high risk factors (AOR:3.70) and ≥3 factors (AOR:10.43) in the present pregnancy; pregnancy induced hypertension (AOR:11.4), poor kitchen ventilation (AOR: 1.99), <8 hours daily rest during pregnancy (AOR:7.20), no Folic Acid intake (AOR:1.70), <100 tablets of Iron and Folic Acid (IFA) tablets (AOR: 4.5), irregular consumption of IFA (AOR:5.61), no Calcium intake (AOR: 12.45) and irregular consumption of Calcium (AOR:76.96). The combined influence of these 22 predictors of LBW was estimated to be 74.1%. An

antenatal risk scoring tool developed in the present study using 14 measurable significant predictors of LBW had 82.4 percent sensitivity and 79.7 percent specificity to predict the chances of delivering babies with LBW.

**Conclusion:** Proportion of LBW babies in the present study was 24.7 percent. A total of 22 predictors of LBW like sex of the newborn, parental height, maternal age, father's occupation, history of delivery of LBW, preterm and neonatal death, artificial conception, primigravida, preterm birth, calorie and protein intake during pregnancy; number of high risk factors present during pregnancy, PIH, poor kitchen ventilation, maternal rest during pregnancy, Folic acid, IFA and Calcium intake during pregnancy; and regularity of IFA and Calcium intake were identified. The combined influence of these predictors was estimated to be 74.1 percent. A risk scoring tool that developed in the present study was 82.4 percent sensitive and 79.7 percent specific to predict chances of delivering LBW babies. A well planned periodic training programme has to be organized for ANC service providers including Female Health Workers focusing on predictors of LBW and their prevention. Community based studies are needed to test the feasibility and acceptability of the risk scoring tool by the health workers.

**Key words: Birth weight; Predictor; Prospective study; Tertiary care hospital; Tool**

# INTRODUCTION

# INTRODUCTION

## 1.1 Background

The spectrum of events leading from conception to birth of a healthy baby is both biologically and epidemiologically complex phenomena. Pregnancy is influenced by the interplay of several exogenous and endogenous factors that result in several expected and unexpected outcomes.[1-2] The successful reproduction should ideally mean that every pregnancy should result in healthy mother and a healthy baby. However, many pregnancies terminate into adverse outcomes such as pregnancy loss, intrauterine fetal death, Low Birth Weight (LBW) and the anomalous births.[1-3] Intrauterine period is a crucial and vulnerable period of human life.[4] The defective fetal growth and development during pregnancy can have profound physical and physiological impact throughout the life of newborns.[4] Therefore, identification of detrimental factors and their prevention is the most crucial task of the safe motherhood programmes.[5]

Low birth weight is one of the long standing birth outcomes amongst all adverse pregnancy outcomes, which have lasting influences in the later life span.[1,2,4] Infants born with low birth weight begin disadvantaged life and face extremely poor survival rates.[6] The accurate estimation of birth weight and measurement of magnitude of LBW is still lacking due to variability in the definition of LBW in different countries. Further, it is evident that many expectant mothers in Developing countries still deliver at home without the assistance of skilled birth attendants and without the facilities to assess the health status of the newborn.[7-8] World Health Organization (WHO) in the year 1992 defined LBW as birth weight less than 2500 Grams (gms) irrespective of the gestational

age; Very Low Birth Weight (VLBW) as birth weight 1500gms or less and Extremely Low Birth Weight (ELBW) as birth weight 1000gms or less.[9]

LBW babies can be either preterm LBW or Small for Gestational Age (SGA). Preterm LBW babies have normal growth potential for gestational age ($10^{th}$–$90^{th}$ percentile) whereas SGA commonly have the birth weight below $10^{th}$ percentile or less than two standard deviations for their gestational age. A fetus may be constitutionally small or it may be the result of pathological process. In Developing countries, about two-thirds of LBW babies born at term are SGA whereas, in Developed countries the majority of LBW babies are due to premature births. Identification of babies with distinct types of LBW and their causal factors are essential for the prevention and management of LBW babies. In addition to the short gestational age, socioeconomic factors, nutritional status of the mother, intrauterine environment, genetic factors, maternal pathology and external exposures have been documented as the risk factors for the LBW. LBW babies have multifold higher chances of having complications such as asphyxia, hypothermia, pulmonary distress syndromes, fetal shock, cerebral hemorrhage, cardiac failure, retinopathy, infection and metabolic disorders. Babies who have low weight at birth are prone to growth retardation during childhood period and face delay in the developmental milestones. These LBW babies are at risk of obesity, diabetes, hypertension, metabolic disorders and increased susceptibility to the infection in the adulthood or later in life.[9]

Medical innovations have contributed to advance in early diagnosis of the poor fetal growth by different clinical and sonographic techniques.[9] Special care services such

as intensive care and Kangaroo mother care have been developed for the care of babies with Intrauterine Growth Retardation (IUGR) to promote their survival and proper growth.[9-11] Thus, birth weight can be considered as one of the powerful predictors of infant growth and survival; and a predictor of adult health.[6,12]

Globally, an estimated 211 million pregnancies occur every year; out of which only 136 million result in live births.[5] Amongst these annual births, 15.5 percent babies are born with low birth weight (<2500gms).[13] Almost 96 percent of these LBW babies are born in Developing countries.[13-15] Incidence of LBW in Developing world (16.5%) is more than two times higher than that of Developed world (7.0%).[14-15] South East Asia Region has the highest incidence of LBW with the regional prevalence of LBW being 24 percent.[12] The incidence of LBW ranges from an average of 6 percent in Eastern Asia to 24 percent in Southern Asia. Out of 19 million LBW babies born in Developing countries each year, more than half are born in Southern Asia. Customarily, Southern Asia also has the highest proportion of newborns (≈70%) that are not weighed at birth.[16]

India is one of the countries in the World that consistently reports huge burden of adverse pregnancy outcomes. Organization for Economic Co-operation and Development (OECD)/WHO reported that more than 7 million babies in India are born with weight less than 2500gms each year. India accounts for 40 percent of LBW babies of the Developing World and more than half of those in Asia.[14] According to WHO, 28 percent newborns in India had LBW in 2011.[12] National Family Health Survey-3, India reported that there is a wide range of variation in the prevalence of LBW amongst the Indian states from 7.6

percent in Mizoram to 32.7 percent in Haryana. Proportion of the LBW babies in Karnataka (18.7%) was lower than the national average (21.5%). Prevalence of LBW being 23 percent in rural and 19 percent in urban areas.[17-18]

On the other hand, wide range in the prevalence of infant macrosomia (birth weight ≥4000gms) has been reported from different countries (10% in United Kingdom, 2010; 36 % in Canadian Province, 2011) with the increasing trend in Developing countries like China (6.0% in 1994 and 10.5% in 2005), Pakistan and Iran.[19-26] Infrequently, macrocosmic births have also been reported in India[27]; however, the issues of low birth weight remain challenge because of its overwhelming burden (7.6-32.7%) in most of the Indian states.[17-18] In reality, the magnitude of low birth weight is even more than that was reported by NFHS-3, India.[28] Therefore, both the extremes of birth weight (LBW and macrosomia) are the matter of clinical and public health concern worldwide and the LBW is even more serious issue in India.

### 1.2 Need for the study

Worldwide focus on the safe motherhood programme has tremendously reduced the maternal, perinatal, neonatal, infant and under five mortality rates in both the Developed and Developing countries.[29-30] Inspite of these achievements, reduction in the incidence and the consequences of LBW remain one of the great challenges in the Developing countries.[31] It has been well documented that birth weight has bearing on mortality, morbidity and growth of the newborn during early childhood and later in the life. Noticeable increased risks of perinatal morbidity, mortality and developmental

delays have been seen amongst the LBW infants as against the normal birth weight babies.[31-33] Moreover, infants with low birth weight carry 40 fold higher risk of dying during neonatal period.[33]

Low birth weight is an outcome of detrimental effects of multiple factors. Kramer has identified 43 risk factors of LBW which he has grouped into seven categories like genetic and constitutional factors, maternal nutrition during pregnancy, demographic and psychosocial factors, obstetric factors, maternal morbidity during pregnancy, environmental and behavioral factors; and low utilization of antenatal services.[34] On the other hand, Sachdev argued that more than 71 factors are known to have correlation with the birth weight.[4] Additionally, Shah and Ohlsson have documented some more predictors such as maternal infections during pregnancy and environmental exposures.[35] Recent studies from India have shown that short maternal stature (<145cms), weight (<40Kgs), Body Mass Index (BMI <18.5Kg/$m^2$), presence of morbid condition, birth interval <24 months, rural residence, earlier unfavorable pregnancy outcomes, anemia, low socioeconomic status, exposure to tobacco, low maternal age (<20 years), primigravida and low utilization of antenatal services have statistically significant association with LBW babies.[36-40] In addition to these factors; consanguinity, low gestational age, non-consumption or irregular intake of Iron and Folic Acid tablets; and inadequate food consumption during pregnancy were identified as significant predictors of LBW in Pakistan, Vietnam and Malaysia.[41-43] Although, several risk factors of LBW have been reported by multiple researchers, the findings in one or more studies contradict the results of others. Similarly, strength of association of some of the risk factors of LBW

varied in several other studies.[4.35,38-44] Additionally, area specific findings lack in uniformity in methodology because of which extrapolation of these results is not possible. Therefore, systematic reviews conclusively stated that there is an immense need of well designed prospective studies.

Large number of studies have attempted to establish the association between potential risk factors of LBW, its magnitude and consequences at different territory and across the globe; however, a small number of studies have reported deterministic effects of multiple predictors on birth weight.[32,35] It is further debated that whether all the predictors carry equal deterministic effects, produce the cumulative effects or vary in their strengths. A systematic review revealed that demographic factors, fetal sex and heredity collectively are known to explain up to 40 percent variation in the birth weight.[35]

Numerous studies have assessed the risk factors to predict a woman's chances of a high risk pregnancy; nonetheless, only a few studies have appraised risk factors for LBW.[39,43-45] Several diagnostic tools and risk assessment methods such as clinical assessment, biochemical analysis, laboratory services and ultrasonography are available to identify the risk of adverse pregnancy outcomes at specialized care hospital; nevertheless, limited population have access to these services. A large proportion of pregnant women in developing countries like India avail safe motherhood services from primary level health care facilities where advanced, sophisticated and more accurate diagnostic facilities are lacking. Even if such facilities are available at the private sectors, services are not affordable. Therefore, it is not possible to rule out the risk of LBW at

primary level health care facilities. Several risk scoring tools have been developed by Dutta and Das, Edwards; Talsania and Lala including Indian Council of Medical Research. However, sensitivity (35%-98%) and specificity (19.7%-35%) of these tools are variable and not acceptable because of either too low sensitivity or specificity.[46-49] There is a need to develop scientifically sound, cost effective, simple to use and easy to understand risk predicting tool with acceptable sensitivity and specificity. Such a tool will enable the health workers to identify the mothers with high risk of delivering LBW babies and refer them to the higher health care facilities with the specialized care. Therefore, in the present study, an endeavor has been made to develop an antenatal risk scoring tool which can be used by health care workers to identify the mothers likely to deliver LBW babies.

Tertiary care hospitals cater to the people from different sections of the population of rural and urban areas. As per the policy of Government of India, all the deliveries of high risk pregnant women have to be conducted at secondary or tertiary care hospitals. Additionally, tertiary care hospitals have facilities to manage the babies with LBW. Hence, the data from tertiary care hospital is expected to cover a wide range of risk factors of LBW. Because of the above reasons, it was felt that hospital based study to identify the predictors of LBW and to develop an antenatal risk scoring tool is necessary.

## 1.3 Research question

What are the predictors of birth weight amongst the babies born at a tertiary care hospital of Belgaum, Karnataka?

## 1.4 Objectives of the study

### Primary Objectives

- To identify the predictors of birth weight amongst the babies born at a tertiary care hospital of Belgaum, Karnataka,
- To assess the individual and combined effects of socio-demographic, parental anthropometric, obstetric and reproductive health related factors, health service use during pregnancy, maternal nutrition status and behavioral predictors on the birth weight of newborns.

### Secondary Objective

To develop an antenatal risk scoring tool to identify pregnant women likely to deliver low birth weight babies.

## 1.5 Conceptual framework

A number of analytical frameworks have been developed by different authors to conceptualize the risk factors for low birth weight. One of the most often referred models was given by Kramer in 1987. His model comprised the synthesis of 43 potential maternal risk factors for low birth weight; which he has grouped into seven categories: [34]

1. Genetic and constitutional factors
2. Demographic and psychosocial factors
3. Obstetric factors
4. Nutritional factors
5. Maternal morbidity during pregnancy
6. Toxic exposures
7. Antenatal care

Kallan, in 1993 presented a comprehensive and operational overview of maternal risk factors for the low birth weight. He has categorized all the maternal risk factors of LBW into four categories. These are socio-demographic (age, education and marital status) characteristics, health related (parity, prior history of fetal loss or LBW, hypertension, diabetes and pelvic infectious diseases) factors, attitudinal (wanted pregnancy) factors and behavioral (smoking and prenatal care) factors [50].

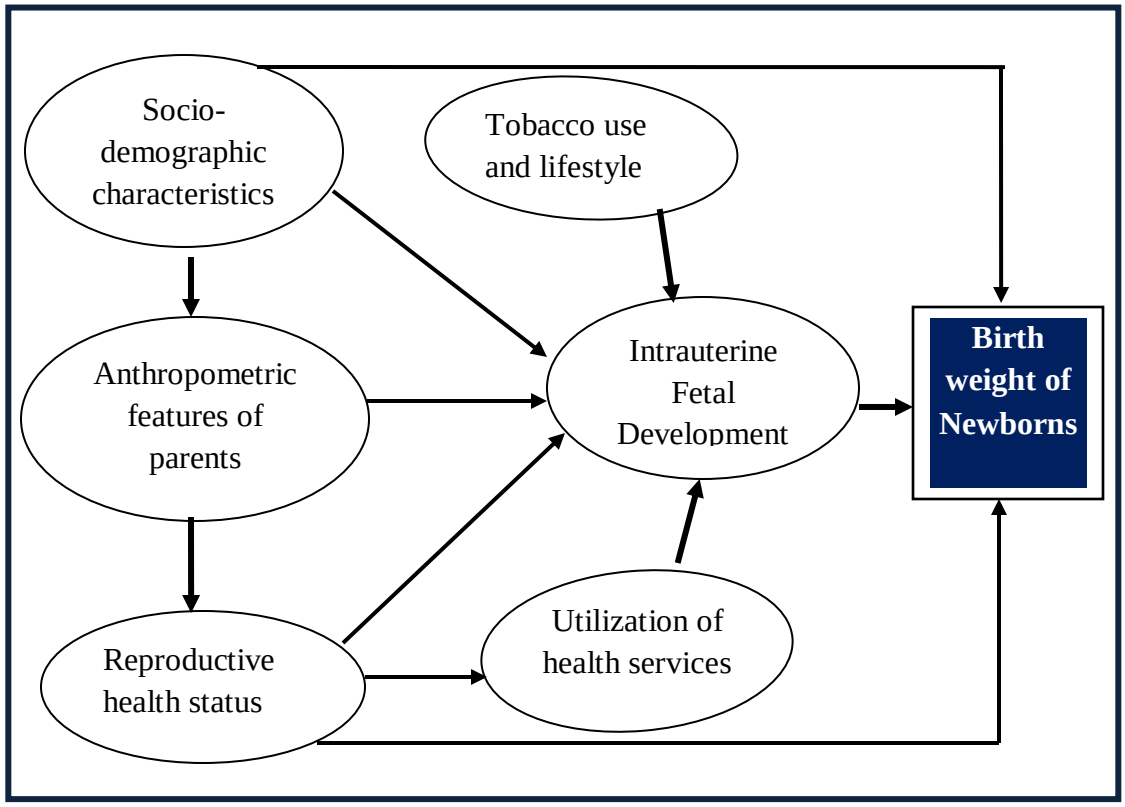
Shah and Ohlsson, in 2002 presented a comprehensive model to study the determinants of low birth weight. They have mentioned all the potential risk factors into four categories which are presented in order of their deterministic effects. These are:

- Determinants with proven association,

- Determinants with possible association but further research is needed,
- Determinants with no association,
- Determinants for which no information is available.[35]

Present conceptual framework has utilized the amalgamated ideas of all the three aforementioned models to study the predictive roles of independent factors over the birth weight of a newborn.

**Figure 1.5.1: Conceptual framework**

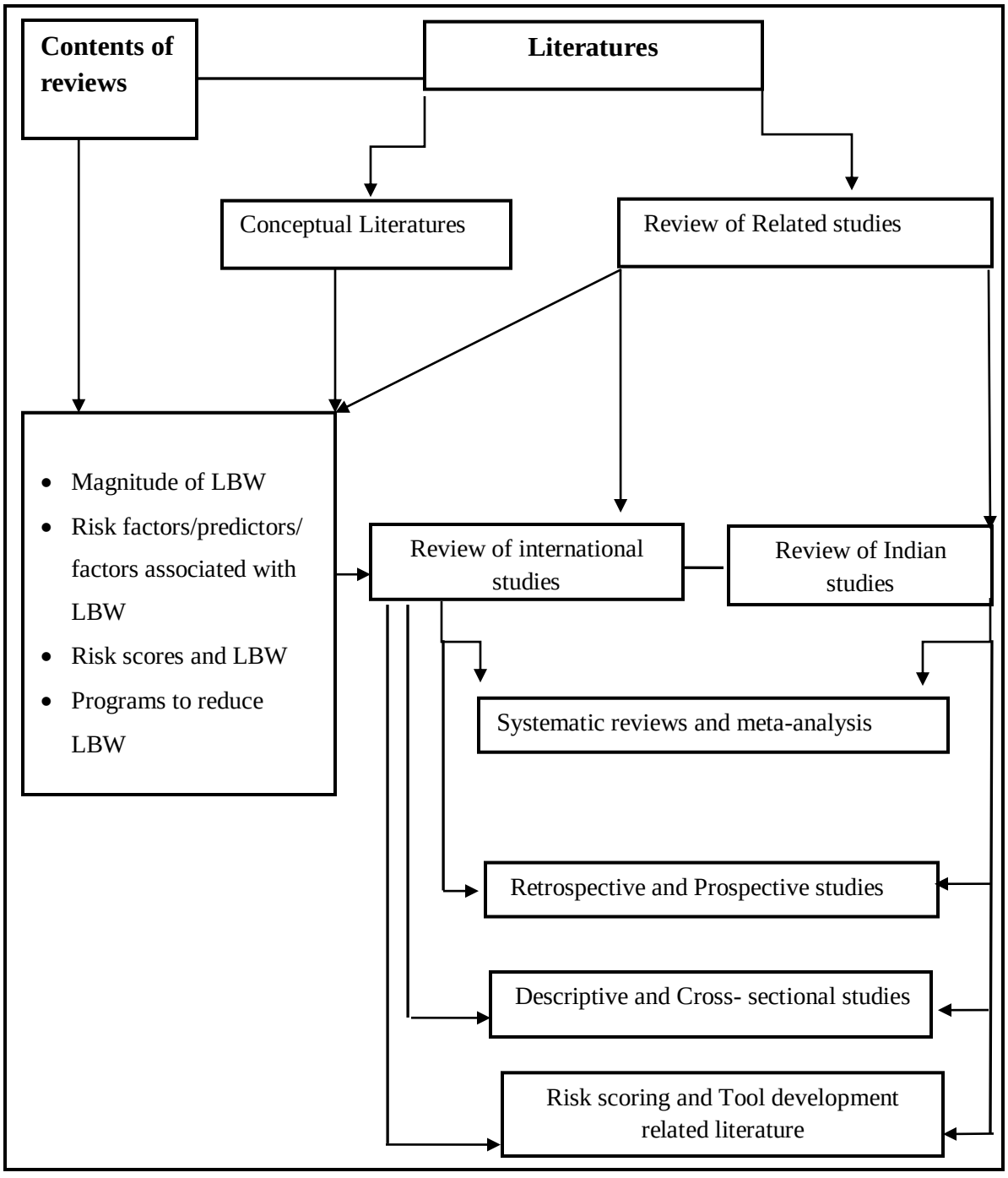


# REVIEW OF LITERATURE

# REVIEW OF LITERATURE

The scheme of literature review is portrayed in a flow diagram 2.1.1. Literature concerning the magnitude of low birth weight (incidence, prevalence and proportion), its associated risk factors and their interaction effects; evaluation of the risk score models, interventions and policy attempts to reduce LBW; risk score estimations and their corresponding prevalence of LBW have been presented in the chronological order of publications. Older studies have been placed in first followed by recent ones in the respective sub-sections. All the literature reviewed in this chapter are broadly organized under two categories: Conceptual literature and Review of related studies. Conceptual literatures have been presented in the first part whereas the findings of pertinent studies are assembled thereafter in the subsequent pages. The second category "review of related studies" has further subdivisions: Review of international studies and the Indian studies. Further, depending upon the hierarchy of evidences generated from different type of studies, the reviews have been presented in three levels of studies: Descriptive and cross-sectional studies, retrospective and prospective studies; and the systematic reviews and meta-analysis. The flow diagram presented below shows the contents of this review, types of studies reviewed with their hierarchical evidences and linkages of information required for this study.

**Figure 2.1.1: Flow diagram showing process of Literature Review**



## 2.1 Conceptual Literature

### 2.1.1 Classification of Low Birth Weight

According to the international agreement, LBW has been defined as a birth weight <2500gms including 2499gms. Depending on the period of gestation, the newborn can be preterm (born before completion of full 37 weeks of gestation or 259 days of gestation period), term (born between 37-42 weeks of gestation or 259-293 days) and post term (born after 42 weeks of gestation or more than 293 days). LBW babies may be either prematurely born or constitutionally Small for the Gestational Age (SGA). SGA is considered if the newborn weight is significantly less than expected for the gestational age. Some consider the SGA as a weight less than two standard deviations (SD) below for gestational age ($3^{rd}$ percentile) whereas some others consider $10^{th}$ percentile as a cutoff point. In majority, SGA infants weigh less than $10^{th}$ percentile for the gestational age. Generally, it is the result of intrauterine growth retardation.[51-52]

### 2.1.2 Etiology and Risk factors for low birth weight

The etio-pathogenesis of low birth weight, prematurity and SGA are complementary and contrasting. Some factors are common to both, while others are outcome specific. Several determinants of LBW still remain unexplained. LBW is generally due to alterations in placental circulation. Preterm low birth weight may be due to multiple pregnancies, maternal infections; hard physical work by mother and hypertensive disorders during pregnancy. Witter and Keith have categorized the causes of prematurity into five groups. These factors are demographic and psychosocial, obstetric, nutritional, maternal morbidity during pregnancy and toxic exposures.[52]

Most consistently reported demographic and psychosocial factors are low social class, low maternal age, low level of literacy, low pregravid weight, stress, prolonged standing and strenuous work; and short stature. Obstetric factors associated with prematurity are previous fetal/neonatal death, abortion, preterm delivery, cervical incompetence and maternal genital abnormality; exposure to diethylstilbestrol, placenta previa and abruptio placentae; and premature rupture of membrane. Factors related to current pregnancy are preterm onset of labor, premature rupture of membrane, no ANC, advanced cervical dilatation, preeclampsia/eclampsia, hyperemesis, hydramnios, isoimmunization, placenta previa and abruptio placentae; multiple gestations, nephritis, liver disease, pulmonary disease, viral pneumonia and chronic hypertension. Maternal morbidity during pregnancy such as infections caused by Chlamydia, streptococcus and gonococcal infection, trauma, surgery, hyperthyroidism etc are known to have bearing on prematurity. Additionally, exposure to harmful factors like smoking, gases and narcotics; and drug abuse are known to have detrimental effects on fetal weight gain and are predisposing factors for preterm delivery.[52]

Similarly, various causes of SGA are described under four categories: defective placental function, maternal factors, fetal factors and unknown factors. Maternal factors such as hard physical work, hypertension, exposure to toxic materials, malaria, toxoplasmosis, smoking, low socioeconomic status, short stature, very young age, high parity, close birth spacing, low education and poor maternal nutrition before and during pregnancy are described as risk factors for LBW. LBW is also attributed to the placental dysfunction caused by placental insufficiency and placental abnormality. Certain fetal

factors like fetal abnormality, intrauterine infection, chromosomal abnormality and multiple gestations also contribute to the intrauterine growth retardation.[9-10,51,53-54]

Irrespective of the duration of gestation, major causes of low birth weight can be categorized as socioeconomic factors, medical risks before or during gestation, maternal lifestyles; and genetic and constitutional factors. Genetic and constitutional factors perhaps explain 40 percent of birth weight whereas remaining 60 percent are due to environmental and other factors.[34-35]

### 2.1.3 Health consequences of LBW and its Public health significance

Infants born with low weight at birth face multiple disadvantages immediately after birth and later in life. Spectrum of disorders over the small for date newborns and the preterm babies vary in different ways. It has been reported that, preterm SGA infants face long term disadvantages in the life.[53]

Low birth weight in the Developing countries remains a public health problem because of its high incidence and prevalence; increased risk of mental retardation, perinatal and infant mortality; and morbidity. It is either due to premature birth or manifestation of intrauterine growth retardation due to SGA. In countries where the proportion of low birth weight is less, the short period of gestation is a major cause; nevertheless, SGA is a major manifestation in Developing countries.[6,51,55] Early identification of cause of IUGR and its intervention may be useful in reducing the incidence of LBW.[56]

Despite the remarkable success witnessed in reducing incidence of LBW in Developed world; its reduction remains a challenge in Developing countries. Inspite of the global and national initiatives launched in the last two decades, there has been marginal reduction in the incidence of LBW.[51,55-60] Reduction of LBW forms an important contribution to the Millennium Development Goals (MDG) for reducing child mortality. Low birth weight is; therefore, an important indicator for monitoring progress towards this international goal.[14,58-60]

## 2.2 Review of related studies

The review has made known that there has been intra-state, inter-state and international variation in the prevalence of LBW. In Developed countries, LBW ranges from 1.2 percent to 7 percent; while in some of the Developing countries, its occurrence is as high as 40 percent. Prevalence of LBW varied between 7.6-45.5 percent in India. Institution based research studies revealed the higher burden of LBW than that was identified in community based studies. Several national and international studies have made clear that the LBW is an outcome of multi-factorial interplay of various risk factors. Broadly, the etiology of LBW has been described under maternal factors, fetal factors and the placental factors. Multiple systematic reviews documented that there are >71 risk factors for LBW which are grouped into several categories on the basis of type of predictors, strength of association, potential impact, modifiability and the availability of information. Several genetic and constitutional factors, obstetric factors, nutritional factors, demographic and psychosocial factors; maternal morbidities during pregnancy, toxic exposures and antenatal care have been reported to have deterministic effects on

birth weight. Inspite of availability of these evidences; several controversial, inconsistent and inconclusive findings have been reported in case of maternal and environmental predictors of LBW. Despite the availability of abundant number of literature related to the factors affecting birth weight of a newborn, lots of discrepancies have been reported in the methodology and the results of several studies. Some studies have sound methodology; however, results were inadequately described while others have excellent findings but there have been inadequate explanations of methodologies. Several risk identification systems have been developed to categorize the expectant mothers into high risk and the low risk groups to provide remedial measure for such mothers. The predictive accuracies of these tools were below acceptable limits. The details of the published literature have been presented as follows:

### 2.2.1 Systematic reviews and meta-analysis

Kramer, in1987 carried out a systematic review by assembling 895 English and French languages medical literature published from 1970 to 1984. He concluded that there are forty three determinants of LBW which were classified into seven groups.[34]

**Table 2.2.1: Determinants of low birth weight and determinant categories**

| Categories | Determinants of low birth weight |
|---|---|
| Genetic and constitutional factors | Infant sex, racial/ethnic origin, maternal height, pre-pregnancy weight, maternal hemodynamics, paternal height and weight; and additional genetic factors. |
| Obstetric factors | Parity, inter-pregnancy interval, sexual activity, intrauterine growth, gestational duration in prior pregnancies, prior spontaneous abortion, induced abortion, stillbirth/neonatal death, prior infertility; and exposure to diethylstilbestrol. |
| Nutritional factors | Gestational weight gain, caloric intake, energy expenditure, work and physical activity; protein intake and intake of Iron and anemia; Folic acid and vitamin B12; Zinc and copper; Calcium, Phosphorus and Vitamin D; Vitamin B6; and other Vitamins and trace elements. |
| Demographic and psychosocial factors | Maternal age, socioeconomic status (education, occupation and income), marital status and maternal psychological factors. |
| Maternal morbidity during pregnancy | General morbidity, episodic illness, malaria, UTI and genital tract infections |
| Toxic exposures | Cigarette smoking, alcohol consumption, caffeine and coffee consumption; use of marijuana, narcotic addiction and other toxic exposures. |
| Antenatal care | First antenatal care visit, number of antenatal care visits and quality of ANC |

A meta-analysis was carried out by Sachdev to observe the magnitude of low birth weight and its associated factors using available published and electronic databases. The analysis focused on the south Asian context of Developing countries. A total of 71 risk factors were identified through the review of several studies including intervention studies. All the identified factors were categorized into 8 groups based on the strength of available evidences, potential public health impact and modifiability.[4]

**Table 2.2.2: Factors evaluated for their effects on duration of gestation and intrauterine growth**

| Intrauterine Growth Retardation (IUGR) | Gestation duration (prematurity) |
|---|---|
| **Causal effect ruled out with a high probability** | |
| Protein intake | Infant sex, paternal height and weight, parity, protein status/intake |
| **Causal effect unlikely, but evidence insufficient to rule out totally** | |
| Marital status, maternal psychological factors, sexual activity, prior spontaneous abortions, prior induced abortion, prior stillbirth, neonatal death, prior infertility, In utero exposure to diethylstilbestrol, Vitamin B12, Zinc and Copper, Calcium, Phosphorous and Vitamin D, Vitamin B6, UTI, Genital tract infection, Caffeine and Coffee consumption, use of marijuana | Racial/ethnic origin, maternal height, Maternal hemodynamics, marital status, sexual activity, prior stillbirth, neonatal death, prior infertility, gestational weight gain, Vitamin B12, Zinc, Copper, Calcium, Phosphorous, Vitamin D, Vitamin B6, UTI, Alcohol consumption Caffeine and Coffee consumption, use of marijuana, narcotic addiction |

**Continue...**

| Intrauterine Growth Retardation (IUGR) | Gestation duration (prematurity) |
|---|---|
| **Causal effect uncertain, but importance unlikely, owing to small effect magnitude or low prevalence** | |
| Birth or pregnancy interval, heavy alcohol consumption and narcotic addiction. | In utero exposure to diethylstilbestrol, birth or pregnancy interval, prior induced abortion, Vitamin B6. |
| **Causal effect established, but importance unlikely owing to small effect magnitude or low prevalence** | |
| Antiplatelet agents (Aspirin) | Antiplatelet agents (Aspirin) |
| **Causal effect established and important, but Non-modifiable** | |
| Infant sex, parity | |
| **Causal effect established and important, but modifiable over long term** | |
| General morbidity, episodic illness Socioeconomic conditions, maternal height, | Socioeconomic conditions |
| **Causal effect established, important, and modifiable over short /intermediate term** | |
| Pre-pregnancy weight, very young maternal age, maternal education, gestational weight gain, caloric intake, malaria, tobacco chewing | Pre-pregnancy weight, very young maternal age, maternal education |

**Continue…..**

| **Intrauterine Growth Retardation (IUGR)** | **Gestation duration (prematurity)** |
|---|---|
| **Causal effect uncertain, but potentially important and modifiable** | |
| Maternal hemodynamics, strenuous maternal work, Folic acid, Iron intake and anemia, Other vitamins and trace elements, Magnesium, Cigarette smoking and indoor smoke, first antenatal care visit, number of antenatal care visits, quality of antenatal care | Stress and anxiety, maternal work, caloric intake, Folic acid, Other vitamins and trace elements , Iron and anemia, General morbidity, episodic illness, Malaria, Genital tract infection, Cigarette smoking and indoor smoke, tobacco chewing, environmental toxins, first antenatal care visit, number of antenatal care visits, quality of antenatal care |

Shah and Ohlsson have evaluated the determinants of LBW to identify the contribution of each of the factors on birth weight. They have categorized all the identified factors into four groups according to the strength of association. [35]

**Table 2.2.3: Determinants of low birth weight**[35]

| Category | Determinants |
|---|---|
| **Determinants with proven association** | short (<18 months) and long (>60 months) birth interval, history of preterm/LBW births, Race/ethnicity, extremes of maternal age, maternal malnutrition, bacterial vaginosis, UTI, HIV infection, chronic stress, low SES, tobacco use, heavy alcohol use, cocaine use, passive smoking/environmental tobacco smoke exposure, violence/abuse, ANC, placental factors, multiple births |
| **Determinants with possible association but further research is needed** | Primiparity, single mother, inadequate weight gain during pregnancy, short maternal height, low pre-pregnancy weight, maternal medical/pregnancy associated conditions, maternal trichomoniasis infection, periodontal infection, heavy caffeine use, marijuana use, licorice ingestion, environmental pollution, noise, occupational hazards, physical works and prolonged standing at work, uterine factors, pharmacological factors, paternal factors and genetic factors |
| **Determinants with no association** | Fetal sex, maternal use of electromagnetic beds |
| **Determinants for which no information is available** | Alternative and herbal medicines |

A systematic review was done to document the risk factors for low birth weight in 2004. This review reported the global incidence of LBW around 17 percent. There was wide variation in its occurrence; ranging from 5-7 percent in Developed countries to the 19 percent in the Developing countries where LBW remains a public health problem. They have classified the number of risk factors in different groups which are as follows:[53]

**Table 2.2.4: Risk factors for low birth weight**

| Risk group | Risk factors |
|---|---|
| **Socio-demographic risk factors** | **Constitutional factors**: Maternal height , weight (<45 Kgs), mother's birth weight, father's birth weight, Chromosomal anomalies such as trisomy 21, trisomy 18 and Turner's syndrome etc<br>**Demographic factors:** Ethnicity, maternal age, marital status, educational status, and socioeconomic status. |
| **Medical risks before pregnancy** | Chronic hypertension, renal diseases, glucose metabolic disorders, chronic cardio-respiratory disease and other disorders that involve hypoxemia, genitourinary anomalies, autoimmune diseases and inherited or acquired Thrombophilia, history of miscarriage, placenta previa, stillbirth, preterm and LBW. |

**Continue**

| Risk group | Risk factors |
|---|---|
| **Risks of the current pregnancy** | Chronic hypertension, gestational diabetes, poor maternal weight gain during pregnancy, maternal malnutrition, short birth interval, multiple pregnancies, placental insufficiency, vaginal bleeding, infection due to Chlamydia, Beta-hemolytic Streptococcus, Ureoplasma urealyticum, Mycoplasma, Trichomonas, Staphylococcus aureus , Toxoplasma, Rubella, Cytomegalovirus and Herpes simplex, Gonorrhea, Syphilis; increased α-fetoprotein, anemia, congenital anomalies, |
| **Health care, environmental and behavior risks** | **Poor prenatal care**: visits, prophylaxis medications, monitoring. Maternal work and stress, smoking, alcoholism, caffeine consumption, exposure to toxin, illicit drug consumption, radiation, agricultural hazards, environmental pollution. |

A systematic review was carried out by the expert panel of WHO in 2007 to observe the linkage of indoor air pollution to the occurrence of LBW and stillbirths. Five studies (one cross-sectional survey, two cohort studies, one case-control study and one randomized control trial) were included in the review. The review identified that birth weight of newborns whose mothers were exposed to the biomass had 59 to 175gms lower weight than the newborns of gas user mothers. The risk of delivering LBW babies was almost two times higher among the biomass users when compared with gas users. The review has found the consistent impacts of solid fuel smoke exposure on LBW.[61]

A review was performed with an aim to assess the effects of programs offering additional social support for women at high risk for giving birth to babies either preterm or weigh less than 2500gms, compared with routine care. Reviewers included 17 trials that met the quality and standard criteria. Findings revealed that programs offering additional social support for at risk pregnant women were not associated with improvements in any perinatal outcomes. These interventions did not have any significant role in reducing the number of preterm and low birth weight babies.[62]

A systematic review was done by Shah in 2010 to identify pregnancy outcomes among women of different parity. A review included forty published studies. It indicated that nulliparity was associated with increased odds of delivering LBW and SGA babies; however, grand multiparity and great grand multiparity were not associated with LBW.[63]

A systematic review of the risk of LBW, preterm and SGA births in relation to paternal factors was performed by Shah in 2010. Thirty six 36 studies meeting the inclusion criteria were reviewed. The findings revealed that paternal age was associated with the risk for LBW. Babies born to tall fathers were found to have an average 125-150gms higher birth weight when compared to the infants whose fathers were short. Paternal LBW was associated with lower birth weight of offspring. Paternal occupational exposure and low levels of education might be associated with LBW; however, further studies are needed. [64]

Langer has performed a systematic review to assess the effects of additional social support to pregnant women at high risk for giving birth to LBW babies. Seventeen trials meeting inclusion criteria were analyzed to observe the effects on birth weight. Social support during pregnancy provided to women at high risk of having LBW babies did not reduce the number of preterm and LBW newborns. Inspite of potential benefits, social support as an intervention did not achieve significant effects to reduce LBW and prematurity. Study concluded that there is no need to conduct further studies to observe the effects of social support during pregnancy to reduce LBW incidence.[65]

A literature review was carried out by Aras in 2013 to observe relation between the maternal age and the incidence of LBW. The review reported that maternal age had significant association with LBW babies. A very young maternal age is causally implicated risk for LBW and preterm births. Further, multivariate analysis showed a U-shaped relationship between maternal age and LBW where the youngest (<15 years) and the oldest (≥40 years.) mothers being at high risk of delivering LBW than 25-29 years old mothers.[66]

### 2.2.2 Review of international studies

#### 2.2.2.1 Retrospective and Prospective studies

Abrams and Newman examined the relationship between maternal characteristics and the SGA infants among 2228 women participating in the Prenatal Nutrition Project of University of California. Cigarette smoking, Asian ethnicity, primiparity, low maternal

height and low weight gain during pregnancy were found to be the significant predictors of SGA and preterm births.[67]

A prospective study was carried out by Lawoyin and Oyediran in1992 in Ibadan, Nigeria to evaluate factors associated with birth weight. A total of 600 randomly selected women who registered for antenatal care were followed up till delivery. Data on 492 women who gave normal, singleton live babies were analyzed. The study revealed that 8.3 percent newborns weighed <2500gms. The mean birth weight was 3167±451gms and male babies had significantly higher weight than female babies. Twenty percent were preterm births. Mother's age, parity, height, ponderal index at delivery, weight gain during pregnancy and the birth interval were significantly related to LBW babies.[68]

Data of 7776 singleton birth cohort with birth weight below the $10^{th}$ percentile was analyzed after adjusting for gestational age and sex. Findings revealed that the highest relative risks were associated with severe antepartum hemorrhage, severe preeclampsia and the maternal tobacco consumption for SGA.[69]

The effect of maternal cigarette smoking on birth weight of the cohort of infants was estimated in 1995. Data of 1205 multiparity singleton pregnancies attending the ANC clinic of University of Alabama at Birmingham were analyzed. Neonates born to the women who reported smoking during first trimester had overall reduction of 130gms (4.0%) birth weight and those who continued to smoke throughout pregnancy had an average adjusted reduction in birth weight of 189gms (5.9%). Women who continued to

smoke more number of cigarettes were associated with increased reductions in birth weight of newborns.[70]

An association between intensity and duration of cigarette smoking during pregnancy and the frequency of LBW, preterm births and IUGR was investigated in a historical cohort. A total of 5166 live births occurring in the city of Pelotas, Brazil were included in the study. After adjusting for confounding factors, mothers who smoked during pregnancy had delivered 142gms lower birth weight babies than those were non-smokers. Odds LBW among babies of smokers was almost two times and the odd of IUGR was even more than two times higher than those of non-smoking mothers. Smoking was not found to be significantly associated with the preterm delivery. Women whose partners smoked were also at higher risk of having fetal growth retardation. The effect of maternal smoking on low birth weight seems to be attributable to IUGR rather than preterm delivery.[71]

A case-control study was carried out in East and West Berlin in 2002. All consecutive VLBW babies born at two (East and West Berlin) University hospitals were treated as cases and the two normal birth weight infants born next to a VLBW infant in the same hospital served as controls. Study identified that low maternal education, smoking during pregnancy; maternal unemployment and previous fetal loss were significant risk factors for VLBW baby by multivariate analysis.[72]

Boy, Bruce and Delgado observed the effect of domestic use of wood fuel on birth weight among 1,717 women and newborns in Guatemala. Data was collected on the type of household fuel used, type of fire and socioeconomic status including other confounding factors. Study revealed that babies of mothers who habitually cook on open fires had the lowest mean birth weight than those using a chimney stove users and the clean fuels users. After adjustment of confounding factors, wood users still had delivered significantly high proportion of LBW babies as compared to clean fuel users.[73]

A case-control study of 844 SGA cases and 870 appropriate for gestational age (AGA) was conducted to assess the effect of maternal diets during pregnancy on SGA babies. Retrospective food frequency questionnaires were completed at the time of conception, last month of pregnancy and at childbirth. After adjustment for potential confounders, fish intake, carbohydrate rich foods and foliate supplementation were associated with a reduced risk of babies with SGA. During the last month of pregnancy, only Iron supplementation was associated with a reduced risk of SGA after adjustment for potential confounders. Here, study is well designed and the potential effects of the confounders were taken into account; however, food frequency was obtained retrospectively; inculcating potential recall bias.[74]

The influence of paternal anthropometry on birth weight of newborns was studied in 2005. A prospective cohort study was carried out among 567 singletons, non-diabetic, full term pregnancies in Central Exeter, United Kingdom (UK). This study found positive correlation with paternal height and the birth weight of newborns. Both the maternal

height and BMI were correlated with birth weight. On multivariate analysis, 38 percent of the variance in fetal height was explained by gestation, sex, paternal height, maternal height, maternal glucose, maternal BMI, parity and maternal smoking. Study concluded that paternal height has an independent influence on size at birth.[75]

A case control study was undertaken at two university hospitals in Tehran to determine the risk factors for low birth weight. A total of 160 neonates with birth weight less than 2500gms (cases) were compared with the 300 babies with ≥2500gms (controls). After controlling all the confounding factors, low maternal BMI, low education, too short and too long inter-pregnancy intervals, history of delivery of LBW and maternal diseases were associated with an increased risk of LBW.[76]

A prospective study was conducted to determine the incidence of LBW and associated risk factors among neonates born at Shahid Rajaee hospital in Tonekabone, Iran. The results revealed that the incidence of LBW was 4.2 percent. Significantly higher proportion of LBW neonates were born to the primigravida, who had short birth interval and prematurity.[77]

Torres-Areola and Constantino-Casas carried out a case-control study in the three hospitals of Mexico City to identify factors associated with LBW. Babies with birth weight <2500gms and ≥2500gms were considered cases and controls respectively. Study found that low SES, poor maternal nutrition, smoking, morbidity during pregnancy, accessibility to health services and prenatal care were significant factors for LBW.[78]

Authors have examined the factors associated with LBW in Bangladesh in 2006. A total of 350 pregnant women enrolled in the first trimester were followed till delivery. Study revealed that almost a quarter of babies (24%) were born with LBW. Mean birth weight of newborns was 2961gms. Multivariate analysis revealed that gestational age; hemoglobin levels at first visit and weight gain during pregnancy were significant predictors of LBW.[79]

A secondary data analysis of UK Millennium Cohort Study (MCS) was done by Ward, Lewis and Coleman using data of 8,819 newborns. Study revealed that mean birth weight was lower in infants born to women in both the active and environmental tobacco smoke (ETS) exposure groups than in non-exposed. After adjustment for all confounding factors, tobacco exposure remained significant factor for LBW. Prematurity increased significantly with maternal smoking. There was a significant linear trend for reduced birth weight with increasing level of maternal exposures to smoking and ETS.[80]

A community based longitudinal study was conducted to determine the predictive effects of maternal anthropometry on birth weight using a sample of 1104 normotensive and non-smoking pregnant women in a rural union of Bhaluka Upazila, Mymensingh, Dhaka, Bangladesh. Study reported that most of the pregnant women were between 20-34 years of age. LBW was observed among 17 percent newborns. Polynomial regression analyses showed that the best predictors of birth weight were maternal weight at registration and weight at ninth (Adjusted $R^2$, 2.5%-20%) months. Sequential regression analyses with height and weight showed that there was a significant effect of height after

removing the weight variables. Weight and height at registration month continued to be the best predictors of LBW. Study concluded that maternal weight at registration was the best predictor of birth weight and each 1Kg increase in the maternal weight at registration was associated with the 260gms increase in birth weight. The predictive capacity of maternal weight at the time of registration and at nine months was largely varied to predict LBW. [81]

A population based cohort study was conducted by Isaranurug, Mo-suwan and Choprapawon in 2007 to determine the maternal risk factors of LBW in Thailand. A total of 3522 pregnancies that completed the follow up visits and eventually delivered a singleton baby at four districts across Thailand were included in the study. Only singleton live births were included in the present study. Findings of this showed that 8.6 percent newborns were LBW babies. Maternal factors affecting LBW were maternal age (<20 years), total weight gain during pregnancy <10Kgs, primiparity and the poor antenatal service utilization.[82]

A longitudinal study was conducted in China in 2007 to observe the relationship between first trimester hemoglobin level and the occurrence of LBW. A total of 88,149 women whose hemoglobin was measured in the first trimester were selected for the study. Findings of this indicated that the mean birth weight of newborn was 3345.9±432.9gms. LBW, preterm birth and SGA were found among 1.9 percent, 4.5 percent and 4.5 percent newborns respectively. After controlling for confounding factors, maternal hemoglobin <9.9gms/dl was significantly associated with the LBW.[83]

A hospital based case-control study was carried out in the maternity wards of three hospitals of Karachi, Pakistan. A total of 262 singleton full term LBW live babies were compared with the equal number of normal weight babies born to the 15-35 years aged mothers. Findings of the study revealed that maternal hemoglobin, IFA supplementation during pregnancy and maternal age were found to be significantly associated with the LBW when subjected to the multivariate analysis.[84]

Khatun and Rahman carried out a case control study at Azimpur Maternal and Child Health Training Institute, Dhaka, Bangladesh to ascertain the significant determinants of LBW. One hundred and eight singleton live LBW babies were compared with 357 normal birth weight babies. Study identified that maternal age <20 years, maternal illiteracy, <4 antenatal visits and low per capita income were the independent factors affecting birth weight. The combined effects of these significant factors explained the variation in birth weight by 86.1percent. [85]

A comparative study was conducted in 2008 to observe the risk of low birth weight among those wood fuel users and natural gas (NG) users during prenatal period. A historical cohort of women who had a singleton live birth in semirural area of Pakistan was included in the study. On an average, infants born to wood users were 82gms lighter than infants born to NG users when weight was adjusted for confounders. The rate of LBW was 22.7 percent among wood users as compared to the 15.0 percent in NG users. Cooking with wood fuel during pregnancy was associated with LBW and marginally lower mean birth weight compared with using NG.[86]

A prospective public hospital based study was carried out in 2008 to investigate associated factors for LBW babies born at full term. Data of 1039 singleton full term live births that were born in four public hospitals of Peshawar, Pakistan were collected. The study indicated that 9.9 percent newborns had LBW and 41.6 percent were preterm LBW babies. Maternal anemia, history of abortion and the maternal age (<20 years) were reported as significant factors for LBW.[41]

Vahdaninia, Tavafian and Montazeri carried out a retrospective study using data from 15 University maternity hospitals in Tehran, Iran. Data on 3734 singleton term births in these hospitals were extracted from case records. Findings of the study indicated that the mean age of women was 25.7±5.3 years. About 5.2 percent full term births were of LBW. Maternal age, history of LBW deliveries, smoking during pregnancy and hypertension were identified as significant factors of LBW.[87]

Authors have examined the individual and combined effects of nine maternal parameters on the rates of prematurity and LBW in 2009. A retrospective analysis on data of 2.3 million pregnancies taken from the German perinatal statistics of 1995-2000 was done. Study revealed that 7.0 percent babies were preterm births. The highest proportion of prematurity (27.5%) was observed among the combined predictors: ≥1 stillbirth, ≥2 terminations of pregnancy and ≥2 miscarriages. A rather higher risk of premature delivery (>11%) was found for elderly (≥40 years), grand multiparity, small (≤155cms) and slim women (≤45Kgs). Although statistical calculations were applied, only few parameters were assessed retrospectively.[88]

Lesley and Richard have reviewed the risk factors for SGA infants in Auckland, New Zealand. They reported that short maternal stature, low weight, Indian or Asian ethnicity, nulliparity, mother born SGA, cigarette smoking and cocaine use; maternal medical history of chronic hypertension, renal disease, anti-phospholipids syndrome and malaria were responsible for SGA. Further, heavy bleeding in early pregnancy, abruptio placentae, preeclampsia and gestational hypertension, short or very long inter-pregnancy interval, previous SGA infant or previous stillbirth also were found to be the risk factors for SGA. Paternal factors including short stature and fathers born SGA also contributed to SGA babies. This study has well documented the confirmed as well as potential risk factors.[89]

A hospital based retrospective study was conducted at Neonatal Intensive Care Units (NICU) of BP Koirala Institute of Health Sciences, Nepal to analyze maternal risk factors for VLBW births using data of 140 VLBW babies. Study revealed that the mean birth weight was 1188.9±212.78gms. Maternal risk factors associated with VLBW deliveries were: inadequate ANC visits, antepartum hemorrhage (APH), premature rupture of membrane (PROM), pregnancy induced hypertension (PIH), bad obstetric history (BOH) and maternal age <20 years. [90]

Latiffah and Hanachi carried out a case-control study in Obstetric Ward of Maternity Hospital in Kuala Lumpur to examine the effects of maternal hypertension and smoking on birth weight of newborn. A total of 110 cases of LBW and 220 controls were selected randomly. Results of the study identified that maternal height <150cms, maternal

weight<45Kgs and weight gain during pregnancy <10Kgs were found to be risk factors for LBW. Similarly, premature delivery, maternal vaginal bleeding and IUGR had significant association with LBW.[43]

A case-control study was carried out to identify the factors affecting LBW using data of women who delivered at four central hospitals in Vientiane, LAO PDR. A total of 235babies who had birth weight <2500gms was compared with the 265 normal birth weight babies. Study revealed that after adjusting the confounding effects, maternal age (<18 years), weight <70Kgs, educational status, hard physical works, primigravida and the knowledge of mothers regarding nutritional and health care were significantly associated with birth weight of newborn.[15]

A case-control study was conducted in Dhulikhel hospital, Kavre, Nepal by Singh, Shrestha and Marahatta in 2010 among 401 full tem cases (<2500gms) and the equal number of age matched controls (≥2500gms). Findings indicated that maternal hemoglobin, height, weight gain during pregnancy and the number of ANC visits were statistically associated with LBW.[91]

A hospital based prospective study was conducted in Iran. Out of 4510 newborns included in the analysis, 6.8 percent had LBW. Among these LBW babies, majority were preterm births. Low maternal education, husband's farming occupation, inter-pregnancy interval ≤1year and maternal height <155cms were associated with LBW.[92]

Li, Sundquist and Sundquist carried out a nationwide study to analyze the risk of SGA births in Sweden. Of total 816,310 first singleton live births, 3.6 percent were SGA. Further, the study revealed that families with low income had an increased risk of SGA births. Maternal age at delivery, gestation age, family income, area of residence, marital status and smoking habits, several maternal occupational groups (including mechanics and iron and metal ware workers and packers, loaders and warehouse workers) had significantly higher risk of SGA births than the reference group. Among paternal occupational groups, only waiters had an increased risk of SGA births. This large scale follow up study shows that maternal occupation influenced the occurrence of SGA, whereas paternal occupation does not seem to have an impact on SGA birth. Further studies are required to examine the specific relationship between those maternal occupations associated with increased risk of SGA.[93]

A mixed method study was carried out to assess the risk factors for low birth weight in a North-Eastern Chitral district of Pakistan in 2012. A facility based records of 1316 mothers and their newborns was obtained using structured questionnaire and the individual interview including group discussions were organized to supplement the data. Results of this study indicated that approximately 26 percent mothers were primigravida, 63 percent had no formal education and 68 percent were housewives. Further, there was significant association between the occurrence of LBW babies and parental education and paternal occupation; and the antenatal care visits.[94]

A prospective hospital based study was conducted to examine the pattern of LBW babies, maternal complications and its related factors among Arabian women in Women's Hospital, Doha, Qatar. Pregnant women in their third trimester were enrolled in the study and they were followed till delivery. Out of 2238 pregnant mothers, 1674 met the eligibility criteria and consented to participate in the study. Findings of the study indicated that 6.7 percent newborns weighed <2500gms. On Multivariate analysis; previous LBW, consanguinity, parity, smoking APH, anemia, PROM, maternal occupation and housing condition were found to be significantly associated with the LBW. Screening and prompt treatment of maternal complications and counseling for cessation of smoking were recommended to reduce the incidence of LBW.[95]

An association between socio-demographic and biological risk factors for LBW was observed among Arabian women in Qatar in 2013. A total of 863 mothers of LBW babies and equal number of mothers of normal weight babies were included in the study. Findings revealed that low maternal education, first degree consanguinity and preterm delivery were the significant risk factors of LBW. [96]

A retrospective analysis of children born in 39 hospitals in China in 2013 was carried out to identify incidence and risk factors of LBW. Data of 1,01,163 singleton live births was included in the study. The results indicate that 6.1 percent newborns were of LBW wherein the incidence of full term LBW was two percent. Incidence of LBW was the highest in Southwestern China (9.4%) and lowest in central China (2.5%). Maternal age (<20 years), low maternal education, previous history of adverse pregnancies,

pregnancy with co-morbidities and complications such as hypertensive disorders during pregnancy, anemia, oligohydramnios and premature rupture of membranes were significantly associated with LBW babies. [97]

A cohort study was done in Taiwan amongst 21,248 postpartum women and their newborns in 2014. After adjusting for the physical and socioeconomic status of the parents, maternal smoking was related with the decreased birth weight. Incidence of LBW, SGA and preterm births were significantly higher amongst the babies born to the smoking mothers when compared to the non-smokers. Maternal smoking in the preconception time and during pregnancy was strongly associated with LBW; however, paternal smoking was not associated with the birth weight. Their study concluded that maternal smoking was responsible for increased incidence of LBW and preterm delivery. Further studies are needed to clarify correlation of fetal weight with passive smoking and exposure to environmental tobacco smoke.[98]

A hospital based case control study was conducted in Kuala Lumpur, Malaysia to identify the determinants of low birth weight. A total of 180 pairs of cases (<2500gms) and controls (≥2500gms) were randomly selected. Results of this study indicated that mean gestation amongst the cases (35.8±4.8 weeks) was significantly lower than the controls (38.6 ±1.3 weeks). Mean birth weight of LBW infants was 2.1±0.4Kgs as against 3.1±0.3Kgs for normal birth weight babies. Significant predictors of LBW identified in this study were: Young maternal age, history of LBW, prematurity and PIH. Importance

of pre-pregnancy screening and proper identification of high risk mothers was recommended to reduce LBW.[99]

A prospective study was carried out by Ugwa in 2014 in Amunu Kano Teaching Hospital, North West Nigeria to examine the relationship between birth weight and the maternal anthropometric characteristics. A total of 200 singleton pregnancies attending ANC clinic were studied. Findings of the study revealed that 50 percent of the pregnant women were of 15-24 years and their mean age was 28.2±5.7 years. Majority (73%) were unemployed and almost half (49.5%) had tertiary education. Average gestational age at delivery was 38.5±2 weeks. Five percent newborns were LBWs and 7 percent were macrosomic babies. Mean birth weight of newborns was 3270±550gms. Maternal health and weight had strong positive correlation with birth weight; however, maternal BMI was weakly associated with the birth weight.[100]

**2.2.2.2. Descriptive and Cross-sectional studies**

Lang et al., in the year 1996 estimated the effects of 23 factors on the prevalence of premature labor and fetal growth retardation. Risk factors for fetal growth retardation were studied among 10,889 full term babies. The study revealed that preterm labor was independently associated with young maternal age, low pre-pregnancy weight, nulliparity, previous preterm birth, history of $\geq$ 2 induced abortions, spontaneous abortions, stillbirths, uterine exposure to diethylstilbestrol, incompetent cervix, uterine anomaly and pyelonephritis.[101]

Karim and Mascie-Taylor observed the relationship between socio-demographic variables, maternal anthropometry and the birth weight in Dhaka, Bangladesh. Findings of the study showed that the LBW was significantly high among the babies of young (<20 years) and elderly (>30 years) mothers, belonging to the low-income group and those mothers who were illiterates.[102]

A population based study was carried out from the Swedish Medical Birth Register to identify the risk factors for SGA. A total of 96,662 singleton live infants born to nulliparous women were included in the study. This study revealed that maternal age (≥30 years), short maternal height, low maternal education, low pre-pregnancy BMI, preeclampsia and essential hypertension emerged as the risk factors for very preterm and term SGA.[103]

Philip, in the year 2000 stated that severe anemia (hemoglobin <8gms/dl) is associated with the birth of small babies. Hemoglobin concentrations <12gms/dl at the end of the second trimester are associated with three-fold increased risk of preeclampsia and IUGR. The incidence of LBW and preterm labor (<37 completed weeks) was statistically associated with hemoglobin concentration of 9.5–10.5gms/dl.[37]

In Mexico, an attempt was made to establish a model relating to birth weight and placental weight. A total of 300 full term singleton newborns were included in the study. Multiple linear regressions were used to observe the effects of placental weight on birth weight. There was positive correlation between birth weight and the placental weight.

The linear model estimated that each gram increase in placental weight was associated with the 1.98gms increase in birth weight of newborns. About 32 percent variation in the birth weight was explained by gestation age, maternal age and height. In this study, study duration and methods of sample selection are poorly mentioned however, statistical analysis was applied rigorously.[104]

A descriptive cross-sectional study was carried out by Makki in 2002 in Yemen to estimate the birth weight distribution and to determine the contributing risk factors. A total of 2256 women aged 14-45 years who delivered in four main hospitals in Sana's City were included in the study. Study revealed that the mean birth weight of the newborns was 2812gms where 22 percent newborns had birth weight <2500gms. Maternal age <20 years, weight <50Kgs, height <150cms, presence of UTI and maternal anemia during pregnancy were statistically associated with LBW babies.[105]

A cross-sectional study was conducted in 2004 to determine the prevalence of low birth weight among 202 babies who were born at labor ward of Dhaka Medical College Hospital, Bangladesh. Study revealed that majority (68.8%) were in the age group 20-29 years. Among them 94.5 percent were Muslims and 5.4 percent were Hindus. Majority of them (83.1%) were housewives and 58.9 percent were in the middle socioeconomic class. Most of them (70.7%) had height between 146-156cms and 9.9 percent had short stature. Mean maternal height was 152.1±5.5cms. Most of mothers (93.5%) gave birth to full term babies. About 11.3 percent had history of PIH. Mean birth weight was 2.7±0.5Kgs and 21.2 percent babies had LBW. [106]

A descriptive cross-sectional study was conducted among 648 pregnant women registered at Kilimanjaro Christian Medical Centre in Moshi, Tanzania. Parental education, hypertensive disorders during pregnancy, APH, anemia, maternal infection (tuberculosis, and malaria), PROM, preterm delivery, maternal BMI <18 $Kg/m^2$ and poor ANC were identified as the significant predictors of LBW.[107]

Panahandeh has undertaken a study to investigate the relation between weight gain during pregnancy and birth weight in Guilan Province, Iran using prenatal data of 918 women. Study found that incidence of LBW and macrosomia was 7.1 percent and 5 percent respectively. Women who gained weight less than the recommended range according to the Institute of Medicine guideline had significantly higher rate of LBW in their newborns. [24]

A cross-sectional study was conducted by Yadav, Chaudhary and Shrestha in 2011 in maternity wards of Janakpur Zonal Hospital, Nepal to explore the effects of various maternal risk factors on birth weight of newborn. A total of 306 mothers – newborn pairs were included in the study. Data was collected through individual interview and reviewing the patient case sheets. This study revealed that mean birth weight of newborns was 2.75± 0.6Kgs. About 21.5 percent babies had LBW and their mean birth weight was 1.96±0.4Kgs. On multivariate analysis, maternal age, education and antenatal service utilization were found to be significantly associated with LBW.[108]

Golestan, Karbasi and Fallah carried out a cross-sectional study to examine the prevalence and risk factors for LBW in Yazd, Iran. Results indicated that the prevalence of LBW was 8.8 percent. On multivariate analysis, preterm labor, working mothers and PIH were found to be the risk factors for LBW.[109]

A study conducted was conducted in 2011 in the central hospitals of Vietnam. This study identified that gestational weight gain of <10Kgs, low BMI and preeclampsia were associated with the risk of SGA babies. Younger (<24 years) and having a low BMI were associated with the risk of LBW.[42]

The combined effects of prenatal smoking and pre-pregnancy BMI was observed on birth weight of 34,928 singletons and term babies of New York City in 2011. Findings indicated that the increasing pre-pregnancy BMI was associated with the decreased risk of SGA and increased birth weight. Further, prenatal smoking did not have significant impact on SGA among those women who were overweight or obese before pregnancy; however, there was overall reduction of birth weight of the babies who had smoking and underweight respectively.[110]

Muula, Siziya and Rudatsikira have assessed the factors associated with LBW amongst the Malawi newborns using Malawi Multiple Indicator Cluster Survey (MICS-2006). Study revealed that most (60.5%) of the mothers were 20–29 years age. On multivariate analysis, the mothers who belonged to low wealth quintile, who had no education and primigravida had significant high risk for giving LBW babies.[111]

A cross-sectional study was conducted at a referral hospital in Northwest Ethiopia to study the correlates of LBW. Study found that more than half (53.4%) were primiparity women. About three-fifths (59.1%) had at least four ANC visits. The mean birth weight was estimated to be 2976±476gms. Incidence of LBW was 61.9 percent, 14.3 percent and 9.4 percent among the preterm, term and post term babies respectively. More than three-fifths of the (62.5%) mothers with preeclampsia/eclampsia had delivered LBW babies. LBW was found to be associated with first delivery; and lack of antenatal care and infrequent visits.[112]

A descriptive cross -sectional study was conducted at Bangabandhu Sheikh Mujib Medical University (BSMMU) teaching hospital, Dhaka in 2013. A total of 700 mothers who delivered in the study hospital and their newborns were recruited for the study. Findings revealed that 16 percent newborns were LBW and 18.5 percent were preterm births. Maternal weight, occupation, food intake status, malnutrition, antenatal check up, parity, gestational age, maternal disease were statistically associated with the delivery of LBW baby.[113]

A descriptive study was conducted to study the factors contributing to LBW. A total of 140 pregnant women from three tertiary care hospitals of District Quetta, Pakistan were recruited for the study. Findings of the study revealed that maternal education status, socioeconomic status, maternal infections (UTI, Bacterial Vaginosis, malaria, glomerulonephritis, chest infections), anemia, hypertension, cardio-vascular problems, antennal visits, familial history of LBW, maternal BMI, inter-pregnancy interval,

macronutrient supplementation and maternal nutritional status during pregnancy were found to be associated with the birth weight.[114]

### 2.2.3 Review of Indian studies

#### 2.2.3.1 Retrospective and Prospective studies

A case-control study was conducted in 1994 in the three teaching hospitals and a population survey in Ahmedabad City, India to identify risk factors for SGA. A total of 617 cases of SGA and 1851 AGA infants were selected as cases and controls respectively. The most important risk factor for SGA was poor maternal nutrition (weight <51Kgs) which explained 42 percent variation in the birth weight. Other significant risk factors were anemia, primiparity, bad obstetric history (BOH), lack of antenatal care and hypertension during pregnancy and the birth defects.[115]

A cohort study was carried out to estimate the prevalence of LBW and its association with maternal factors using a sample of 210 pregnant women residing in the field practice area of Government Medical College, Nagpur in 1994. Prevalence of LBW was 30.3 percent. On multivariate analyses, maternal anemia, low socioeconomic status, short birth interval, tobacco exposure, height, maternal age, BMI, and primiparity were found to be the maternal factors statistically associated with LBW babies.[38]

A longitudinal study was carried out to study the factors affecting birth weight among the institutional births in Sevagram, Maharashtra. A total of 256 mothers delivering at Kasturba Hospital and Maternal and Child Health (MCH) centre Sevagram were included

in the analysis. Findings of the study indicated that average weight of newborns was 2.53±0.4Kgs. Antenatal care, maternal education, occupation, per capita income, parity, bad obstetric history, maternal weight before delivery and the hemoglobin concentration were statistically associated with the LBW.[116]

A community based longitudinal study was conducted by Rao, Prakash and Nair in 2001in the rural field practice area of Kasturba Medical College, Manipal, Karnataka. A total of 75 pregnancies were followed till delivery. The average pre-pregnancy weight was 43.7±6.6Kgs and the mean maternal height was 154.2±5.2cms. Mean weight gain during pregnancy was 8.0±2.6Kgs and the mean birth weight was 2869.7±467.2gms. There was statistically significant correlation between birth weight, maternal height and the weight gain during pregnancy.[117]

A case-control study was carried out by Acharya, Nair and Bhat in 2004 to study the maternal determinants of IUGR among pregnant mothers admitted for delivery in rural Maternity and Child Welfare Homes in Udupi district of Southern Karnataka. Findings of the study revealed that maternal age over 30 years, primiparity, maternal height <145cms, maternal weight <45Kgs and anemia during pregnancy were significant risk factors for IUGR.[118]

A retrospective study was conducted among 331 Bengalese mother-baby pairs at M.R. Bangur Hospital, South Kolkota. Study revealed that mean birth weight of newborns was 2592±37gms and the mean weight of male (2658±362gms) was slightly

more than female (2515±367gms) babies. About 36.6 percent newborns weighed <2500gms.Young maternal age <19 years and primiparity were significantly associated with LBW.[119]

Negi, Kandpal and Kukreti have conducted a longitudinal study among 172 newborns at Rural Health Training Centre and Maternity wards of Himalayan Institute of Medical Sciences, Dehradun in 2006. Results of this study showed that almost half (49.4%) pregnant women were 20-25 years ages and 12.8 percent were adolescent mothers with the mean age being 24.1±1.1 years. About two-fifths (40.7%) were primigravida. Out of 102 (59.3%) multigravida pregnant women, history of abortion, stillbirth and preterm delivery was reported by 21.6 percent, 12.7 percent and 13.7 percent mothers respectively. Mean birth weight of the newborns was 2.67±0.4Kgs. The incidence of LBW babies was 23.8 percent. Late ANC registration, ANC visits <3 times, primiparity, short inter-pregnancy interval <2 years, maternal height <150cms, maternal weight before delivery <45Kgs, history of abortion, stillbirth, perinatal death and premature delivery were statistically associated with LBW babies.[120]

The usefulness of maternal anthropometric parameters such as weight, height, mid upper arm circumference, and body mass index as predictors of low birth weight among 395 singleton pregnancies was observed in 2006. The maternal anthropometric parameters were measured in the first trimester of pregnancy. These parameters were plotted against the birth weight of newborns. Significant positive correlations were observed among maternal weight, height, mid upper arm circumference and BMI; and the

birth weight of newborns. For prediction of LBW, the critical limits of maternal weight, height, and BMI were 45Kgs, 152cms and BMI 20Kg/$m^2$ respectively. Mothers who have anthropometric parameters in the "red zone" are at risk of delivering LBW babies.[121]

A longitudinal study was undertaken by Vijayalaxmi and Urooj in 2009 to assess the influence of maternal factors on mode of delivery and birth weight of newborns among 100 pregnant women visiting at Government and private hospitals of Bangalore for ANC. Study reported that 98.0 percent pregnant women were Hindus, 54.0 percent belonged to joint families and 54.0 percent studied upto secondary level education. Almost 78 percent were multigravida and majority of them (82%) were using mixed type of diets. Diarrhea (11.0%), cough (9.0%) and UTI (1.0%) were commonly reported medical illnesses during pregnancy. About 43.5 percent mothers had Cesarean delivery. Maternal age and parity were found to be statistically significant factors influencing birth weight of newborns.[122]

Velankar, in 2009 carried out a prospective study in an urban slum of Sahaji Nagar, Mumbai to find out the proportion of LBW and to assess the maternal factors associated with LBW. A total of 282 randomly selected pregnant women were followed till delivery. Out of 282 study samples, 252 women were analyzed at the end of the study excluding those loss to follow up, multiple births and pregnancy wastage. Results of this study revealed that there was high incidence of LBW (45.2%). On multivariate analysis, pregnant women who had not taken ANC services or who had made <3 visits and late ANC registration had delivered significantly higher proportion of LBW babies as

compared to those who had made adequate ANC visits. Similarly, adolescent pregnancies and low socioeconomic were also emerged as the risk factors for LBW.[123]

A retrospective study was carried out by Singh, Chouhan and Sidhu in 2009 to identify the maternal risk factors for LBW. Forty LBW babies (cases) were compared to the 300 normal birth weight babies. Results of the study revealed that pre-pregnancy BMI (<20), unbooked status, preeclampsia and BOH were the risk factors for LBW.[124]

A retrospective study was carried out to explore changes in birth weight over a period of two decades. Twenty years records (1989 to 2007) of all births occurring in a private nursing home of Dindori block of district Nashik, Maharashtra were analyzed. The study revealed that there was no change in the average birth weight over a period of two decades (mean birth weight: 2.7Kg±0.48Kg). The proportion of LBW was 24% and showed modest decrease after 1998 (20.4 %). Birth weight was found to be associated with the maternal age; however, birth order and gender of the baby did not have statistically significant association with birth weight.[125]

An age, parity and gestation weeks matched case-control study was carried out among women delivering (n=860, equal numbers of controls) in Government Medical College of Nagpur City during June 2007 to December 2009. Study reported that majority of the pregnant women (65.1%) were of 20-24 years old, 60.7 percent were primigravida; and 8.2 percent were preterm births. Previous unfavorable pregnancy outcomes, rural residence, weight <40Kgs, birth interval <24months, hemoglobin level

<11gms/dl, BMI<18.5Kg/$m^2$ and morbid conditions were significant risk factors for LBW. After multiple regression analysis, presence of morbid conditions, previous unfavorable pregnancy outcomes and residence in rural areas were reported as independent predictors of LBW.[36]

A case-control study was carried out in 2011 in the teaching hospital of Western Maharashtra to investigate maternal risk factors for full term LBW newborns. Pregnant women (18–35 years age mothers) who delivered a live newborn weighing <2500gms and ≥2500gms were defined as case and controls respectively (n=2000/group). Low income, illiterate/primary level education, farmers and laborer mothers; primigravida and women with birth spacing of <2 years had delivered significantly high proportion of LBW babies. LBW was associated with anemia. Significant risk factors indentified in this study were: Maternal anemia, PIH, maternal weight, maternal height <145cms and inadequate ANC.[126]

A retrospective study was carried out using the data of 2396 women delivering in S.N. Hospital, Agra in 2012. Data was obtained from the medical records section of the hospital using structured proforma. Mothers having existing illness, pregnancy induced hypertension and stillbirths were excluded from the study. Study found that sex ratio of the newborn babies was 840:1000. About 38.0 percent of them had weight <2.5Kgs. Majority of the LBW babies were female and those babies born to Muslim women. Other risk factors were higher parity (≥4), teen age (43.43%) and over 30 years mothers (41.62%). Majority of the LBW babies were delivered virginally (41%). Sixty four

percent of the preterm babies had LBW whereas 30 percent of the full term babies had birth weight <2500gms.[127]

A community based longitudinal study was conducted by Metgud, Naik and Mallapur to know the factors affecting birth weight of a newborn and to estimate the prevalence of LBW in the catchment area of Kinaye Primary Health Centre, Belgaum district of Karnataka, India. A total of 1138 mothers and their newborns were included in the study. Results of this study revealed that a great majority of the pregnant women (86.2%) were between 20–29 years and 6.9 percent were teenage pregnancies. Majority (85.8%) were Hindus, 86.5 percent were literates, two-thirds (66.9%) were housewives and 67.6 percent belonged to III$^{rd}$ and IV$^{th}$ socioeconomic class. About 55.0 percent pregnant women had total weight gain 5-7Kgs whereas a quarter (25.5%) of the mothers had ≤4Kg weight gain during pregnancy. History of caesarean section, abortion, stillbirth, low birth weight, Rh negative status and PIH were observed among 15.4 percent, 13.6 percent, 3.6 percent, 3.0 percent, 4.6 percent and 11.4 percent respectively. More than four-fifths (81.0%) pregnant women had made ≥3 antenatal visits, 68 percent had taken ≥100 tablets of IFA. Average birth weight of newborns was 2.6±0.4Kgs with the range of 1.2-3.8Kgs. Prevalence of LBW was 22.9 percent. After controlling the effects of potential confounding factors, 12 factors such as maternal illiteracy, exposure to passive smoking, late child bearing, short inter-pregnancy interval, history of previous LBW delivery, maternal weight, weight gain during pregnancy, PIH, high risk factors during pregnancy and late antenatal registration were identified as the risk factors for LBW. Targeted

population specific interventions were recommended for the modifiable risk factors to reduce the magnitude of LBW babies.[128]

A retrospective analytical study was conducted in 2013 to measure the frequency of LBW and its determinants at a secondary level hospital of Bhopal. Obstetric records of 441 women who delivered in the Indira Gandhi Mahila Evem Balya Chikitsalaya, Bhopal were examined. Study revealed 54.9 percent of the newborns were male. Mean weight of newborns was 2.72+0.4Kgs. About 11.8 percent had birth weight <2.5Kgs. The period of gestation, maternal anemia during pregnancy, parity, maternal age and sex of the baby were significantly associated with birth weight of newborns.[129]

A community based cohort study was conducted in 2013 among pregnant women of an urban slum in Bhopal, India. Study population comprised of women in third trimester of pregnancy (completed sixth months), agreed to follow the intervention protocol during third trimester and supposed to be delivered at J. P. Hospital, Bhopal, India. Study revealed that the mean birth weight of newborns was 2.57±0.36Kgs. About 36.2 percent newborns had birth weight <2500gms. Statistically significant association was found between the maternal occupation, daily calorie intake and duration of day time rest and the birth weight of newborns.[130]

A case-control study was carried out by shah, Parikh and Bala at Odhav ward of Ahmadabad Municipal Corporation to study the effects of maternal risk factors on birth weight. Information about purposively selected 200 LBW (cases) babies and age, sex

matched 200 normal birth weight babies (controls) was collected from the link workers. Study revealed that the mean birth weight of newborn was 2.52±0.53Kgs. Average birth weight of LBW babies was 2.09±0.3Kgs which was almost 1.0Kg lower than that of normal birth weight (2.95± 0.32Kgs) babies. Male babies had slightly higher birth weight than female babies. Literacy of mother has positively affected the birth weight whereas labor occupation had a negative effect on the birth weight. Maternal age <15 years and >30 years, short birth interval and history of LBW were also found to have significant impact on birth weight of newborns.[131]

**2.2.3.2. Descriptive and Cross-sectional studies**

Misra and Sharadamma identified that there were 23 percent LBW babies in an industrial area of Delhi. Out of these LBW babies, 76 per cent were full term SGA babies. Hypertensive disorders during pregnancy remained a single most common obstetric problem associated with term SGA births. Age, parity, booking and low socioeconomic status were also found to be associated with reduced birth weight.[45]

A community based study was conducted to identify the socio-demographic, maternal and obstetric determinants of LBW. Study utilized the data of 2919 child-mother pairs of all live births which occurred in the rural areas of Udupi Taluk of Karnataka. On multivariate regression analysis, primigravida, elderly mothers and mothers who had not received good quality ANC were found to be more at risk of delivering LBW babies.[39]

A cross-sectional study was carried out at Queen Mary Hospital, Lucknow among 889 mothers along with their 901 newborns. Results indicated that the mean birth weight of newborns was 2669.7±447gms and 32.2 percent weighed LBW. Maternal complications during current pregnancy, history of stillbirth, neonatal death and LBW; ANC status, dietary intake and nature of work during pregnancy, anemia, chronic infections and cardiovascular disorders were significantly associated with LBW.[132]

A study was conducted in 2004 among 576 non-smoking women who delivered in a teaching hospital of North Western, India with an aim to identify the effects of environmental tobacco smokes (ETS) on the outcome of pregnancy. There was a significantly higher incidence of preterm birth and SGA babies among those exposed to ETS as compared to unexposed mothers. The mean birth weight of the babies born to the mothers exposed to ETS was 138gms less than that of babies in the unexposed group (2632±57gms Vs. 2770±56gms) respectively. The multiple logistic regression analyses showed that ETS exposure during pregnancy was significantly associated with a higher risk of SGA babies.[133]

Dasgupta, Roy and Mandal carried out a cross-sectional study at NRS Medical College Hospital, Kolkata in 2004. This study revealed that the incidence of LBW was 34.7 percent and 10.2 percent weighed below 2000gms. LBW was significantly high among the infants born to illiterate mothers, young mothers <20 years, primigravida, who had physical work during pregnancy, height <145cms, low maternal weight at first trimester (45Kgs) and hemoglobin <8gms/dl in the third trimester of pregnancy.[40]

A cross-sectional study was conducted at the Motilal Nehru Medical College teaching hospital, Allahabad to identify the factors affecting birth weight of newborns. A total of 233 mothers along with their newborns were included in the analysis. Study identified that the mean birth weight of newborns was 2.64±0.4Kgs. LBW was observed among 34.3 percent newborns. Amongst the LBW babies, majority (27.73%) had 2.00-2.49Kgs weight. About 32.5 percent male and 36.3 percent female babies had birth weight <2500gms. Maternal education, occupation, per capita income, poor ANC, maternal nutrition during pregnancy, anemia, close birth spacing, child bearing in young age (<20 years), maternal illness and the complications during pregnancy were significantly associated with LBW babies.[44]

A hospital based study was conducted by Agarwal and Reddaiah in 2005 at a secondary level hospital of Ballabgarh, Delhi to assess the impact of maternal age, parity, gestational age, antenatal care and anemia on birth weight. Out of 2,903 deliveries occurred in study hospital, 2,807 singleton live births were included in the study. Findings revealed that 27 percent of the newborns had LBW. Significantly high proportion of LBW babies were born to the young mothers (<20 years), premature births, mothers who did not avail ANC services and female newborns. Conceptions after 20 years of age and increase the coverage of ANC for pregnant women are recommended for the health promotion of pregnant women.[134]

A cross-sectional study was carried out at a Government hospital in South Kolkata, India to examine the extent of degree to which maternal early second trimester pregnancy

weight is useful in predicting birth outcome of Bengalese women. A total of 295 mother-baby pairs who met the recruitment criteria were included in the study. This study indicated that the prevalence of LBW was nearly 34 percent. Higher incidence of LBW was observed in low weight (≤40Kgs) mothers. Present findings showed that maternal weight of 46Kgs is the best cutoff for detecting LBW with 66 percent sensitivity and 75 percent negative predictive value (NPV). Study recommended that this cutoff value (46Kgs) can be used for screening the pregnant women at early second trimester to identify the maternal risk for delivering LBW.[135]

The risk factors of LBW were investigated among 193 neonates delivered at Government Medical College and Hospital, Chandigarh in 2009. The overall proportion of LBW was 23.8 percent. Significantly higher proportion of LBW babies were born to mothers <20 years of age, poorly educated, belonging to poor and undernourished who had <45Kgs weight before pregnancy as compared to those otherwise.[136]

Dharmalingam, Navaneetham and Krishnakumar in 2010 examined the role of maternal nutritional status and Socio-biological factors in determining the birth weight of newborn. Data from second Indian National Family Health Survey (1998/99) was analyzed. A record of 10,042 newborns was retrieved. Results of this review have shown that maternal nutritional status, use of antenatal care and iron deficiency anemia were found to be the important significant contributors for LBW.[137]

A cross-sectional study was conducted by Sen, Roy and Mondal in 2010 to examine the association between maternal nutrition status, body composition and socioeconomic status and birth weight of newborn. Data of 503 mothers who delivered a singleton baby in a hospital at Siliguri, West Bengal was analyzed. The study identified that mean birth weight of newborns was 2.74±0.4Kgs. About 17.3 percent newborns weighed <2.5Kgs. Multivariate analysis revealed that maternal age, height, weight, nutritional status and household income were significantly associated with LBW.[138]

A cross-sectional study was carried out at tertiary care hospital in Uttar Pradesh. A total of 350 newborns delivered at hospital were studied. Results of the study revealed that almost two-fifths (40.0%) mothers delivered LBW babies. Gestational age <37weeks, maternal age <20 years, irregular ANC visits, mother's height <150cms, weight <50Kgs, hemoglobin <10gms/dl, physical work during pregnancy and tobacco chewing were the significant factors of LBW.[28]

A descriptive cross-sectional study was conducted by Padda, Kishore and Srivastava in 2011among 1300 mother-newborn pairs in the three hospitals of Dehradun. Study revealed that almost equal pregnant women belonged to the rural and urban areas, 1.3 percent of mothers were <18 years and 47.4 percent were in the age group 19-23 years; and majority (89.7%) of them were housewives. Low birth weight was noted amongst 34.7 percent newborns. Maternal age (<18 years and >35 years), low level of hemoglobin and the short birth interval (<2 years) were statistically associated with LBW.[139]

A cross-sectional study was carried out in Pune city of Maharashtra, India among 156 singleton healthy pregnant women to determine the effect of maternal nutritional factors on birth parameters. Study revealed that each 1gram increase in maternal protein intake was associated with a 31.47gms increase in the birth weight (CI: 5.36-57.59gms) and 0.15cms increase in baby length (CI: 0.046-0.27cms). There was positive correlation between percentage of energy derived from protein and birth weight of newborns.[140]

The spatial distribution and factors associated with low birth weight was observed among 7,058 babies born at full term. Data pertaining to maternal socioeconomic indicators and community level environmental factors, antenatal care and perinatal outcomes were recorded from the Health Information System of the Department of Community Health, Christian Medical College, Vellore district of Tamil Nadu. Linear regression revealed that the under education of mothers (up to $5^{th}$ grade), anemia, preterm delivery and distance from a health centre were statistically significant predictors of LBW. Anemic mothers and undereducated mothers had delivered significantly higher proportion of LBW babies who were born at full term.[141]

A hospital based cross-sectional study was conducted among 325 women delivering live infants in a tertiary care hospital, Meerut in 2012. The study revealed that 32.3 percent newborns weighed <2500gms. Majority (71.42%) of mothers were from rural areas, 52.3 percent belonged to joint families, 52.3 percent were illiterates, 76.19 percent were housewives and almost 47 percent belonged to the $IV^{th}$ class socioeconomic status.

LBW was significantly high among the babies of young mothers (<18years), tobacco consumers, pre-pregnancy weight <40Kgs, hemoglobin <8gms/dl and primiparity.[142]

A cross-sectional study was carried out at Government Medical College Teaching Hospital, Miraj amongst 509 mothers-newborn pairs to identify the maternal factors associated with LBW. Individual interview followed by clinical examinations and anthropometric measurements of mothers and newborns was done. Study revealed that 18.1 percent newborn had birth weight <2500gms. After controlling potential confounders, preterm delivery (<37 weeks), number of antenatal visits (<3 visits), anemia (<10gms/dl), bad obstetric history, mothers weight (≤40Kgs), low socioeconomic status, birth interval <3 years, heavy physical work, no Iron and Folic Acid intake during pregnancy, female newborns and primigravida were the significant factors associated with LBW.[143]

A community based cross-sectional study was carried out in 2013 in West Bengal among 540 births. The study identified that 30.9 percent newborn infants had birth weight <2500gms. Teenage mothers (≤19 years) and elderly mothers (≥40 years) had delivered significantly higher proportion of LBW babies than those of 20-39 years old mothers. Religion (Muslims), literacy status (illiterate), occupation (housewives), tobacco chewing mothers, late enrolment for ANC care (>12 weeks), number of ANC visits <4 times, daily sleep and rest <8 hours, mothers who consumed <100 IFA tablets during pregnancy, not taken TT injection during pregnancy, female babies, short maternal height

(<145cms.), infection during pregnancy, anemia and complications during pregnancy had significant association with LBW babies .[144]

A record based study was carried out using the data of 1176 mothers who delivered singleton live births at the Kinaye Primary Health Care Centre of Belgaum district of Karnataka in 2013. Study revealed that 94.9 percent mothers were 20-29 years old. About 78.4 percent of the mothers were educated with 3.4 percent having more than Secondary School Leaving Certificate (SSLC) education. Most of the mothers were housewives. Majority were Hindus (94.6%) and Muslims (5.4%). About two-fifth (41.6%) were primigravida. About 51.5 percent were male and 48.5 percent were female newborns. The prevalence of LBW was 8.3 percent. The prevalence of LBW was high in the extremes of maternal age (<20 and >35 years). Primigravida and women of birth order ≥5 showed a higher prevalence of LBW as compared to those $2^{nd}$-$4^{th}$ gravida.[145]

An observational study was undertaken at JSS Medical College Teaching Hospital, Mysore, Karnataka in 2013. A total of 1000 mothers admitted for delivery were recruited and their hemoglobin was measured. Results of this study showed that 39 percent of the mothers were anemic throughout the pregnancy. Mean birth weight of the babies born to anemic mothers was significantly lower than that of babies born to non-anemic mothers. There was 6.5 percent increase in the incidence of LBW babies in mothers who were anemic in the third trimester.[146]

Swarnalatha and Bhuvaneswari carried out a cross sectional study at a Government Maternity Hospital attached to S.V. Medical College, Tirupati in 2013 to observe the prevalence of LBW and its association with socio-demographic and maternal factors. A total of 1200 postnatal mothers who delivered single live baby were selected by systematic random sampling method. Study revealed that 26.8 percent were LBW babies. LBW was found to be significantly higher among the babies of young mothers (<20 years), illiterate mothers, laborers, mothers with low income, consanguinity, primigravida, short birth interval, preterm delivery, weight gain during pregnancy<6 Kg, maternal height (<145cms), weight (<45Kgs), anemia, ANC (<3 visits), not consumed or consumed <50 IFA tablets, hard physical labor during pregnancy, tobacco chewing, female babies and obstetric complications during pregnancy.[147]

A community based cross-sectional study was conducted to estimate the prevalence of LBW and to identify various factors determining it in rural area of Mysore. A total of 293 births occurring during 2010 among permanent residents of this area were included in the study. Findings showed that >50 percent of mothers had conceived before the age of 20 years, more than 52 percent mothers had secondary level education and 70 percent of them belonged to class III$^{rd}$ and IV$^{th}$ of socioeconomic status. Mean birth weight of newborns was 2723.54±91gms. LBW was prevalent amongst 20.1 percent babies. Prematurity, intrauterine complications, no consumption of IFA tablets and poor weight gain during pregnancy were significantly associated with LBW.[148]

A record based cross-sectional hospital based study was carried out in 2013 in Pune to study the effects of maternal exposure to various kitchen fuels on birth weight. A total of 328 mothers and their newborns were included in the study. Study revealed that almost all (96.9%) mothers were housewives and (33.2%) had high school level education. About 50.3 percent newborns were males and 49.6 percent were female babies. Male babies were slightly heavier than the female babies. Mean birth weight of babies of the mothers who were Liquid Petroleum Gas (LPG) users, wood users and LPG + wood user were 2.669±0.44Kgs, 2.465±0.46Kgs and 2.557± 0.60Kgs respectively. Significantly lower birth weight was observed among the infants born to wood users as compared to the LPG users. Logistic regression analysis showed that type of fuel is only the best predictor of LBW. Further, the duration of exposure to wood fuel increases the chances of LBW significantly.[149]

A cross-sectional study was carried out in 2013 to estimate the incidence of LBW at a tertiary care hospital, Jaipur and to determine the maternal factors affecting the birth weight of newborn. Study revealed that out of 796 mothers studied, 50 percent were 20-25 years of age, 26.2 percent were illiterates, and 70.2 percent were from joint families. The median age at marriage and first pregnancy was 17.8 years and 19.6years respectively. About 44.2 percent mothers were primigravida, 51.1 percent anemic according to WHO criteria, 24.7 percent had one of the obstetric complications during pregnancy and 61.8 percent had moderate physical activities during pregnancy. Almost 28 percent newborn had LBW and the occurrence of LBW among female was higher than the male newborns (30.1% Vs 25.6%) respectively. Significant predictors of LBW

identified in this study were: Primigravida, illiteracy, birth spacing (<35 months), preterm birth, booking status, not consumed IFA, hard physical work, mother having any medical illness such as anemia, PIH and any previous/present obstetric complications.[150]

### 2.2.4: Risk scoring systems related literature

A simplified antepartum high risk pregnancy scoring form (modified Goodwin, Durrn and Thomas scoring systems) was designed and evaluated in 1977 for the series of accepted risk factors to which arbitrary values 0, 1 and 2 were assigned to predict pregnancy outcomes. The form was evaluated among 5459 eligible patients in Manitoba University Teaching Hospital by assigning risk scores (RS) to the individual factors present during pregnancy. The originally developed design comprised 29 risk factors which were grouped into four categories like reproductive history (ten factors), present pregnancy (ten factors), associated health conditions (five factors) and perinatal outcomes (four factors).[49] Study has shown that there was positive relationship between risk scores and the incidence of premature birth as well as LBW. Almost four percent newborns of the mothers who had antenatal risk scores 0 had delivered LBW babies whereas noticeably higher proportion of mothers (31.5%) who had ≥7cumulative risk scores had delivered LBW babies. This study concluded that risk scoring form designed in this study remained a useful tool to predict prematurity and LBW. [49] Although there was significant relationship between risk scores and birth weight, the scores were assigned to each of the predictor variables arbitrarily on clinical experiences

Ernest stated that preterm low birth weight newborn comprised a subset of extremely high risk infants. Risk factors for preterm low birth weight births were analyzed in a sample of 11,623 women from northwest North Carolina. Significant risk factors for preterm low birth weight were identified and risk scores were assigned to each of the factors. Scoring was done with a strong belief that the application of weighing each patient's specific risk factors identifies women at high risk for a delivery of preterm LBW babies that assists in the determination of appropriate interventions. This study concluded that prospective evaluation of the risk scoring system enable us to judge the predictive accuracy and applicability of the risk scoring system .[151]

The occurrence of pregnancy outcomes amongst 777 mothers delivering at different Hospitals in Lucknow was observed in 1988. Study revealed that 25.1 percent mothers had 0 risk scores. About 41.3 percent, 25.6 percent and 7.9 percent mothers had 1-3, 4-6 and ≥7 risk scores respectively. The incidence of LBW was the lowest (0.5%) when risk score was 0 and highest (43.2%) when risk score was ≥7.[152]

The relationship between antepartum risk assessment and subsequent maternal and perinatal outcomes were examined in 1989 using a sample of 430 randomly selected deliveries at the Oregon Health Sciences University. Antepartum risk scores at the initial prenatal visit and at 37 weeks of gestation were positively correlated with each other. Antepartum risk scores were correlated with gestational age and the birth weight. Increased antepartum risk scores were strongly correlated with lower birth weight and lower estimated gestational age at birth. The ability of the risk scoring system to predict

selected adverse outcomes was then assessed using a high risk cutoff score of ≥5. Sensitivity and PPV were found to be quite low while specificity and NPV were reasonably high. These results suggest that risk scoring system used in identifying low and high obstetrical risk and prenatal care result in reduction of poor neonatal outcomes. This study did not reveal their risk assignment procedures and basis for defining risk scores.[153]

An epidemiologic predictive model was developed in 1989 for early identification of pregnant women at higher risk of delivering LBW infants using data from a random sample of 5125 pregnant women who had made prenatal visits from Obstetrics Hospital of the Guatemalan Social Security Institute, Guatemala, Central America. Medical pathology, respiratory infections, first prenatal care visit after 19 weeks of gestation, maternal age greater than 35 years, history of delivery of LBW baby, maternal weight gain <132gms/week were found to be significantly associated with LBW infants. The predictive capacity of the risk scoring system to identify maternal risk of delivering LBW baby at 26 weeks of gestation was 42 percent. A predictive model like this may enable health care workers to identify cases the pregnant women at high risk of delivering LBW babies. Such early action may help reduce the risk of LBW. If prevention is not possible, early identification of maternal risk for delivering LBW babies might ensure appropriate care at birth.[154]

A simple risk scoring system with the 10 antenatal and intranatal factors was developed in 1990 to categorize pregnant women into low and high risk group using

easily available information like history, clinical findings and simple investigations. Scores 0, 1 and 2 were assigned to each of the variables on the basis of severity. This scoring system was based on the clinical experiences. Scoring was done at the first ANC visit, 28 and 36 weeks of gestation and finally at the time of delivery. The score was correlated with birth weight, maturity, perinatal loss and obstetric outcomes.[155]

Findings revealed that 58.1percent women were having risk scores more than zero. Nearly one-fifth of all women screened were at high risk (score ≥3). Out of 200 preterm deliveries, 78.5 percent were of total risk score ≥3. Nearly seven out of every ten babies with LBW belonged to risk scores ≥1 while more than a quarter of such babies were born to the mothers with risk scores ≥3. Positive correlation was observed between risk scores and the LBW i.e. increase in risk scores led to the increased numbers of LBW ($r=0.6$; $P<0.05$). False negative rate was 4.2 percent for the preterm delivery while sensitivity was 78.5 percent. Moreover, sensitivity and false negative rate for the low birth weight were 64.8 percent and 8.2 percent respectively.[155] This study advocated that sensitivity is more important than specificity for scoring system as delay in referral of high risk cases is worse than diagnosing low risk as high risk. Although, this study have reported higher sensitivity and specificity than other studies, the applicability of this risk scoring system was limited due to large number of false positive and negative cases.

Dutta and Das, in the year 1990 developed a simple risk scoring schedule to identify the risk mothers for effective management, keeping its utility by the paramedical staff. About 310 sample mothers belonging from low socioeconomic group and 180

mothers belonging from high socioeconomic group attending in the antenatal clinic of the urban health care centre in Calcutta, India were selected and Adhoc scores based on clinical experience (0, 1, 2 & 3) were assigned to various 23 factors like age, parity, past obstetric history, associated medical factors and relevant present pregnancy factors. Finally, these scores were added together to observe the cumulative effects.[156]

Study identified that nearly two-thirds of all mothers (61.2%) were having low risk (0-2) scores and remaining was at moderate risk or high risk. Majority (69.24%) of the mothers who delivered LBW babies belonged to moderate scores (3-5) and high risk group (≥6) in the low socioeconomic group while slightly lesser proportions of low weight babies were born to the mothers with moderate and high risk scores in high socioeconomic classes. Consistent inverse relationship was observed with the birth weight and the risk scores in the both SES group mothers. Study concluded that incidence of LBW was higher among mothers who belonged to the low socioeconomic group and inverse relation with risk grades i.e. increase in risk scores decreased birth weight.

In 1991, a study was carried out to identify high risk pregnancies and their problems during pregnancy using a simplified antepartum risk scoring system. He utilized Edward's scoring system and revised to make suitable in Korean situation and applied to the sample of 1300 pregnant women admitted in Chung Ang Medical Center. An association was observed among four categories of independent variables namely demographic, obstetric, medical and miscellaneous factors; and pregnancy outcomes including birth weight. Study revealed that 42.7 percent infants were born to the mothers

with risk scores >7 and 57.3 percent were born to mothers who had risk scores <7. Maternal age, parity and education level were identified as statistically significant predictors of high risk pregnancies respectively. History of cesarean section, Rh negative, abortion, preeclampsia, premature birth and low birth weight infant; abnormal presentation and perinatal loss were also statistically significant predictors of high risk pregnancies. There were statistically significant relation between risk scores (0-3, 4-6, ≥ 7) and the birth weight of newborns.[157]

Talsania and Lala conducted a study to determine risk factors associated with preterm delivery, perinatal mortality and neonatal morbidity among 687 pregnant women in New Civil Hospital, Ahmedabad, India in 1991. Pregnant women were scored according to their level of risk: no risk, mild risk, moderate risk and severe risk on the basis of socio-demographic and obstetric data. Of total 687 pregnant women, 10.2 percent delivered prematurely. About 11.1 percent 14.1 percent and 20 percent pregnant women were labeled under mild, moderate and severe risk groups respectively. Preterm birth was found not associated with pallor and prior history of stillbirth. Factors significantly associated with preterm births were maternal malnutrition, higher pregnancy order; older maternal age at delivery, prior preterm births and fetal loss. Pregnant women with risk more factors had multifold higher risk of preterm births. Risk scores had high sensitivity (95.7%), but had low specificity (19.6%) and low PPV (11.9%) to predict LBW babies. Study concluded that the risk scores had high sensitivity to predict preterm birth among high risk women but poor sensitivity among low risk women. [48]

A study was conducted in 1992 to develop an instrument to identify mothers at risk of delivering LBW babies. It was conducted among 17,135 pregnant women attending in prenatal care clinic of the Gynecology and Obstetrics Hospital (GOH) of the Guatemalan Social Security Institute in Guatemala City. The instrument was used as a part of GOH's prenatal record, proposed by Pan American Health Organization for Latin America. Instrument was further evaluated for its capacity to predict low birth weights in advance. In the study, Odds ratio of the significant factors associated with birth weight at $p<0.01$ in the univariate analysis were further adjusted for confounding factors. Factors which were significant at 0.05 were subjected for the logistic regression analysis and then transformed to the logistic regression coefficients to obtain final model into odds ratio (OR). These odds ratio were used to weigh each variable in constructing the risk score and the risk score itself was then evaluated by applying it to the 6,542 eligible women who had received prenatal care at the hospital clinic before 26 weeks of gestation. Findings revealed that the risk score between5-10 was found to produce a sensitivity of 42– 64 percent and a specificity of 57-76 percent to identify mothers at high risk of delivering LBW babies. Of the 1,534 mothers, 23.4 percent with a risk score of $\geq 11$ deemed to be at high risk of LBW and predicted 39.8 percent of the LBW deliveries (sensitivity:39%, specificity:78%, and false positive rate: 34%). The best overall predictability was obtained at 25 percent of the population classified as being at high risk (score=10, with high risk mothers accounting for 42% of LBW deliveries). At this cutoff point, sensitivity and specificity were 42 percent and 76 percent respectively. Study concluded that early identification of the pregnant women at relatively high risk of

delivering LBW babies can enable health care workers to implement appropriate prenatal interventions to reduce the risk of delivering LBW babies.[158]

A pregnancy risk scoring was developed and evaluated by Humphrey in 1995 using data of 2875 women with singleton pregnancies who gave birth at Cairns Base Hospital. The study indicated that there was high incidence of at-risk pregnancies and limited availability of caregivers to provide antenatal care in the remote region of the Peninsula and Torres Strait Health Region in Far North Queensland. Preterm birth, LBW and birth interventions were less likely to occur among women with low risk scores, with the lower likelihood of preterm birth reaching clear statistical significance; while in the remote areas, large numbers of high risk pregnant women were scattered and the adverse outcomes (preterm birth and low birth weight) were significantly related to the risk scores. In the resources scarce areas, risk scoring tool would assist in decision making about the best use of resources. This study, although stated the paramount importance for the decision making, there was no further specification of risk scoring system used.[159]

A double blind prospective study of 979 mother-infant pairs was evaluated in 1997 in Argentina, Colombia, Honduras and Uruguay to identify the predictive value of prenatal biomedical risk scale (PBRS) including a prenatal bio-psychosocial risk assessment for LBW. All the pregnant women who had made first antenatal visit during 14-28 weeks of gestation at either of seven health centers located in Argentina, Colombia, Honduras, and Uruguay were evaluated. High PBRS scores showed a sensitivity of 62.1 percent and the specificity of 81.3 percent, PPV of 45.3 percent and

NPV of 89.5 percent to predict LBW babies. With the addition of psychosocial factors (PBRAS), sensitivity of 75.7 percent and specificity of 76.1 percent, PPV of 55.1 percent and NPV of 88.9 percent were observed. The study provided strong evidences for the conclusion that prenatal bio-psychosocial risk adjusted for variables such as length of gestation, neonatal APGAR, perinatal mortality, socioeconomic status, drinking and smoking status significantly improved the PPV of the assessment of women at risk of delivering LBW babies. Despite the increased accuracy parameters in combination (PBRAS), their system had poorly defined risk scoring systems and scales of measurements.[160]

Lala and Talsania, in 2001 evaluated and predicted the neonatal outcomes (birth weight, morbidity and mortality) using ICMR's 21 factorial antenatal scoring method among 900 pregnant women who attended antenatal OPD and consequently delivered at Civil Hospital, Ahmedabad, Gujarat. Maternal factors such as age, parity, maternal height and weight; pallor, edema, blood pressure, Rh status, TT immunization, factors related to present pregnancy and past obstetric history were assessed to observe the relationship of antenatal risk scores and outcomes like LBW, neonatal morbidities and mortality. The risk scores obtained for each of the pregnant women at first ANC visit (first trimester) was updated in second and third trimester and finally before delivery.[47]

Study revealed that 60.7 percent women had a risk scores 1-3 (mild risk), 20.2 percent women had risk scores 4-6 (moderate risk) and 5(0.73%) had risk scores ≥7 (severe risk), whereas, remaining 18.3 percent had a score of '0' which was considered as

"no risk group". The incidence of LBW babies increased significantly with increasing risk scores. There was positive correlation between risk scores and corresponding numbers of LBW babies. Proportion of LBW babies was the lowest (7.9%) among women with risk score '0' and increased with the increase in risk scores. The sensitivity of ICMR antenatal scoring system was high (96.3%), while the specificity was quite low (20.7%) in predicting the outcomes (neonatal morbidity, birth weight and mortality).

As reported by Gomez and Young in 2002, the antepartum numerical scores based on gestational risk factors derived from risk index were evaluated for the pregnancy outcomes using 782 pregnant women. Birth weight was significantly correlated with risk scores. Further, the study revealed that break point score of ≥6 had estimated sensitivity of 80.2 percent for low risk and 19.8 percent for high risk pregnancies in predicting LBW. Birth weight <2500gms was inversely correlated. Risk scores developed and utilized in this study were not clearly mentioned.[161]

A population based epidemiological study was conducted in 2003 in South Western Sydney, Australia as a part of the mother and infant network (MINET) initiative (1995). Data of 3242 mothers-newborn pairs were analyzed in relation to their demographic characteristics and socioeconomic indices. To derive the risk scores in relation to the birth weight, each of the factors were coded as 1 and 0 respectively for the presence and absence of potential risk factors. A 'risk score' was then derived by summing up the individual scores. Predictive values of risk factors were evaluated by the area under ROC curves. The study revealed that overall prevalence of LBW was 1.9 ±0.2 percent. Mean

birth weight of newborns was 3377± 577gms. In multiple linear regression analysis, smoking during pregnancy, marital status, parity and country of birth were found to be independently associated with birth weight. A higher risk score was associated with low birth weight. Each unit increase in the risk score was associated with almost two times increase in the chances of LBW. The area under the ROC curves for this model was estimated to be 68 percent. [162]

Samiya and Samina, in 2008 performed a case-control study among 400 women attending in the OPD of maternity hospital of Kashmir, India to find out correlation between perinatal outcome and various degrees of risks. Based on this scoring system, patients were classified in to three risk groups: Low risk (1-2), Moderate risk (3-5) and High risk (6≥). Out of 400 women enrolled in the study, 200 normal pregnant women were evaluated with no risk factor (Risk score=0). Those mothers measuring "0" scores were selected as controls. The correlation between various risk groups and the birth weight were observed.[46]

Proportion of preterm births and LBW babies were directly correlated with the risk scores. The likelihood delivering LBW babies among women who had risk factors (cases) was 17.11 times higher than in controls. Risk of delivering LBW babies was significantly higher among high risk women (risk score >6) when compared to those who had low risk scores. This risk scoring system had high sensitivity to predict LBW babies (93.4%); however, it had low specificity (54.4%) and PPV (20.6%).[46]

A retrospective cohort study was conducted by Burstyn in 2010 among all live singleton births (n=191,686) to determine, whether the antepartum risk scores used across Alberta was associated with neonatal morbidity and adverse pregnancy outcomes for singleton live births and to examine whether the current classification of "lower risk" pregnancies (score<3) is justified. Adverse pregnancy outcomes were assessed by APGAR scores, transfer of the infant to a neonatal intensive care unit, "serious" resuscitation measures, preterm birth, and low birth weight. Study revealed that the incidence of complications was increased steadily with increase in risk scores. Approximately, one third of the complications were observed among those having 2-6 risk scores. This study conclusively stated that antepartum risk scoring system, being currently used in Alberta is a useful tool for identifying women at higher risk of aforementioned four adverse outcomes. Additionally, standardized risk assessment plays an important role in providing medical care of uniform quality to pregnant women, despite the fact that it is not a substitute for clinical judgment but rather a supplement.[163]

A systematic review was performed to evaluate the use of a risk screening tool to predict preterm birth that reduces the incidence of preterm birth and associated adverse outcomes. Risk scoring for independent factors like age, marital status, socioeconomic factors, smoking, threatened miscarriage, previous LBW baby, previous stillbirth, maternal weight and height in relation to prediction of preterm birth were analyzed. Study revealed that many scoring systems designed to classify the risk of poor pregnancy outcomes (perinatal mortality, LBW and preterm birth) have been developed and introduced in the health care system. However, majority of these were used without

evaluation of their utility and validity. Their ability to identify women at increased risk of preterm birth, and subsequently to prevent preterm birth, has not been evaluated by randomized controlled trials. This study indicated the need for prospective studies that evaluate the use of risk scoring systems to prevent preterm births, including an assessment of their impact on women's well-being.[164]

Metgud, Naik and Mallapur conducted a community based longitudinal study amongst 1138 pregnant women residing in area covered by Kinaye Primary Health Center (PHC) in rural Karnataka, India. This study aimed to assess the prediction of LBW using modified Indian Council of Medical Research (ICMR) antenatal scoring method. ICMR's risk scoring system was modified to make more precise measurement of levels of risk. [65] The modified risk scoring comprised of 28 variables. The study revealed that 52.5 percent pregnant women had risk scores 6–10, 12.5 percent had 11–15 risk scores and 2.5 percent had risk scores ≥16. Almost one-third (32.5%) pregnant women had risk scores 0–5 which was considered "no risk group". There was negative correlation between the risk scores and the birth weight. The sensitivity of modified ICMR's risk scoring system was 80.6 percent and specificity was 70.4 percent. PPV was 43.8 percent and NPV was 92.7 percent for the prediction of LBW babies. The optimum cutoff risk score was ≥7.[165]

# MATERIAL AND METHODS

# MATERIAL AND METHODS

## 3.1 Research design and settings

This prospective study was carried out at tertiary care hospital of Belgaum district of Karnataka. Belgaum is one of the North districts of Karnataka which is well linked with railways and roadways. The health care needs of North Karnataka are catered by the network of Public Health Care System, Private Hospitals and Medical College Teaching Hospitals.

Belgaum City is located at the heart of Belgaum district. There are two tertiary care hospitals that provide modern health care services. These render wide range of health care services under the single umbrella of organized hospitals. These hospitals are KLE's Dr. Prabhakar Kore Charitable Hospital (DRPKCH) and a Civil Hospital (A Teaching Hospital of Belgaum Institute of Medical Science, Belgaum). Out of these two hospitals, DRPKCH was randomly selected as study settings.

### Overview of study hospital

KLE's Dr. Prabhakar Kore Charitable Hospital is a multispecialty, teaching hospital of KLE University's Jawaharlal Nehru Medical College (JNMC) which is located at Belgaum City at the headquarter of Belgaum district.[166] It is one of the largest hospitals of North Karnataka having 1300 free beds. This hospital has been developed as a center for health care, academia and research.

### 3.2 Study population

All the pregnant women registered within 20 weeks of gestation and who had planned to deliver at DRPKCH constituted the study participants. Finally, data of all those enrolled pregnant women who had delivered singleton live baby in the same hospital were considered for analysis.

### 3.3 Sample size

World Health Statistics, 2011 reported that 28 percent of Indian newborns were low birth weight.[12] Using this information, total number of study subjects were computed as:

$$n = \frac{z^2(1-p)}{e^2\ p} \text{ X } \text{ TP}$$

Where, p is the proportion of low birth weight babies in India = 0.28

1-p = 0.72

Z is the standard normal variate at 5 percent significance level (Value of Z at 95% confidence limit is 1.96).

e is the allowable relative error = 10 percent

Required minimum sample population = 987.78

TP=total expected population after 20 percent attrition

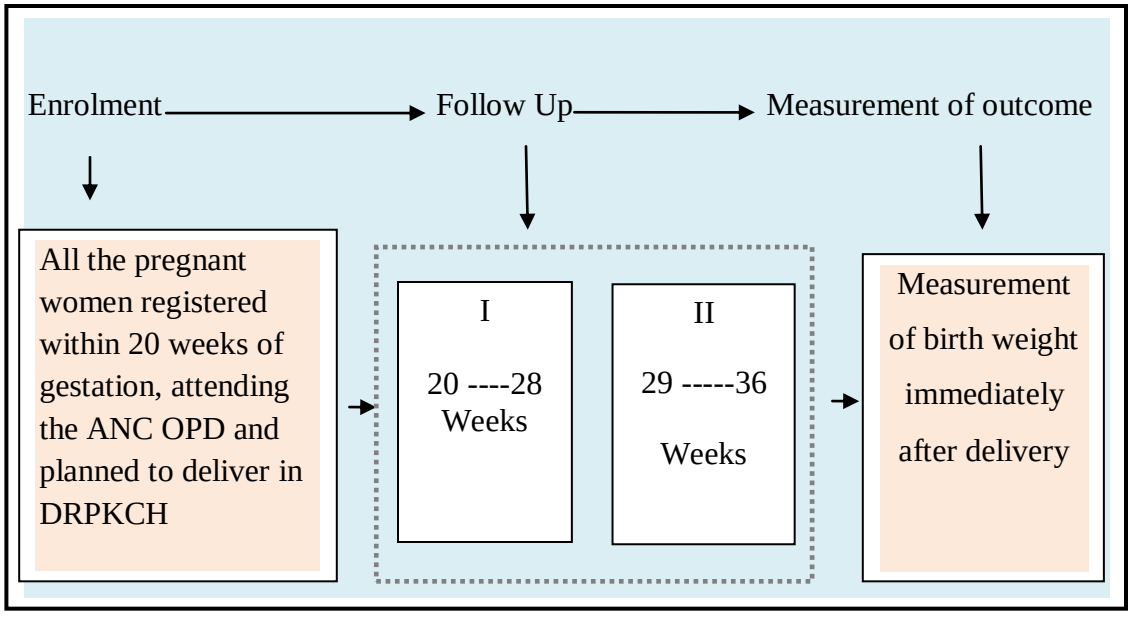
Hence, sample size estimated for the study was= 1234.72 ≈ 1235

### 3.4 Sampling method

All pregnant women registered within 20 weeks of gestation who attended the antenatal Out Patient Department (OPD) of DRPKCH were sample universe. Among

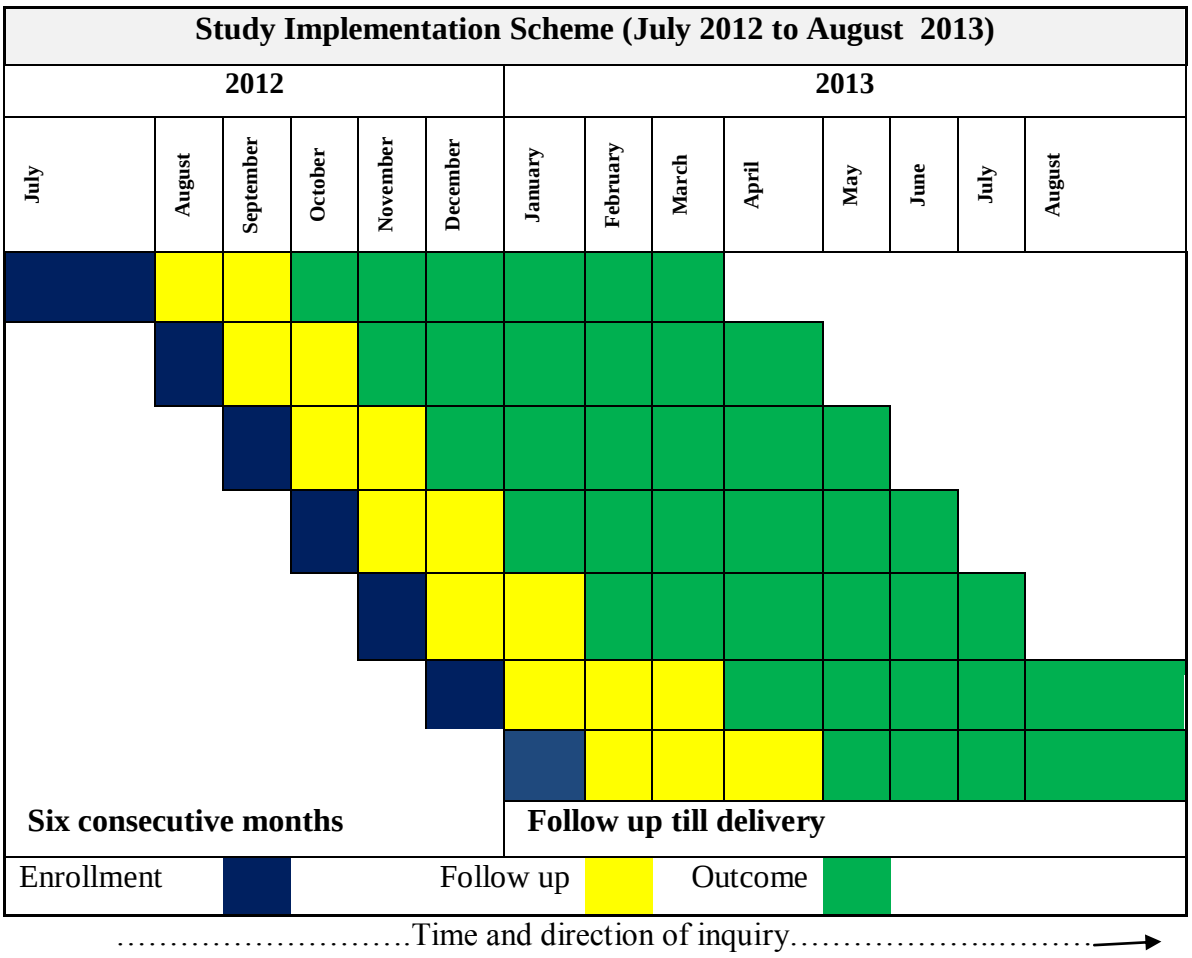
them, those who had planned to deliver in DRPKCH; and gave informed consent to participate in the study were enrolled. The enrolled pregnant women were followed till delivery. The schedule of follow up visits made with study pregnant women was as follows:

**Figure 3.4.1: Schedule of data collection**




A pilot study conducted by the research scholar revealed that; on an average of 10-13 eligible pregnant women attend the antenatal OPD and 11-14 deliveries take place in DRPKCH every day. Further, 74.2 percent of the mothers who delivered had registered at the hospital. With the expected hospital delivery rate of 11-14 deliveries/day, the total duration of enrolment for pregnant women was estimated to be six months. Hence, the enrolment of pregnant women was made from July 2012. The duration of this study was from July 2012 to August 2013. The conceptual design of the study implementation schedule is depicted below.

**Figure 3.4.2: Study implementation schedule**




### 3.5 Inclusion and exclusion criteria

**Inclusion criteria:**

- All pregnant women registered within 20 weeks of gestation at Dr. Prabhakar Kore Charitable hospital and who had planned to deliver in the same hospital.
- Pregnant women who had given informed consent to participate in the study.

**Exclusion criteria:**

- Women who were known cases of Diabetes Mellitus.
- Women who eventually delivered babies with congenital anomaly.

### 3.6 Administrative and ethical considerations

Ethical clearance was obtained from Ethical Committee (Human subjects) of KLE University, Belgaum, Karnataka. Permission was taken from the hospital administration and concerned head of the departments before the study implementation. Written Informed consent was obtained from each of the pregnant women in vernacular language prior to the enrollment.

### 3.7 Tools and techniques for data collection

- **Tools of data collection:**

**Structured and pretested questionnaire**: It was used to collect information on socio-demographic and parental anthropometric features; obstetrics and reproductive history, health service utilization during pregnancy; and maternal nutritional status during pregnancy. The questionnaire had three major parts:

**Part I**: It was designed to collect the non-changeable parameters of the pregnant mothers. This information was collected at the OPD at the time of enrollment of pregnant women.

**Part II**: It was designed to collect information regarding dietary pattern of the mothers. It also included some of the information pertaining to her husband such as height and blood group.

**Part III**: This was the follow up questionnaire. It was used for the follow up of cases during pregnancy and finally to record the birth weight after delivery. This part of the questionnaire also included the information related to Iron and Folic Acid (IFA) consumption and the calcium intake during pregnancy.

**Weighing machine**: CE certified digital adult weighing machine with the accuracy of 100gms and baby weighing machine with the accuracy of 10gms was used to take maternal/paternal and newborn weight respectively.

**Measuring tape**: A static height scale was used to measure maternal height. A measuring tape was used to take the father's height and Crown-heel length of the newborn baby.

- **Techniques of data collection:**

Data was collected by study personnel by face to face interview with pregnant women in the OPD of Obstetrics and Gynecology at a convenient and confidential place. The data was also obtained during the follow up visits. Birth weight was measured within half an hour of delivery. Health profile of the pregnant women was recorded from the patient case sheet and investigation reports. Data was collected at the OPD, free labor room and postnatal ward.

- **Development of antenatal risk scoring tool**

In this study, an attempt has been made to develop the antenatal risk scoring tool to identify the maternal risk of delivering low birth weight baby. The rationale behind risk scoring is to classify pregnant women into different groups according to risk scores. Such early identification of risk status may contribute to modify maternal risk through appropriate referral services. The present risk scoring system was based on high risk pregnancy scoring systems developed by Indian Council of Medical Research. [156]

Present risk scoring system was based on the Adjusted Odds Ratio (AOR) identified in the present study. Since odds ratio is a measure of risk and the aim of the study was to develop a risk scoring tool, the odds ratio was used to assign the risk scores to each of the predictors of low birth weight. The cutoff odds ratio and the corresponding risk scores were identified by estimating the quartiles of odds ratio. Quartile (Q) odds ratio identified in the present study were: 3.99 (Q1), 5.61(Q2) and 12.45(Q3) and the risk scores were assigned in following ways:

Risk scores from 0-3 were assigned to each of the significant predictors of LBW. Risk score "0" was assigned for the reference category (AOR=1) of all the predictors. Risk score 1 was assigned to the predictors measuring adjusted odds ratio up to the first quartile (AOR: >1-3.99). Similarly, risk scores 2 and 3 were assigned to the predictors measuring odds ratio between >Q1-Q3 (AOR: 4.0-12.45) and >Q3 (AOR: >12.45) respectively. After assigning the risk scores to each of the predictors, cumulative risk scores for all the pregnant women were identified.

- **Addressing loss to follow up**

Each participant's contact phone number was noted at the time of enrolment. If the woman failed to attend the antenatal OPD for consecutive two months, she was contacted on phone and was requested to attend the OPD. If the woman did not come to OPD because of abortion, stillbirth and any change of residence, she was considered as loss to follow up.

### 3.8 Data management and analysis

Collected data was managed carefully by taking into consideration of the data safety and completeness. All the measurements were taken in standard units. Data was entered into Statistical Package for Social Sciences (SPSS-20 version) software. Necessary data transformations were made for further analysis. Data has been summarized, presented and inferred using appropriate statistical tests.

- **Statistical analysis**

- Frequency distribution and the variation in the data were observed by calculating percentage, mean, median, standard deviation, range, quartiles.
- Association between birth weight and several independent predictors like socio-demographic and parental anthropometric features; reproductive health, health service use during pregnancy, maternal nutritional status during pregnancy and behavioral factors was established using bivariate and multivariate analysis.
- In the bivariate analysis, Chi-square test, independent student's't' test and correlation coefficients (Pearson's and Spearman's correlation coefficients) were applied.
- Predictors that were found to be statistically associated with birth weight on bivariate analysis were further subjected for multivariate analysis to identify the real predictors by controlling potential confounding factors.
- Multivariate linear regression analysis was performed to estimate the birth weight and to find out the influence of the several predictors of birth weight.

- Multivariate logistic regression (Forward Likelihood Method) analysis was done to identify the predictors of low birth weight and to observe the combined effects of these predictors on birth weight.
- Test values, degree of freedom, Odds ratio (unadjusted and Adjusted), coefficient of multiple determination ($r^2/R^2$) values and the corresponding P values were specified for each of the predictors.
- P value <0.05 was considered significant.
- Association between the cumulative risk scores and the birth weight was observed by Chi-square test and the relationship was estimated by the spearman's correlation coefficient.
- Validity of the risk scoring tool was assessed in terms of sensitivity, specificity and predictive values which were so identified by comparing cumulative cutoff risk scores and the factual birth weight.
- The optimum cumulative cutoff risk scores to predict low birth weight was estimated using receivers operating characteristic (ROC) curves. The area under ROC was used to estimate optimal cutoff risk scores.

### 3.9 Quality control

a. **Training of study team:** Investigator (Ph.D. scholar) organized orientation training for the study team to familiarize them about the study protocol and to make them able to collect data according to the stipulated guideline. A training package containing description of tools and techniques, procedure for obtaining informed consent, technique of measurement of birth weight and follow up procedures was developed.

Two days training was conducted at two sessions: one in the month of June 2012 for the Nursing staff working at antenatal OPD and second session in the month of September 2012 for those nurses working at the Maternity ward. OPD staff were trained about the collection of information at enrollment and follow up procedure whereas staff of the maternity ward were trained on the measurement of birth weight and, assessment of antenatal care service utilization and review of pregnant women' case sheet. Hands on training was given to the study personnel. Thereafter, a simulation exercise was done by the team members. Demonstration, sample exercise about the data collection and discussion was held to clarity the doubt amongst all the team members. **Retraining:** During the study period, the investigator observed the data collection activities of the team members and cross checked the filled questionnaire after its completion. Meanwhile, several reinforcement discussions/observations were done with the team members to ensure quality of data.

b. **Pilot study:** A pilot study was conducted in the month of May and June 2012 in the antenatal clinic to observe the feasibility of the study.

c. **Pre-testing of study tool:** Pretesting of the data collection tool was done amongst the mothers who delivered singleton live births during 1-15 of June 2012. After pretesting, necessary modifications were made in the questionnaire. Thus, the utilization of pre-tested and standardized instruments, trained enumerators yielded good quality data.

d. **Quality check**: supervision and monitoring of data collection was done by the investigator himself and the overall guidance was taken from the research

supervisors. During the study, 10 percent of the data collected by team members was cross verified by the investigator.

### 3.10 Potential biases and the elimination measures

a. Random errors were minimized by taking adequate sample size and taking consideration of attrition too.
b. To reduce measurement bias, standardized and calibrated instruments were used.
c. Trained study personnel had collected data using structured tools.
d. Missing cases were identified and their effects were minimized by double entry system using SPSS validation tools and missing factors analysis.

### 3.11 Definitions and measurement methods of study variables

**Birth weight**: It is the weight of a newborn and measured (in grams) in a lying down supine position with/without light napkins. It was measured using CE certified digital weighing machine with an accuracy of 10gms. Birth weight was taken within half an hour after birth. Newborns weighing <2500grams was considered low birth weight. Macrosomia was considered for the birth weight ≥4000grams.

**Tertiary care hospital:** It is the hospital which is attached to medical college.

**Residence:** Municipal corporation, cantonment board or notified town area were considered the urban residences; whereas others were rural places.

**Religion:** Categorized into Hindu, Muslims, Christians and Jain according to the belief of participant.

**Age:** Measured in the number of completed years. It was obtained at the time of enrollment. Husband's age was assessed either by probing question to the participant or her husband (if accompanying). Maternal age at marriage and first pregnancy was obtained through interview and also measured in the completed years.

**Educational status:** Those who could not read and write were defined as illiterates whereas those who can read and write were literates. Amongst the literates, primary education was termed for education upto $7^{th}$ standards, 8-$10^{th}$-secondary (high school), 11-$12^{th}$ standard was considered for pre-university course; and bachelor or higher degree was considered as higher education. The same category was applied for the husband's educational status.

**Occupation:** Participant or her husband's work for the economic gain for maintenance of livelihood is termed as occupation.

**Type of family:** Parent with their unmarried children living in a house and sharing a common kitchen was considered nuclear family and a family consisting of two or more generations living under the same roof and sharing a same Kitchen is joint family.

**Socioeconomic status (SES)**: It was estimated using BG Prasad's classification system which was expressed in per capita income per month. [168]

**Table 3.11.1: Assessment of SES by modified BG Prasad's classification system**

| Socio Economic Class | BG Prasad's Classification, 1961 | Modified Prasad's Classification for July 2012-January 2013 |
|---|---|---|
| I | Rs 100 and above | Rs 5000 and above |
| II | Rs 50-99 | Rs 2500-4999 |
| III | Rs 30-49 | Rs 1500-2499 |
| IV | Rs 15-29 | Rs 750-1499 |
| V | Below Rs 15 | Below Rs 750 |

Modification was done for the study period with the aid of following information:

Average of All India Consumer Price Index (AICPI) for Industrial workers (Base 1982 = 100) for the study period (July 2012- January 2013) was 1002.7.[169]

Multiplication factor = average CPI of the study period (1002.7)* CF (4.93)/100=49.52

Multiplication factor so derived has to be multiplied with BG Prasad's value of 1961 and rounded off to nearest rupee.

**Family income per month:** Earning of money by sum of all means of occupations in a month by all the family members; expressed in Indian currency was termed as income.

**Marital relation**: Marriage in the blood relation was regarded as consanguineous marriage, while others were labeled as non-consanguineous.

**Tobacco products**: Cigarette, Kaini, mix of Tobacco in pan, Gutka etc were treated as tobacco products. The duration of use was measured in numbers of completed years. Frequency of use was categorized as daily user, weekly (not regular but consumes

frequently in a week) and occasional users are those who takes infrequently, mostly on some occasions.

**Alcohol**: Any branded (manufactured by company) or locally prepared alcohol product is referred as alcohol for the study purpose. Frequency of use was categorized as daily user, weekly (not regular but consumes frequently in a week) and occasional users are those who takes infrequently, on some occasions.

**Indoor air pollution:** It expresses the condition in which smoke produced during the preparation of food items get accumulated in kitchen. It is measured as the presence or absence of smoke-vent and presence/absence of window in kitchen. If none of the ventilation items are present in the kitchen, it was considered as poor ventilation.

**ANC visits:** Frequency of consultation in OPD for the care during pregnancy and expressed in number of visits.

First trimester: Up to 12 weeks of gestation.

Second trimester: Over 12 weeks of gestation to the 28 weeks of gestation.

Third trimester: More than 28 weeks of gestation till delivery

**Dietary habit**: Classified as vegetarian and non-vegetarians. Those who never took meat and meat products are vegetarians, while others were grouped as non vegetarians.

**Working during pregnancy**: Women who look after the routine household activities such as housekeeping, cooking and family care are considered household workers. Any of the women who work in either private or government organizations were considered the office workers. A business worker was considered if the woman has her own small or large scale investment.

**Rest:** A time period (measured in hours) during which a pregnant woman sleeps and do not engage in any physical work.

**Abortion:** Expulsion of products of conception before 28 weeks of gestation. Spontaneous abortion is the natural termination of pregnancy; while induced abortion is the termination of pregnancy intentionally by any medical or other traditional measures.

**Stillbirth**: Birth of dead fetus after 28 weeks of gestation.

**Pregnancy Induced Hypertension:** Increased Blood pressure ≥140/90 mm of Hg with or without pedal edema and proteinuria after 20 weeks of gestation.

**Laboratory measurements:** Reports were obtained from the case sheet.

- Hemoglobin status: It was recorded from the participant's case sheet. Hemoglobin level was measured at enrollment, first follow up, second follow up and before delivery. Hemoglobin level was categorized according to the WHO criteria for pregnant women: [170]

**Table 3.11.2: Classification of hemoglobin level**

| Hemoglobin level (gms/dl) | Status |
|---|---|
| ≥11 | Normal |
| 10-10.9 | Mild anemia |
| 7-9.9 | Moderate anemia |
| <7 | Severe anemia |

**Blood group:** A, B, AB and O; and Rhesus positive or negative as reported in the case sheets. Similarly, reports for the urine glucose and protein analysis and blood glucose testing were obtained from case sheets.

**Antepartum hemorrhage (**APH): Any blood loss per vagina (not due to any injuries and accidents) during the pregnancy was treated as APH. It is recorded form antenatal case sheet or personal complaints.[9]

**Preterm births**: Delivery of the baby before completion of 37 weeks of gestation and after the period of viability (>28 weeks) were termed as preterm births. Full term births were those who were born after completion of 37 weeks of gestation.

**Perinatal and neonatal deaths**: Stillbirths and deaths in the first week of life are perinatal deaths while newborns dying within 28 days of birth are neonatal deaths.

**Normal delivery and assisted delivery**: Delivery with minimal aids, mentioned as "normal" in the delivery registers, certified by Obstetrician and Gynecologist was labeled as normal, while any forceps or vacuum vaginal delivery was as assisted delivery.

**Cesarean section delivery**: Delivery with the surgical procedure and reported as C/S was considered as Cesarean delivery. Type of section (emergency or elective) was also noted.

**Gravidity**: Number of times a woman has become pregnant. Primigravida was one who has conceived for the first time and all others who have two or more time pregnant were multigravida. Elderly Primigravida was considered when the pregnant woman has conceived for the first time after 30 years of age.

**Parity**: Number of times a woman has given birth to a baby after the period of viability (≥28 weeks of gestation) regardless of whether the baby was born alive or dead. Grand multiparity was one who has delivered more than four viable births.

**Last Menstrual Period** (**LMP):** Computed from the first day of last menstruation.

**Expected Date of Delivery** (**EDD)**: Calculated as (average) 280 days from the first day of LMP and was expressed in completed 40 weeks of gestation.

**Type of conception**: This was categorized as spontaneous and assisted reproduction. Spontaneous conception is without the use of any medical technology. If the conception was after the use of modem medical techniques/medications, either for ovulation induction or any artificial conceptions, advised/prescribed by consultant expert was treated as assisted conception.

**Height**: Participant and her husband's height were measured in centimeters using tape without footwear. Along with the participant's height, her husband's height was also measured in ANC OPD whenever he accompanied. If he did not come at any time to the hospital during her ANC visits, the participant was instructed to get his height measured at the nearest health facility. In case when the husband's height was not available during ANC visits, it was measured after childbirth during the postnatal observation period of mother and her newborn. Fathers were categorized into short (below mean-SD), average (mean ± SD) and the tall (above mean ± SD) according to the height.

**Weight:** Weight of the Participant and her husband was measured in kilograms (up to 2 decimals) with light clothing. The difference in weight before delivery and at the time of registration was noted to calculate total weight gain during pregnancy. Maternal weight was measured at enrollment, first follow up, second follow up and before delivery in the last weeks of pregnancy.

**Body Mass Index (BMI):** Calculated as the ratio of height (in square meter) to the weight (in Kilograms). It was categorized on the basis of classification for Asian population ($Kg/m^2$).[55]

**Table 3.11.3: Classification of Body Mass Index**

| **BMI value ( $Kg/m^2$)** | **Category** |
|---|---|
| <18.5 | Under weight |
| 18.5-23.0 | Normal |
| >23-27.5 | Pre-obesity |
| >27.5 | Obesity |

**Premature Rupture of Membrane (PROM)**: If the participant reports any leakage of fluid per vagina more than one hour before onset of labor.

**Antenatal care**: Health care intended to assesses and promote health status during pregnancy.

**TT immunization**: Number of times of TT immunization the pregnant woman had received.

**Status of Iron and Folic acid (IFA) tablets intake**: This was assessed on the basis of number of tablets taken during pregnancy. Intake status was treated as regular if she has missed <5 routine doses in a month, intermittent if she has missed 7-10 days and irregular if more than 10 days doses were missed.

**Fetal presentation:** Head of the fetus presenting towards downward the vaginal canal was considered as vertex while rest types were malpresentations recorded in the case sheet.

**Inborn diseases among newborns:** Any diseases mentioned in the newborn case sheet as "inborn diseases"; stated by the pediatrician's/obstetrician's remarks.

**Dietary assessment**: Seven consecutive days food consumption practices were recorded during second and the third trimester. First day's dietary consumption was recorded by the investigator or study personnel in the Obstetrics and Gynecology OPD of the study hospital by 24 hours recall method. Thereafter, the proforma was distributed to the pregnant women to record dietary intake in the subsequent six days. National Institute of Nutrition, Hyderabad developed daily allowance of calorie and proteins which were used for the reference.[55, 172]

**High risk factor:** Any condition that significantly increases the likelihood of adverse pregnancy outcomes such as stillbirth, low birth weight, complications during pregnancy.

# RESULTS

# RESULTS

A total of 1235 eligible pregnant women were attending the ANC OPD of DRPKCH during the study period. Out of them, 1044 mothers eventually delivered singleton live births in the study hospital. Hence, the data of 1044 mother-newborn pairs was analyzed in this study and the results are presented under following headings:

4.1 Socio-demographic and anthropometric characteristics of pregnant women

4.2 Exposures and life style of pregnant women

4.3 Reproductive and obstetric characteristics of pregnant women

4.4 Utilization of antenatal services and nutritional status of pregnant women

4.5 Characteristics of newborns

4.6 Predictors of Birth Weight

4.7 Development of antenatal risk scoring tool

# Descriptive Findings: Univariate analysis

## 4.1 Socio-demographic and anthropometric characteristics of pregnant women

**Table 4.1.1: Distribution of pregnant women by age and educational status**

| Characteristics | Number of pregnant women | Percentage |
|---|---|---|
| **Age (in years)** | | |
| <20 | 79 | 7.6 |
| 20-24 | 597 | 57.2 |
| 25-29 | 301 | 28.8 |
| 30-34 | 57 | 5.5 |
| ≥35 | 10 | 1.0 |
| Total | 1044 | 100.0 |
| **Educational status** | | |
| Illiterate | 12 | 1.1 |
| Primary | 38 | 3.6 |
| Secondary | 642 | 61.5 |
| Pre-University | 243 | 23.3 |
| Higher education | 109 | 10.4 |
| Total | 1044 | 100.0 |

Out of the total 1044 pregnant women, majority 597(57.2%) were 20-24 years old. Three hundred and one (28.8%) were 25-29 years and 79(7.6%) were adolescent pregnancies. A total of 57(5.5%) pregnant women were 30-34 years and only one percent of them were ≥35 years old. The mean age of the pregnant women was 23.58±3.4 years.

Majority 642(61.5%) of them had secondary education, 243(23.3%) had Pre-University education, 109(10.4%) had higher education and 12(1.1%) were illiterates. Almost all pregnant women 1013(97.0%) were housewives and 31(3.0%) were doing either service or business.

**Table 4.1.2: Distribution of pregnant women by religion and type of family**

| Characteristics | Number of pregnant women | Percentage |
|---|---|---|
| **Religion** | | |
| Hindu | 883 | 84.6 |
| Muslim | 126 | 12.1 |
| Jain and Christian | 35 | 3.4 |
| Total | 1044 | 100.0 |
| **Type of Family** | | |
| Nuclear | 153 | 14.7 |
| Joint | 891 | 85.3 |
| Total | 1044 | 100.0 |

Majority of the pregnant women 883(84.6%) were Hindus while 126(12.1%) were Muslims and 35(3.4%) were either Jains or Christians. Majority of pregnant women 891(85.3%) belonged to the joint family.

Consanguinity was observed amongst 211(20.2%) pregnant women whereas 833(79.8%) had marriage outside of the blood relation. A total of 612(58.2%) pregnant women were from rural areas while 432(41.4%) were from urban areas.

**Table 4.1.3: Distribution of pregnant women by socioeconomic status**

| Socioeconomic class | Number of pregnant women | Percentage |
|---|---|---|
| I( ≥ 5000) | 40 | 3.8 |
| II (2500-4999) | 139 | 13.3 |
| III (1500-2499 | 159 | 15.2 |
| IV(750-1499) | 363 | 34.8 |
| V(<750) | 343 | 32.9 |
| Total | 1044 | 100.0 |

Three hundred and sixty three (34.8%) pregnant women belonged to $IV^{th}$ class socioeconomic status, 343(32.9%) were of $V^{th}$ class; 159 (15.2%) and 139(13.3%) pregnant women belonged to the $II^{nd}$ and $III^{rd}$ class respectively. Only 40(3.8%) of the pregnant women were from high class (class I) as per BG Prasad's classification of SES.

**Table 4.1.4: Distribution of pregnant women based on height**

| Height ( in cms) | Number of pregnant women | Percentage |
|---|---|---|
| ≤145 | 84 | 8.0 |
| 145-150 | 332 | 31.8 |
| 150-155 | 339 | 32.5 |
| 155-160 | 235 | 22.5 |
| >160 | 54 | 5.1 |
| Total | 1044 | 100.0 |
| **Mean height : 152.78±5.35cms** | | |

Three hundred and thirty nine (32.5%) of the pregnant women had the height of 150-155 centimeters (cms) and 332(31.8%) were of 145-150cms. Two hundred and thirty five (22.5%) measured 155-160cms in height, 84(8.0%) of the pregnant women had ≤145cms and 54(5.1%) had height of >160cms. The mean height was 152.78±5.35cms.

**Table 4.1.5: Distribution of pregnant women based on Weight and BMI**

| Maternal weight (in Kgs) | Number of Pregnant women | | | |
|---|---|---|---|---|
| | Enrolment (<20 weeks) | I follow up (20- 28weeks) | II follow up (28-36) | Before Delivery |
| **Weight during pregnancy** | | | | |
| ≤40 | 208(19.9) | 58(5.6) | 18(1.7) | 8(0.8) |
| 40-50 | 532(51.0) | 467(44.7) | 310(29.7) | 219(21.0) |
| 50-60 | 249(23.9) | 397(38.0) | 498(47.7) | 527(50.5) |
| 60-70 | 47(4.5) | 105(10.1) | 184(17.6) | 245(23.5) |
| >70 | 8(0.8) | 17(1.6) | 34(3.3) | 45(4.3) |
| Total | 1044(100.0) | 1044(100.0) | 1044(100.0) | 1044(100.0) |
| Mean weight | 46.98±7.5 | 51.19±7.7 | 54.46±7.9 | 56.27±7.90 |
| **BMI during pregnancy( in Kg/m$^2$)** | | | | |
| <18.5(underweight) | 356(34.1) | 122(11.7) | 40(3.8) | 15(1.4) |
| 18.5-23.0(normal) | 502(48.1) | 604(57.9) | 509(48.8) | 405(38.8) |
| 23.0-27.5(pre-obesity) | 165(15.8) | 262(25.1) | 374(37.5) | 456(43.7) |
| >27.5(obesity) | 21(2.0) | 56(5.4) | 121(11.6) | 168(16.1) |
| Total | 1044(100.0) | 1044(100.0) | 1044(100.0) | 1044(100.0) |

*Figures in the parenthesis indicate the percentages of respective frequency.*

In the present study, 532(51.0%) pregnant women were weighing 40-50 Kilograms (Kgs), 249(23.9%) had 50-60Kgs and 208(19.9%) had ≤40Kgs weight at the time of enrollment. Forty seven (4.5%) pregnant women had 60-70Kgs weight at the enrollment. By the first follow up, only 58(5.6%) had ≤40Kgs weight and the highest proportion of pregnant women 467(44.7%) had 40-50Kgs, 397(38.0%) had weight

between 50-60Kgs. Similarly, by the time of second follow up, 498(47.7%) of the pregnant women had 50-60Kgs weight, 310(29.7%) had 40-50Kgs, 184(17.6) had 60-70Kgs weight. Proportion of the pregnant women having ≤40Kgs and >70Kgs weight were 18(1.7%) and 34(3.3%) respectively by the second follow up. A total of 527(50.5%) pregnant women had 50-60Kgs and 245(23.5%) had 60-70Kgs weight before delivery. Two hundred and nineteen (21.0%) pregnant women had 40-50Kgs weight before delivery. Although, number of pregnant women with weight <40Kgs decreased by the time of delivery, 8(0.8%) still had weight ≤40Kgs. The mean weight of the pregnant women at enrollment, first follow up, second follow up and at the time of delivery was 46.98±7.5Kgs, 51.19±7.7Kgs, 54.46±7.9Kgs and 56.27±7.9Kgs respectively.

Proportion of pregnant women with normal BMI was 502(48.1%) at the enrollment, 604(57.9%) at the time of first follow up (second trimester), 509(48.8%) at the time of second follow up (third trimester) and 405(38.8%) before delivery. Three hundred and fifty six (34.1%) pregnant women at the time of enrollment were underweight. Although the number of underweight pregnant women declined from enrollment to delivery, 15(1.4%) remained underweight at the time of delivery. Proportion of the pregnant women falling under the pre-obesity category were 165(15.8%), 262(25.1%), 374(37.5%) and 456(43.7%) respectively at the enrollment, first follow up, second follow up and at the time of delivery. Similarly, 21(2.0%), 56(5.4%), 121(11.6%) and 168(16.1%) had BMI >27.5 $Kg/m^2$ at the time of enrollment, fist follow up, second follow up and at the time of delivery respectively. There was increasing trend in the mean BMI from enrollment (20.14±3.18) to first follow up

(21.94±3.24), second follow up (23.34±3.31) and before delivery (24.11±3.27). Average increase in BMI from enrollment to the delivery was 4±3.09 (table 4.1.5 and figure 4.1.1)

**Figure 4.1.1: Pregnant women by Body Mass Index**

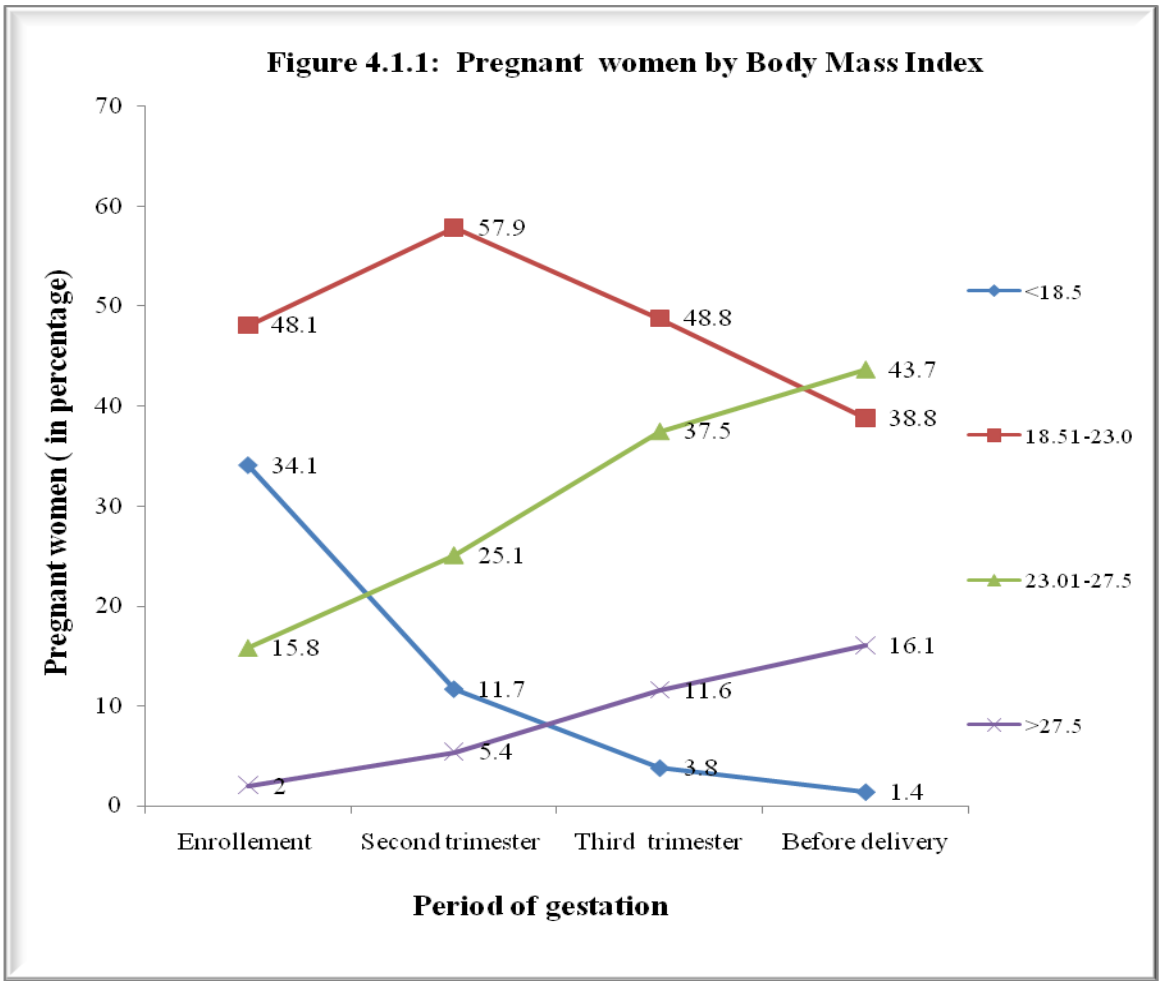
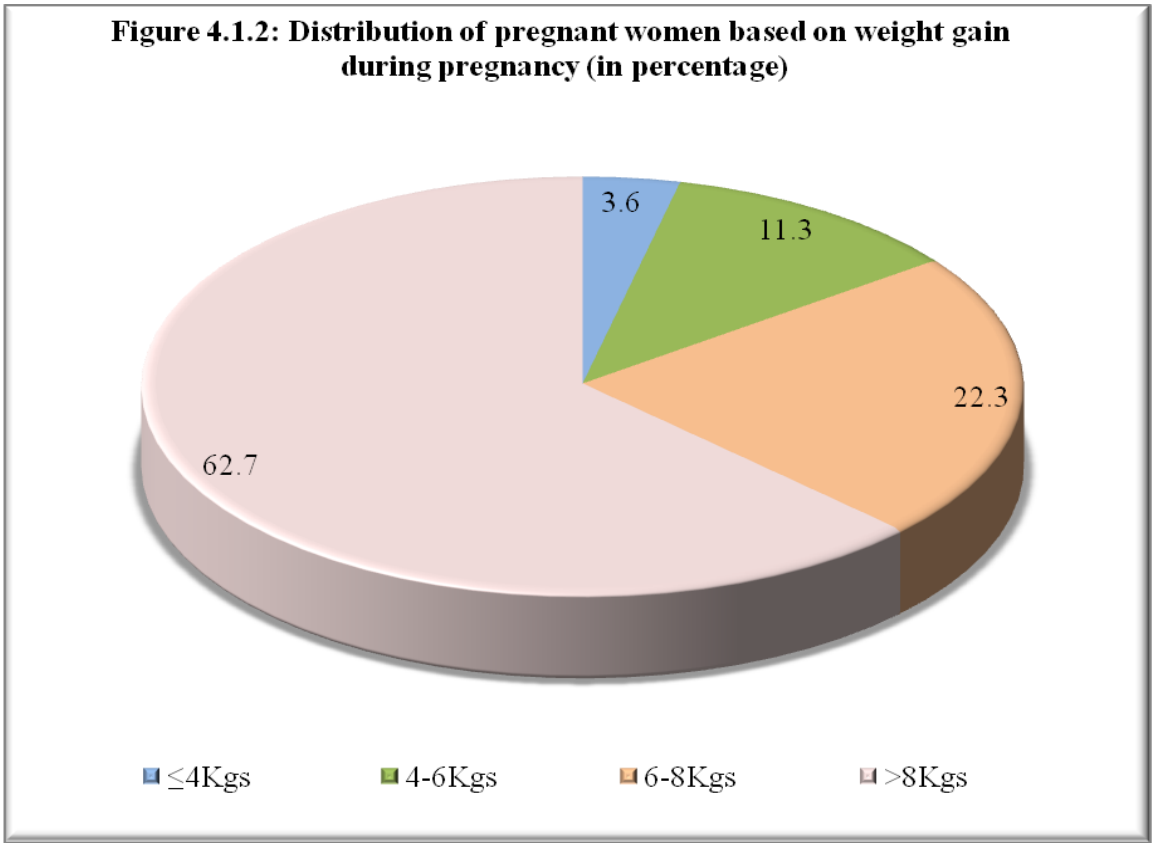


**Table 4.1.6: Distribution of pregnant women based on weight gain during pregnancy**

| Weight gain (in Kgs) | Number of pregnant women | Percentage |
|---|---|---|
| ≤4 | 38 | 3.6 |
| 4-6 | 118 | 11.3 |
| 6-8 | 233 | 22.3 |
| >8 | 655 | 62.7 |
| Total | 1044 | 100.0 |

A total of 655(62.7%) pregnant women had total weight gain >8Kgs during pregnancy; 223(22.3%) had 6-8Kgs, 118(11.3%) had 4-6Kgs and 38(3.6%) had ≤4Kgs weight gain during pregnancy; mean weight gain during pregnancy was 9.28±2.89Kgs.

**Figure 4.1.2: Distribution of pregnant women based on weight gain during pregnancy (in percentage)**



A total of 821(78.6%) pregnant women's husbands were 25-34 years old, and the mean age of their husbands was 30.04±4.56 years.

**Table 4.1.7: Educational and occupational status of the participant's husbands**

| Status | Frequency | Percentage |
|---|---|---|
| **Educational status** | | |
| Illiterate | 17 | 1.6 |
| Primary | 28 | 2.7 |
| Secondary | 512 | 49.0 |
| Pre-University | 271 | 26.0 |
| Higher education | 216 | 20.7 |
| Total | 1044 | 100.0 |
| **Occupation** | | |
| Farmers | 303 | 29.0 |
| Driving | 73 | 7.0 |
| Labor/daily wages | 188 | 18.0 |
| Service or Business | 480 | 46.0 |
| Total | 1044 | 100.0 |

Five hundred and twelve (49.0%) pregnant women reported that their husbands were educated up to secondary level and 271(26.0%) of them had Pre-University level education. Higher education (undergraduate and above) was seen amongst 216(20.7%) husbands. Although majority of the husbands of pregnant women were educated,

17(1.6%) were illiterates and 28 (2.7%) had primary education. A total of 480 (46.0%) participant's husbands were service holders or business people, 303(29.0%) were either farmers, 188(18.0%) were laborers and 73(7.0%) were drivers.

**Table 4.1.8: Anthropometric characteristics of participant's husbands**

| Anthropometric characteristics | Frequency | Percentage |
|---|---|---|
| **Height (in cms)** | | |
| ≤155 | 19 | 1.8 |
| 155-165 | 459 | 44.0 |
| 165-175 | 501 | 48.0 |
| >175 | 65 | 6.2 |
| Total | 1044 | 100.0 |
| **Weight ( in Kgs)** | | |
| ≤50 | 27 | 2.6 |
| 50-60 | 393 | 37.6 |
| 60-70 | 475 | 45.5 |
| >70 | 149 | 14.3 |
| Total | 1044 | 100.0 |

Five hundred and one (48.0%) participant's husbands had height between 165-175cms, 459(44.0%) had 155-165cms, 65(6.2%) had >175cms whereas 19(1.8%) were having height ≤155cms. The mean height of the husbands was 166.85±5.19cms. One hundred and forty five (13.9%) husbands had height below 161.6cms (below mean-SD),

771(73.9%) had height between 161.6-172.0cms (mean ± SD) and 128(12.3%) had height above 172.0cms which are considered short, average and tall husbands in this study. As regards the weight of participant's husbands, 475(45.5%) had weight between 60-70Kgs, 393(37.6%) had 50-60Kgs, 149(14.3%); and 27(2.6%) had weight >70Kgs and ≤50Kgs. Mean weight of the husbands was 63.26±6.91Kgs.

## 4.2 Exposures and life style of pregnant women

- Six hundred and twenty two (59.6%) pregnant women reported that they used wood/cow dung/Kerosene as a cooking fuel whereas 422(40.4%) of them used gas/electricity for cooking.
- Smoke vent was present in the kitchen of 306(29.3%) pregnant women while majority of them 738(70.7%) did not have smoke vent in the kitchen.
- Seven hundred and sixty seven (73.5%) reported that kitchen ventilation (presence of window/gasget) was present in their kitchen; nonetheless, 277(26.5%) of the pregnant women did not have proper ventilation in their kitchen.
- None of the pregnant women were consuming tobacco or alcohol.
- Tobacco consumption was observed in the 244(23.4%) families of pregnant women.
- Most of the pregnant women 905(86.7%) had done limited household works during the pregnancy while 139(13.3%) of them had worked in field /office in addition to the household works.
- Majority 727(69.6%) of the pregnant women had two or more hours rest in day time whereas 288(27.6%) pregnant women had taken less than two hours rest in day time and 29(2.9%) did not have any rest during day time.

- Eight hundred and forty two 842(80.7%) pregnant women had more than eight hours rest and sleep/day whereas 202(19.3%) of the pregnant women had total rest and sleep less than eight hours/day.

## 4.3 Reproductive and obstetric characteristics of pregnant women

**Table 4.3.1: History of bad pregnancy outcomes among pregnant women***

| Pregnancy outcomes (n-608) | Number of pregnant women | Percentage |
|---|---|---|
| History of cesarean section | 210 | 34.5 |
| History of abortion | 141 | 23.2 |
| History of low birth weight | 108 | 17.8 |
| History of preterm births | 102 | 16.8 |
| History of stillbirths | 64 | 10.5 |
| History of neonatal death | 63 | 10.4 |

**Multiple responses*

Out of 608 multigravida pregnant women, 210(34.5%) had the history of delivery by cesarean section, 141(23.2%) had history of abortion and 108(17.8%) delivered LBW babies in the preceding childbirth. Similarly, 102(16.8%) pregnant women had delivered preterm births, 64(10.5%) had delivered stillbirths and 63(10.4%) of them had history of neonatal deaths

**Table 4.3.2: Distribution of pregnant women by age at marriage and first pregnancy**

| Age ( in years) | Number of pregnant women | |
|---|---|---|
| | Age at marriage | Age at first pregnancy |
| <20 | 506 (48.5) | 248 (23.8) |
| 20-24 | 457(43.8) | 655(62.7) |
| 25-29 | 75(7.2) | 133(12.7) |
| ≥30 | 6(0.6) | 8 (0.8) |
| Total | 1044(100.0) | 1-44(100.0) |
| Mean age | 20.09±2.77 | 21.32±2.75 |

*Figures in the parentheses indicate percentage of the respective frequency*

Five hundred and six (48.5%) pregnant women had got married before 20 years of age and another 457(43.8%) were married between 20-24 years. Two hundred and forty eight (23.8%) of the pregnant women had first conception before 20 years of age. Six hundred fifty five (62.7%) of the pregnant women had first conception at the age of 20-24 years, one hundred thirty three 133 (12.7%) of the pregnant women had their first pregnancy during 25-29 years of age and 8(0.8%) were elderly primigravida. The mean age at marriage (20.09±2.77 years) was almost a year lesser than the mean age at first pregnancy (21.32±2.75 years).

- Majority of the pregnant women 608(58.2%) were multigravida and 436(41.8%) were primigravida. Median numbers of gravida was 2 with the range of 1-5.
- Except 36(3.4%) pregnant women who had conceived after treatment or artificial reproduction techniques, 1008(96.6%) had conceived spontaneously.

- Two hundred and four (33.6%) of the pregnant women had inter-pregnancy interval of 13-24 months, 142(23.4%) had ≤ 12 months interval, 135 (22.2%) had ≥37 months interval and 127(20.9%) reported 25-36 months spacing between last two pregnancies. The median inter-pregnancy interval was of 24 months with the range of 138 months (6-144 months).

**Table 4.3.3: Distribution of pregnant women based on high risk factors during present pregnancy ***

| High risk factors | Number of pregnant women | Percentage |
|---|---|---|
| **Risk factors present** | **417** | **39.9** |
| Short birth interval <24 months (n=608) | 232 | 38.2 |
| Obstetric problems[¥] | 254 | 24.3 |
| Medical illness[Ψ] | 217 | 20.8 |
| Pregnancy Induced Hypertension (PIH ) | 126 | 12.1 |
| Maternal weight <45Kgs at delivery | 59 | 5.7 |
| Gestational diabetes | 49 | 4.7 |
| Rh Negative | 48 | 4.6 |
| Total weight gain ≤4Kgs | 38 | 3.6 |
| Others[€] | 34 | 3.2 |
| **Risk factors absent** | **627** | **60.1** |
| **Total** | **1044** | **100.0** |

**Multiple responses*

*¥: APH, Hypermesis, spotting/PV bleeding, oligo/polyhydramnios Ψ: Hemorrhoid, UTI, gastritis, toxoplasmosis, hypothyroidism, viral infection (hepatitis, chickenpox), seizures, systematic diseases (renal, cardiac, respiratory)*

*€: (Hemoglobin<7gm%, Primi<18 years, height<140 cm, elderly primi and Grand- Multipara)*

In the present study, 627 (60.1%) pregnant women had none of the risk factors whereas 417(39.9%) had one or more high risk factors. Two hundred and fifty two (24.1%) of the pregnant women had one risk factor and 165(15.8%) had two or more risk factors. Similarly, 254(24.3%) of the pregnant women had at least one of the obstetric problems like hyperemesis, spotting/PV bleeding, oligo/polyhydramnios. Medical illnesses such as Hemorrhoid, Urinary Tract Infections (UTI), gastritis, toxoplasmosis, hypothyroidism, viral infection (hepatitis, chickenpox), seizures, and systematic diseases (renal, cardiac and respiratory) were evident amongst 217(20.8%) pregnant women. Out of 608 multigravida pregnant women, short inter-pregnancy interval <24 months was reported by 232(.38.2%) and 126(12.1%) pregnant women had PIH at the time of delivery. Fifty nine (5.7%) pregnant women had <45Kgs weight at the time of delivery and 49(4.7%) women developed Gestational Diabetes Mellitus (GDM). A total of 48(4.7%) were Rh Negative mothers, 38(3.6%) had weight gain ≤4Kgs during pregnancy. Other high risk factors were: Hemoglobin <7gms/dl, primigravida <18 years, height<140cms, elderly primigravida and grandmultiparity.

## 4.4 Utilization of antenatal services and nutritional status of pregnant women

- Eight hundred and seventy three (83.6%) pregnant women made 6-10 ANC visits, 147(14.1%) visited >10 times while 24 (2.3%) of the pregnant women had visited ≤5 times during pregnancy. Mean number of ANC visits made by the pregnant women was 8.84±1.97.
- Hundred percent pregnant women had TT immunization; out of which 174(16.7%) had taken one dose and 870 (83.3%) had taken two doses.

- Seven hundred and forty (71.2%) pregnant women had taken Folic Acid during first trimester of pregnancy.
- Although 1042(99.8%) consumed Iron and Folic Acid (IFA), tablets only 144 (13.8%) of them had taken them regularly.
- Out of all those pregnant women who had taken IFA tablets, 654(62.8%) had taken ≥100 tablets and 388(37.2%) consumed <100 tablets.
- Commonest cause for not consuming IFA tablets was negligence (74.2%) followed by intolerance (9.7%).
- Almost all (99.1%) pregnant women had taken Calcium during pregnancy; nevertheless, only 92(8.8%) had taken Calcium regularly as prescribed.

**Table 4.4.1: Maternal hemoglobin level during pregnancy and childbirth**

| **Hemoglobin (Hb) level ( gms/dl) *** | **Number of pregnant women** | | | |
|---|---|---|---|---|
| | **Enrollment** | **I$^{st}$ follow up** | **II$^{nd}$ follow up** | **Before Delivery** |
| >11(normal) | 478(45.8) | 475(45.5) | 573(54.9) | 592(56.7) |
| 10-10.9 (mild anemia) | 286 (27.4) | 326(31.2) | 272(26.1) | 278(26.6) |
| 7-9.9(moderate anemia) | 279(26.7) | 241(23.1) | 196(18.8) | 169(16.2) |
| < 7(severe anemia) | 1(0.1) | 2(0.2) | 3(0.3) | 5(0.5) |
| Total | 1044(100) | 1044(100) | 1044(100) | 1044(100) |
| **Mean hemoglobin level** | **10.65±1.34** | **10.75±1.40** | **10.93±1.22** | **10.96±1.32** |

*Figures in the parentheses indicate percentage of the respective frequency* * *WHO classification*

Four hundred and seventy eight (45.8%) of the pregnant women had normal hemoglobin level at the time of enrollment, 475(45.5) at the time of first follow up, 573(54.9%) at the second follow up and 592(56.7%) before delivery. A total of five hundred and sixty six (54.2%) pregnant women at the enrollment and first follow up 569(54.5%) had anemia. Mild and moderate anemia was reported among 286 (27.4%) and 279(26.7%) pregnant women at the time of enrollment whereas 326(31.2%) and 241(23.1%) of the pregnant women had mild and moderate anemia at the time of first follow up. Similarly, 272(26.1%) and 196(18.8%) pregnant women at the second follow up had mild and moderate anemia respectively. Two hundred and seventy eight (26.6%) pregnant women before delivery were having mild anemia and 169(16.2%) had moderate anemia. Mean hemoglobin level was10.65±1.34gms/dl at enrollment, 10.75±1.40gms/dl at first follow up, 10.93±1.22gms/dl at second follow up and 10.96±1.32gms/dl before delivery. Mean increase in hemoglobin level from enrollment to the delivery was 0.3gms/dl.

**Table 4.4.2: Distribution of pregnant women based on diet consumption during pregnancy**

| Dietary intake | Number of pregnant women | Percentage |
|---|---|---|
| **Dietary habit** | | |
| Vegetarian | 373 | 35.7 |
| Non-vegetarian | 671 | 64.3 |
| Total | 1044 | 100.0 |
| **Calorie consumption*** | | |
| <1250(<50% of RDA) | 0 | 0.0 |
| 1250-1725(50-69% of RDA) | 156 | 14.9 |
| 1726-2225( 69.1-89% of RDA) | 719 | 68.9 |
| >2225( >89% of RDA) | 169 | 16.2 |
| Total | 1044 | 100.0 |
| Mean calorie intake: 2010.88±224.35 | | |
| **Protein intake**** | | |
| <32.5 (<50% of RDA) | 0 | 0 |
| 32.5-44.85(50-69% of RDA) | 8 | 0.8 |
| 44.86-57.85( 69.1-89% of RDA) | 137 | 13.1 |
| >57.85(>89% of RDA) | 899 | 86.1 |
| Total | 1044 | 100.0 |
| Mean protein consumption: 70.22±10.32 | | |

**Recommended Daily Allowance(RDA): 2525 Kcal, **RDA=65gms*

In our study, 671(64.3%) pregnant women were non-vegetarians and rest of them 373 (35.7%) were vegetarians. Only 169 (16.2%) had adequate calories >2225(>89% of RDA) intake. Out of those who had consumed less than recommended daily allowance (RDA=2525Kcal) of calories, majority had consumed 1726-2225 Kcal (>69-89% of RDA) and 156(14.9%) had consumed1250-1725 Kcal (50-69% of RDA). On the other hand, majority 899(86.1%) of the pregnant women had consumed >57.85gms (>89% of RDA) proteins, 137(13.1%) had taken 44.86-57.85gms (>69-89% of RDA) of proteins and 8(0.8%) of the pregnant women had taken 32.5-44.85gms (50-69% of RDA) protein during pregnancy. None of the pregnant women had consumed <50% of RDA of either calories or proteins. Mean calorie and protein intake was 2010.88±224.35 Kcal and 70.22±10.32gms respectively.

## 4.5 Characteristics of newborns

- Six hundred and seventy six (64.8%) were vaginal births and 368(35.2%) were born by Cesarean sections.
- Female newborns 528 (50.6%) were slightly more than the counterpart male babies 516(49.4%).
- One hundred and fourteen (10.9%) newborns were preterm (<37 weeks of gestation) births.

**Table 4.5.1: Distribution of newborns by Length and Birth Weight**

| Characteristics | Number of newborns | Percentage |
|---|---|---|
| **Length of the baby ( in cms)** | | |
| ≤40 | 7 | 0.7 |
| 40-45 | 189 | 18.1 |
| 45-50 | 700 | 67.0 |
| ≥50 | 148 | 14.2 |
| Total | 1044 | 100.0 |
| **Birth weight (in gms)** | | |
| <2500 | 258 | 24.7 |
| 2500-3999 | 782 | 74.9 |
| ≥4000 | 4 | 0.4 |
| Total | 1044 | 100.0 |

**Mean birth weight:** 2720.28±475.94gms

(Male: 2770.79±476.02gms, Female: 2670.92±471.10gms

**Mean difference in birth weight** of male and female newborns: 99.86±29.31 (CI: 42.34-157.38), t value: 3.40, df: 1042.

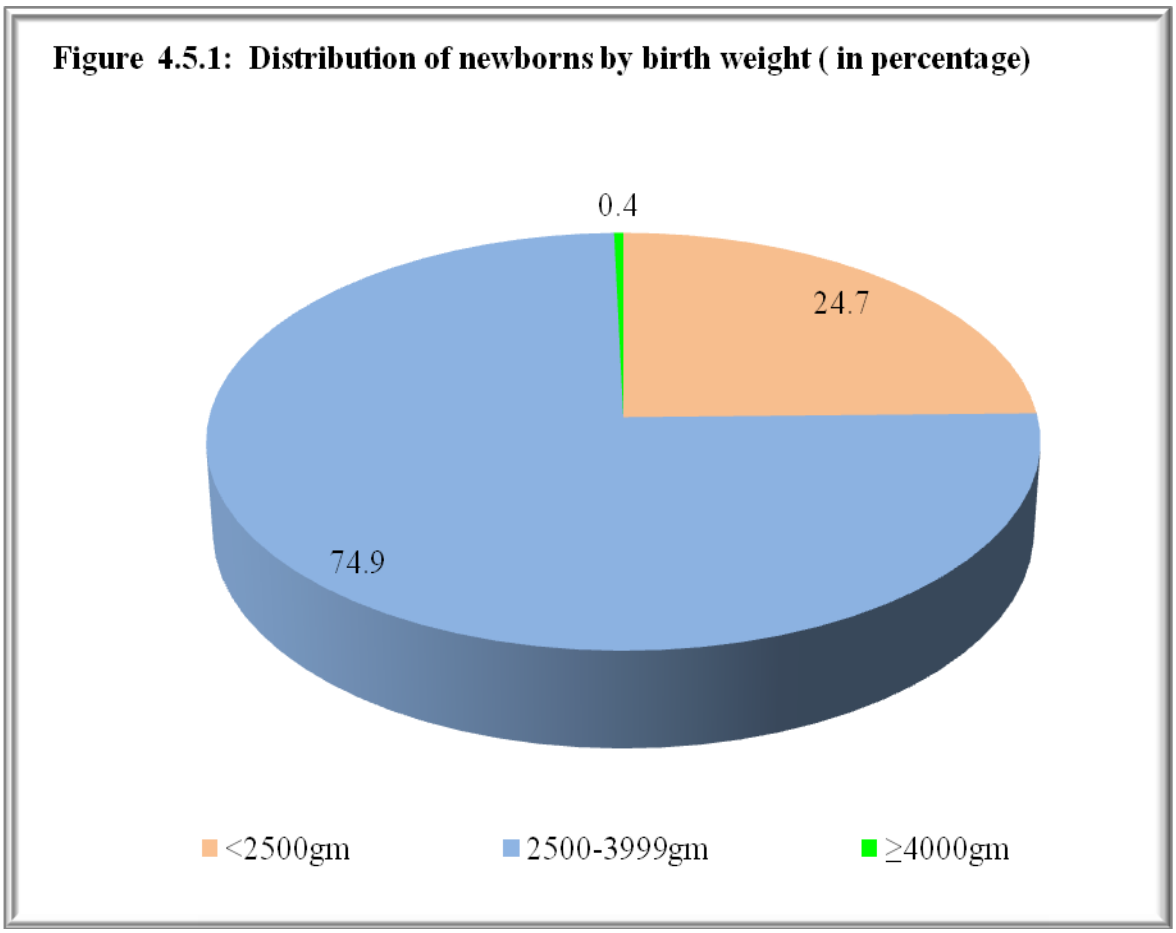
**Quartile birth weight:** Q1=2500.00gms, Q2=2700.00gms and Q3=3000.00gms,

Range=3000.00gms (Minimum=1100gms and Maximum=4100gms)

Majority of the newborns 700(67.0%) measured 45-50cms in length and 189(18.1%) were 40-45cms long at the time of birth. About 148(14.2%) babies had ≥50cms length while 7(0.7%) of the newborns measured ≤40cms. Mean length of

newborns was 47.63±2.6cms. A statistically significant difference was observed between the average length of male (47.93±2.6cms) and female babies (47.34±2.6cms). Two hundred and fifty eight 258 (24.7%) newbons had weight <2500gms (low birth weight); out of whom 199(19.1%) weighed between 2000-2499gms and 59 (5.7%) had <2000gms weight at birth. Out of those normal birth weight babies, 782(74.95%) weighed 2500-3999gms and four babies had macrosomic birth weight (≥4000gms). Mean birth weight was 2720.28±475.94gms and male babies (2770.79±476.02gms) were almost 100gms heavier than female babies (2670.92±471.10gms). Male babies had significantly higher birth weight than the female babies (p=0.01). Mean difference in the birth weight between the male and female baby was (Mean ±SE) 99.86±29.3gms (CI: 42.34-157.38).

**Figure 4.5.1: Distribution of newborns by birth weight ( in percentage)**



# Predictors of Birth Weight: Bivariate analysis

## 4.6 Predictors of Birth Weight

### 4.6.1 Association between predictors and birth weight –Bivariate analysis

In the bivariate analysis, Chi-square test, independent't' test and correlation coefficients (Pearson's and Spearman's correlation coefficients) were applied. Corresponding values of these tests, degrees of freedom, unadjusted odds ratio, confidence interval and P values are mentioned accordingly in the table given below.

**Table 4.6.1.1: Association between sex of newborns, parental height and birth weight of newborns**

| Predictors (n=1044) | Birth weight | | Total | OR | CI | P value |
|---|---|---|---|---|---|---|
| | <2500gm | ≥2500gm | | | | |
| **Sex of the newborn** | | | | | | |
| Female | 153(29.0) | 375(71.0) | 528 | 1.59 | 1.20-2.12 | 0.001 |
| Male | 105(20.3) | 411(79.7) | 432 | 1 | | |
| **$\chi^2$=10.44, df=1, P= 0.001** | | | | | | |
| **Maternal height ( in cms)** | | | | | | |
| <145 | 12(26.7) | 33(73.3) | 45 | 3.15 | 0.80-12.34 | 0.09 |
| 145-154.9 | 180(31.0) | 401(69.0) | 581 | 3.89 | 1.16-13.01 | 0.02 |
| 155-164.9 | 63(16.2) | 326(83.8) | 389 | 1.67 | 0.49-5.70 | 0.40 |
| ≥165 | 3(10.3) | 26(89.7) | 29 | 1 | | |
| **$\chi^2$=30.74, df=3, P = 0.001** | | | | | | |

**Continue**

| Predictors (n=1044) | Birth weight | | Total | OR | CI | P value |
|---|---|---|---|---|---|---|
| | <2500gm | ≥2500gm | | | | |
| **Father's height (in cms)** | | | | | | |
| <157.5 | 219(60.0) | 14(40.0) | 35 | 9.79 | 4.19-22.85 | 0.001 |
| 157.5-162.5 | 51(41.1) | 73(58.9) | 124 | 4.56 | 2.44-8.50 | 0.001 |
| 162.5-167.5 | 128(27.2) | 342(72.8) | 470 | 2.44 | 1.41-4.23 | 0.001 |
| 167.5-172.5 | 41(14.3) | 246(85.7) | 287 | 1.08 | 0.59-1.99 | 0.7 |
| >172.5 | 17(13.3) | 111(86.7) | 128 | 1 | | |
| **$\chi^2$=66.75, df=4, P=0.001** | | | | | | |

Proportion of low birth weight was higher amongst 153 (29.0%) female babies than the male babies 105(20.3%) and this difference observed was statistically significant (P=0.001). An odd of occurrence of LBW was 1.59 times higher amongst female newborns as against the male babies. Almost 180 (31.0%) LBW babies were born to the mothers who had height between 145-154.9cms and 12(26.7%) babies born to the mothers with <145cms height. Almost 63(16.2%) and 3(10.3%) babies born to the mothers who had 155-164.9cms and ≥165cms height had LBW respectively. Difference in the proportion of LBW babies by the height of mother was statistically significant (P=0.001). Babies born to the mothers with height <145cms had 3.15 times risk of LBW and newborns of the mothers who had height of 145-154.9cms had 3.89 times higher chances of having LBW as compared to the mothers who had ≥165cms height. Similarly, LBW was significantly higher amongst the babies whose fathers had <157.5cms (OR=9.79), 157.5-162.5cms (OR=4.56) and 162.5-167.5cms (OR=2.44) height

respectively as compared to the fathers whose height was >172.5cms (P=0.001). LBW was seen among 219(60.0%), 51(41.1%), 128(27.2%), 140(14.3%) and 17(13.3%) babies whose fathers had height of <157.5cms, 157.5-162.5cms, 162.5-167.5cms, 167.6-172.5cms and more than 172.5cms respectively. Likewise, babies of the short fathers whose height was <161.6cms (below mean-SD) and average height of 161.6-172.0cms (mean ± SD) had significantly higher risk of having LBW when compared to the babies of tall fathers (>172.0cms).

**Table 4.6.1.2: Association between maternal weight during pregnancy and birth weight of newborns**

| Weight(Kgs) (n=1044) | Birth weight | | Total | OR | CI | P value |
|---|---|---|---|---|---|---|
| | 2500gm | ≥2500gm | | | | |
| **Maternal weight at enrollment** | | | | | | |
| ≤40 | 59(28.4) | 149(71.6) | 208 | 1.05 | 0.54-2.05 | 0.87 |
| 40-50 | 132(24.8) | 400(75.2) | 532 | 0.88 | 0.47-1.64 | 0.68 |
| 50-60 | 52(20.9) | 1979(79.1) | 249 | 0.70 | 0.36-1.37 | 0.30 |
| >60 | 15(27.3) | 40(72.7) | 55 | 1 | | |
| **$\chi^2$=3.65, df=3, P= 0.302** | | | | | | |
| **Maternal weight at first follow up** | | | | | | |
| ≤40 | 24(41.4) | 34(58.6) | 58 | 2.48 | 1.26-4.87 | 0.008 |
| 40-50 | 123(26.3) | 344(73.7) | 467 | 1.25 | 0.78-2.02 | 0.3 |
| 50-60 | 84(21.2) | 313(78.8) | 397 | 0.94 | 0.57-1.54 | 0.8 |
| >60 | 27(22.1) | 95(77.9) | 122 | 1 | | |
| **$\chi^2$=12.45, df=3, P= 0.006** | | | | | | |

**Continue**

| Weight(Kgs) (n=1044) | Birth weight | | Total | OR | CI | P value |
|---|---|---|---|---|---|---|
| | 2500gm | ≥2500gm | | | | |
| **Maternal weight at second follow up** | | | | | | |
| ≤45 | 39(32.5) | 81(67.5) | 120 | 1.96 | 1.18-3.25 | 0.009 |
| 45-50 | 62(29.8) | 146(70.2) | 208 | 1.72 | 1.10-2.70 | 0.01 |
| 50-55 | 70(23.3) | 230(76.7) | 300 | 1.23 | 0.80-1.90 | 0.3 |
| 55-60 | 44(22.2) | 154(77.8) | 198 | 1.16 | 0.72-1.86 | 0.5 |
| >60 | 43(19.7) | 175(80.3) | 218 | 1 | | |
| **$\chi^2$=10.65, df=4, P= 0.03** | | | | | | |
| **Maternal weight before delivery** | | | | | | |
| ≤45 | 25(34.7) | 47(65.5) | 72 | 2.379 | 1.34-4.20 | 0.003 |
| 45-50 | 53(34.2) | 102(65.2) | 155 | 2.324 | 1.48-3.62 | 0.001 |
| 50-55 | 73(26.6) | 201(73.4) | 274 | 1.624 | 1.0-2.42 | 0.018 |
| 55-60 | 54(21.3) | 199(78.7) | 253 | 1.213 | 0.79-1.85 | 0.370 |
| >60 | 53(18.3) | 237(81.7) | 290 | 1 | | |
| **$\chi^2$=19.91, df=4, P= 0.001** | | | | | | |
| **Weight of father** | | | | | | |
| <55 | 50(41.0) | 72(59.0) | 122 | 7.63 | 2.58-22.61 | 0.001 |
| 55-65 | 167(28.7) | 415(71.3) | 582 | 4.42 | 1.56-12.5 | 0.005 |
| 65-75 | 37(12.7) | 255(87.3) | 292 | 1.59 | 0.54-4.70 | 0.3 |
| >75 | 4(8.3) | 44(91.7) | 48 | 1 | | |
| **$\chi^2$=51.99, df=3, P= 0.001** | | | | | | |

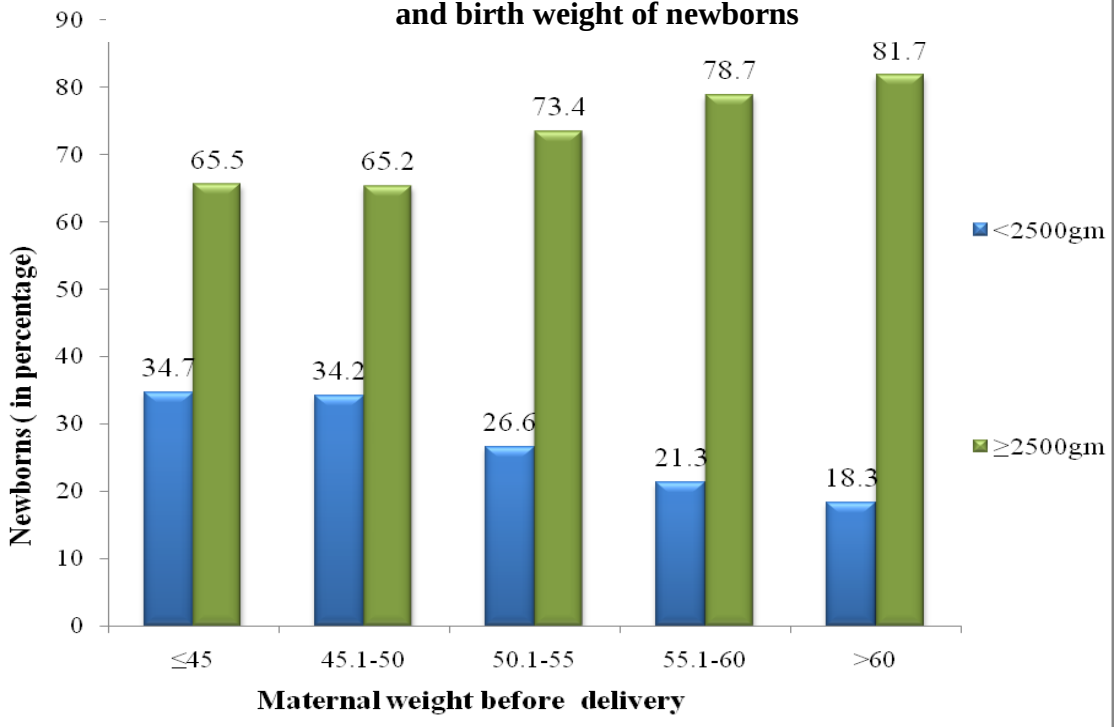
LBW was prevalent amongst 59(28.4%), 132(24.8%), 52(20.9%) and 15(27.3%) babies of the mothers who had weight ≤40Kgs, 40-50Kgs, 50-60Kgs and >60Kgs respectively at the enrollment. Although, proportion of LBW babies born to the mothers of extremes of weight (≤40Kgs and >60Kgs) was slightly higher than those of 40-60Kgs weight, the difference was not statistically significant (P>0.05). Pregnant women who had ≤40Kgs weight at the time of first follow up had delivered significantly higher proportion of LBW babies 24(41.4%) as against those who had >60Kgs weight 27(22.1%) at the time of first follow up (P=0.008). Mothers who had weight ≤40Kgs at the time of first follow up had 2.48 times higher chances of delivering LBW babies when compared with the mothers of >60Kgs weight.

Odds of delivering LBW babies amongst the mothers who had ≤45Kgs and 45-50Kgs weight was 1.96 times and 1.72 times higher than those who had >60Kgs weight at the time of second follow up. The LBW was observed among 39(32.5%), 62(29.8%), 70(23.3%), 44(22.2%) and 43(19.7%) babies of the mothers who had ≤45Kgs, 45-50Kgs 50-55Kgs, 55-60Kgs and >60Kgs weight respectively. Statistically significant difference was observed between the birth weight of babies born to the mothers of <50Kgs weight as against the mothers who had >60Kgs weight at the second follow up (P=0.03).

Statistically significant difference was observed in the proportion of LBW babies according to the maternal weight before delivery (P=0.001). The highest proportion of the LBW babies 25(34.7%) were born to the mothers who had ≤45Kgs weight and the lowest

proportion of LBW 53(18.3%) babies were born to the mothers who had >60Kgs weight before delivery. Similarly, 53(34.2%) LBW babies were born to the mothers who had 45-50Kgs weight, 73(26.6%) were born to the mothers with 50-55Kgs weight and 54(21.3%) were born to those mothers who had 55-60Kgs weight before delivery. Proportion of LBW babies decreased with the increase in maternal weight before delivery.

**Figure 4.6.1.1: Association between maternal weight before delivery and birth weight of newborns**




Low birth weight was most prevalent 50(41.0%) amongst the babies whose fathers had weight <55Kgs. About 167(28.7%) of the LBW babies had their father's weight between 55-65Kgs and the least proportion 4(8.3%) of LBW babies were found to be amongst those whose fathers had >75Kgs weight. This difference observed was statistically significant (P=0.001). Risk of having LBW amongst the babies whose fathers had <55Kgs and 55-65Kgs weight was 7.63 and 4.42 times higher than those babies whose father's weight was >75Kgs.

**Table 4.6.1.3: Association between maternal BMI and birth weight of newborns**

| BMI category (n=1044) | Birth weight <2500gm | Birth weight ≥2500gm | Total | OR | CI | P value |
|---|---|---|---|---|---|---|
| **Maternal BMI at enrollment** | | | | | | |
| <18.5 | 34(27.9) | 88(72.1) | 122 | 0.78 | 0.29-2.08 | 0.62 |
| 18.51-23 | 150(24.8) | 454(75.2) | 604 | 0.90 | 0.34-2.37 | 0.83 |
| 23.01-27.5 | 60(22.9) | 202(77.1) | 262 | 0.64 | 0.23-1.79 | 0.40 |
| >27.5 | 14(25.0) | 42(75.0) | 56 | 1 | | |
| **$\chi^2$=1.12, df=3, P = 0.77** | | | | | | |
| **Maternal BMI before delivery** | | | | | | |
| <18.5 | 9(60.0) | 6(40.0) | 15 | 5.70 | 1.901-17.09 | 0.002 |
| 18.5-23 | 98(24.2) | 307(75.8) | 405 | 1.21 | 0.784-1.87 | 0.3 |
| 23.0-27.5 | 116(25.4) | 340(74.6) | 456 | 1.29 | 0.845-1.99 | 0.2 |
| >27.5 | 35(20.8) | 133(79.2) | 168 | 1 | | |
| **$\chi^2$=11.58, df=3, P= 0.009** | | | | | | |

Thirty four (27.9%) babies of the undernourished mothers (BMI<18.5) had low birth weight whereas 60(22.9%) of the mothers with normal BMI (18.5-23) at enrollment had delivered LBW babies. This observed difference was not statistically significant (p=0.77). Nine (60.0%) of the LBW babies were born to the undernourished mothers at the time of delivery. Almost 98(24.2%) of the LBW babies were born to the mothers who had normal BMI and the least proportion 35(20.8%) of LBW babies were born to the mothers who had BMI >27.5. Proportion of LBW babies born to the undernourished

mothers were significantly higher than those born to the mothers with BMI >27.5Kg/$m^2$. There was no association between father's BMI and the birth weight of newborns.

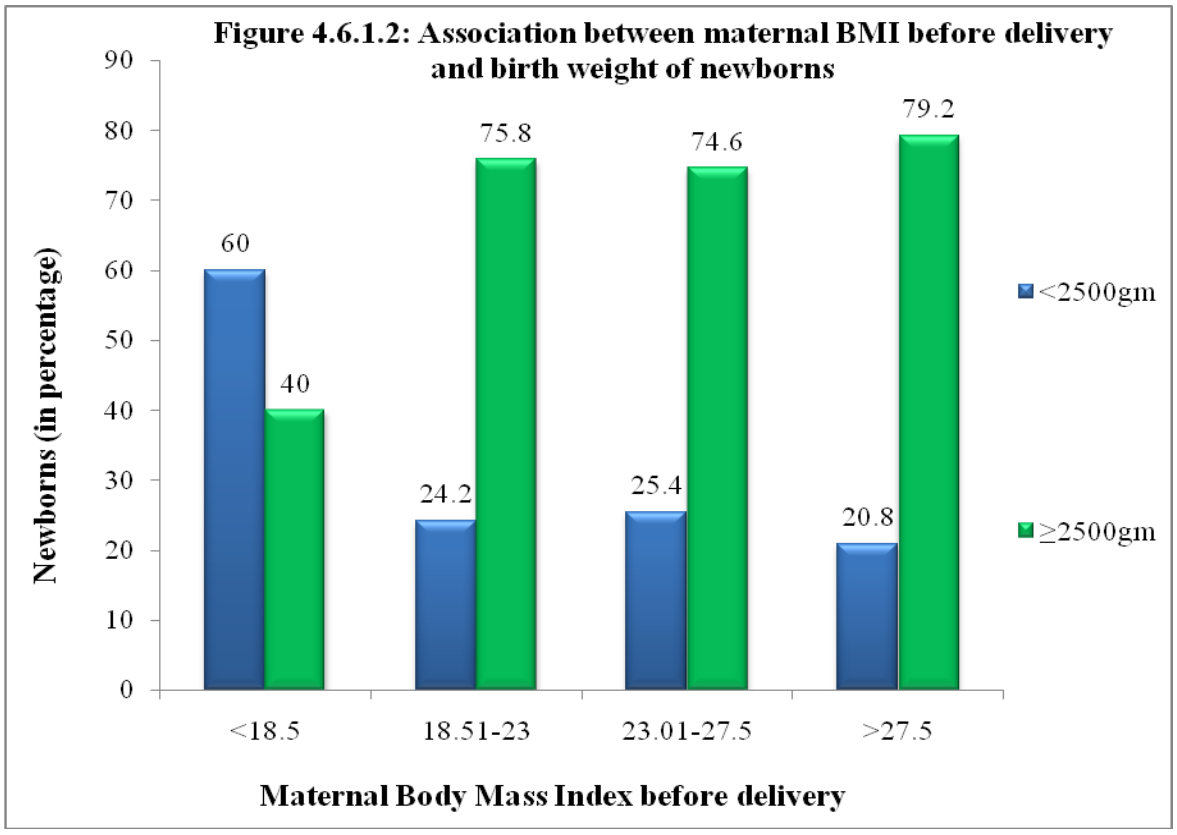



**Table 4.6.1.4: Association between religion and birth weight of newborns**

| Religion (n=1044) | Birth weight | | Total | OR | CI | P value |
|---|---|---|---|---|---|---|
| | <2500gm | ≥2500gm | | | | |
| **Religion** | | | | | | |
| Hindu | 216(24.5) | 667(75.5) | 883 | 1.18 | 0.75-1.86 | 0.4 |
| Christian/Jain | 15(42.9) | 20(57.1) | 35 | 2.75 | 1.24-6.09 | 0.01 |
| Muslim | 27(21.4) | 99(78.6) | 126 | 1 | | |
| **$\chi^2$=6.95, df=2, P=0.03** | | | | | | |

Christian and Jain mothers had delivered the highest proportion of LBW babies 15(42.9%) as compared to the Hindus 216(24.5%) and Muslims 27(21.4%). Statistically significant difference was noted between the proportion of LBW babies of Christian/Jains and Muslims (P=0.01). Risk of delivering LBW babies amongst the Christian/Jain was 2.75 times higher than Muslims. Place of residence and consanguinity had no influence on the proportion of LBW babies. There was significant difference in the proportion of LBW by the type of family (P=0.03) where the mothers of joint families had delivered significantly higher proportion of LBW babies 231(25.9%) as compared to the mothers residing in nuclear family 27(17.6%). Risk of delivering LBW babies was 1.63 times higher among the mothers who lived in joint families as against the nuclear families.

**Table 4.6.1.5: Association between parental age and birth weight of newborns**

| **Age(years)** | **Birth weight** | | **Total** | **OR** | **CI** | **P** |
|---|---|---|---|---|---|---|
| **(n=1044)** | **<2500gm** | **≥2500gm** | | | | **value** |
| **Paternal age** | | | | | | |
| <25 | 15(28.8) | 37(71.2) | 52 | 1.520 | 0.75-3.07 | 0.24 |
| 25-34 | 207(25.2) | 614(74.8) | 821 | 1.264 | 0.84-1.88 | 0.25 |
| ≥35 | 36(21.1) | 135(78.9) | 171 | 1 | | |
| **$\chi^2$=1.81, df=3, P=0.4** | | | | | | |
| **Maternal age** | | | | | | |
| <20 | 32(40.5) | 47(59.5) | 79 | 4.38 | 1.9-10.09 | 0.001 |
| 20-24 | 146(24.5) | 451(75.5) | 597 | 2.08 | 1.00-4.31 | 0.04 |
| 25-29 | 71(23.6) | 230(76.4) | 301 | 1.98 | 0.93-4.21 | 0.07 |
| ≥30 | 9(13.4) | 58(86.6) | 67 | 1 | | |
| **$\chi^2$=15.39, df=3, P=0.002** | | | | | | |

There was no statistical difference between the proportions of LBW babies by the age of father. The highest proportion of LBW was seen among the babies whose fathers were of <25 years age (P=0.4). The lowest proportion of LBW 36(21.1%) was observed amongst the babies whose fathers were ≥35 years old. Similarly, proportion of low birth weight 32(40.5%) was significantly higher among the babies of adolescent (<20 years) and 20-24 years mothers 146(24.5%) as against those mothers who had ≥30 years of age (P=0.002). Odds of occurrence of LBW among the babies of adolescent mothers and those of 20-24 years mothers was 4.48 and 2.08 times more than that of ≥30 years mothers respectively.

**Table 4.6.1.6: Association between maternal age at marriage, first pregnancy and birth weight of newborns**

| Age (years) (n=1044) | Birth weight | | Total | OR | CI | P value |
|---|---|---|---|---|---|---|
| | <2500gm | ≥2500gm | | | | |
| **Age at marriage** | | | | | | |
| <20 | 131(25.9) | 375(74.1) | 506 | 1.31 | 0.74-2.32 | 0.3 |
| 20-24 | 110(24.1) | 347(75.9) | 457 | 1.19 | 0.67-2.12 | 0.5 |
| ≥25 | 17(21.0) | 64(79.0) | 81 | 1 | | |
| **$\chi^2$=1.0, df=2, P=0.58** | | | | | | |
| **Age at first pregnancy** | | | | | | |
| <20 | 60(24.2) | 188(75.8) | 248 | 1.23 | 0.74-2.03 | 0.4 |
| 20-24 | 169(25.8) | 486(74.2) | 655 | 1.34 | 0.86-2.09 | 0.1 |
| ≥25 | 29(20.6) | 112(79.4) | 141 | 1 | | |
| **$\chi^2$=1.75, df=2, P=0.41** | | | | | | |

There was no significant association between the birth weight and maternal age at marriage and first pregnancy; nevertheless, the highest proportion of LBW babies were born to the mothers who were married before 20 years of age and who conceived during the adolescent period and 20-24 years of age (P>0.05). Similarly, mother's educational status and occupation seems to have no significant impact on the birth weight of the babies.

**Table 4.6.1.7: Association between father's educations, occupation, socioeconomic status and birth weight of newborns**

| Education Status (n=1044) | Birth weight | | Total | OR | CI | P value |
|---|---|---|---|---|---|---|
| | <2500gm | ≥2500gm | | | | |
| **Father's education** | | | | | | |
| Illiterate/primary | 9(20.0) | 36(80.0) | 45 | 1.00 | 0.46-2.15 | 0.9 |
| Secondary education | 152(29.7) | 360(70.3) | 512 | 1.69 | 1.26-2.74 | 0.001 |
| Higher education | 97(19.9) | 390(80.1) | 487 | 1 | | |
| **$\chi^2$=13.36, df=2, P=0.001** | | | | | | |
| **Father's occupation** | | | | | | |
| Farmers | 82(27.1) | 221(72.9) | 303 | 1.41 | 1.00-1.97 | 0.04 |
| Driving | 19(26.0) | 54(74.0) | 73 | 1.33 | 0.75-2.35 | 0.3 |
| Labor | 57(30.3) | 131(69.7) | 188 | 1.65 | 1.12-2.42 | 0.01 |
| Service/ Business | 100(20.8) | 380(79.8) | 480 | 1 | | |
| **$\chi^2$=8.02 df=3, P=0.04** | | | | | | |

**Continue**

| Education Status (n=1044) | Birth weight | | Total | OR | CI | P value |
|---|---|---|---|---|---|---|
| | <2500gm | ≥2500gm | | | | |
| **Socioeconomic class** | | | | | | |
| I and II | 31(17.3) | 148(82.7) | 179 | 1 | | |
| II | 29(18.2) | 130(81.8) | 159 | 1.06 | 0.60-1.86 | 0.8 |
| IV and V | 198(28.0) | 508(72.0) | 706 | 1.86 | 1.22-2.83 | 0.004 |
| **$\chi^2$=13.05.02, df=2, P=0.001** | | | | | | |

As seen in the above table, birth weight was significantly associated with father's educational status. Significantly higher proportions of LBW babies 152 (29.7%) was found to be amongst the babies whose fathers had secondary level education as compared to those whose fathers had higher educational status 97(19.9%). There was 1.69 times higher risk of LBW among the babies whose fathers had secondary school education as compared to those who had higher education (P=0.001).

Father's occupation had statistically significant association with the birth weight of baby. Newborns whose fathers were farmers and laborers had significantly higher proportion of LBW [82(27.1%) and 57(30.3%)] as compared to the babies whose fathers were service/business people 100(20.8%).

The mothers who belonged to IV$^{th}$ and V$^{th}$ class socioeconomic status had delivered significantly higher proportion of LBW babies 198(28.0%) when compared to those who had I and II class SES 31(17.3%). Odds of deliveiring LBW babies was 1.86 times higher amongst the mothers of low (IV$^{th}$ and V$^{th}$) SES when compared to the mothers who belonged to I and II class SES (P=0.004).

Wide range of variation was observed between the birth weight of newborns by the gestational age at delivery. The mean birth weight of full term babies (2801.61±415.31gms) was significantly higher than that of preterm babies (2056.82±417.49gms). The mean difference in birth weight (Mean ±Standard Error) was 744.77±41.23gms (P=0.001).

**Table 4.6. 1. 8: Association between gestational age at delivery, gravidity, type of conception, inter-pregnancy interval and birth weight of newborns**

| Characteristics (n=1044) | Birth weight <2500gm | Birth weight ≥2500gm | Total | OR | CI | P value |
|---|---|---|---|---|---|---|
| **Gestation age at delivery** | | | | | | |
| Preterm | 92(80.7) | 22(19.3) | 114 | 19.24 | 11.73-31.55 | 0.001 |
| Full term | 166(17.8) | 764(82.2) | 930 | 1 | | |
| **$\chi^2$=215.62, df=1, P=0.001** | | | | | | |
| **Gravidity** | | | | | | |
| Primigravida | 126(28.9) | 310(71.1) | 436 | 1.46 | 1.10-1.94 | 0.008 |
| Multigravida | 132(21.7) | 47(78.3) | 608 | 1 | | |
| **$\chi^2$=7.05, df=1, P=0.008** | | | | | | |
| **Type of conception** | | | | | | |
| ART/ treatment | 15(41.7) | 21(58.3) | 36 | 2.29 | 1.14-4.43 | 0.01 |
| Spontaneous | 243(24.1) | 765(75.9) | 1008 | 1 | | |
| **$\chi^2$=5.76, df=1, P=0.01** | | | | | | |
| **Inter-pregnancy interval (n=608)** | | | | | | |
| <12 months | 44(48.4) | 47(51.6) | 91 | 4.28 | 2.55-7.19 | 0.001 |
| 12-24 months | 26(18.4) | 115(81.6) | 141 | 1.14 | 0.55-1.38 | 0.5 |
| >24 months | 62(16.5) | 314(83.5) | 376 | 1 | | |
| **$\chi^2$=44.91, df=2, P=0.001** | | | | | | |

As illustrated in the above table, proportion of premature LBW babies 92(80.7%) was significantly higher than those of full term (FT) LBW babies (P=0001). There was multifold risk (OR=19.24) of LBW amongst the preterm births as against the FT births. Out of 436 primigravida, 126(28.9%) had delivered LBW babies whereas 132(21.7%) babies of 608 multigravida mothers had LBW babies. This difference in the proportion of LBW by the maternal gravidity was statistically significant (P=0.008) where the risk of delivering LBW baby by the primigravida was 1.46 times higher than multigravida mother.

Out of 36 pregnant women who had conceived through artificial reproductive technology or conceived after medical treatment, 15(41.7%) delivered LBW babies while 243(24.1%) of those who had spontaneous conception had delivered LBW babies. Risk of having LBW was 2.29 times higher amongst the babies of those pregnant women who conceived by ART (artificial reproductive technique) or after treatment of sub fertility than those who had conceived spontaneously (P=0.01). A statistically significant difference was observed between the proportion of LBW babies born to the mothers who had <12 months inter-pregnancy internal 44(48.4%) as compared to those who had >24 month's interval 62(16.5%) in case of last two consecutive pregnancies (P=0.001). There was 4.28 times higher risk of delivering LBW babies amongst those pregnant women who had <12 months inter-pregnancy interval (P=0.001); however, there was no significant risk of delivering LBW babies amongst those mothers who had 12-24 months and >24 months interval between two pregnancies (P=0.5).

**Table 4.6.1.9: Association between history of bad pregnancy outcomes and birth weight of newborns**

| Variables (n=608) | Birth weight | | Total | OR | CI | P value |
|---|---|---|---|---|---|---|
| | <2500gm | ≥2500gm | | | | |
| **History of preterm delivery** | | | | | | |
| Yes | 46(45.1) | 56(54.9) | 102 | 4.01 | 2.54-6.31 | 0.001 |
| No | 86(17.0) | 420(83.0) | 506 | 1 | | |
| **$\chi^2$=39.44, df=1, P=0.001** | | | | | | |
| **History of low birth weight** | | | | | | |
| Yes | 45(41.7) | 63(58.3) | 108 | 3.39 | 2.16-5.30 | 0.001 |
| No | 87(17.4) | 413(82.6) | 500 | 1 | | |
| **$\chi^2$=8.51, df=1, P=0.004** | | | | | | |
| **History of stillbirth** | | | | | | |
| Yes | 23(35.9) | 41(64.1) | 64 | 2.23 | 1.28-3.88 | 0.004 |
| No | 109(20.0) | 435(80.0) | 544 | 1 | | |
| **$\chi^2$=8.51, df=1, P=0.004** | | | | | | |
| **History of neonatal death** | | | | | | |
| Yes | 24(38.1) | 39(61.9) | 63 | 2.49 | 1.43-4.31 | 0.001 |
| No | 108(19.8) | 437(80.2) | 545 | | | |
| **$\chi^2$=11.10, df=1,P=0.001** | | | | | | |

Proportions of LBW babies born to the mothers who had history of preterm delivery, low birth weight, stillbirth and the neonatal death were 46(45.1%), 45(41.7%),

23(35.9%) and 24(38.1%) respectively. History of delivery of preterm birth, low birth weight, stillbirth and the neonatal death was significantly associated with the LBW babies (P<0.05). History of abortion did not have statistical association with birth weight (P=0.1). The risk of delivering LBW babies amongst the mothers who had history of preterm birth, low birth weight, stillbirth and the neonatal deaths were 4.01, 3.39, 2.23 and 2.49 times higher than those mothers who did not have any history of these bad pregnancy outcomes respectively .

**Table 4. 6. 1. 10: Association between weight gains during pregnancy, hemoglobin level during pregnancy and birth weight of newborns**

| Characteristics (n=1044) | Birth weight | | Total | OR | CI | P value |
|---|---|---|---|---|---|---|
| | <2500gm | ≥2500gm | | | | |
| **Total weight gain ( in Kgs)** | | | | | | |
| ≤4 | 16(42.1) | 22(57.9) | 38 | 3.11 | 1.58-6.10 | 0.001 |
| 4-6 | 46(39.0) | 72(61.0) | 118 | 2.73 | 1.80-4.15 | 0.001 |
| 6-8 | 72(30.9) | 161(69.1) | 233 | 1.91 | 1.36-2.69 | 0.001 |
| >8 | 124(18.9) | 531(81.1) | 655 | 1 | | |
| **$\chi^2$=35.65, df=3, P=0.001** | | | | | | |
| **Hemoglobin level before delivery (gms/dl)** | | | | | | |
| <9 | 18(30.0) | 42(70.0) | 60 | 1.35 | 1.01-1.81 | 0.04 |
| 9-10.99 | 109(27.8) | 283(72.2) | 392 | 1.50 | 0.84-2.70 | 0.1 |
| ≥ 11 | 131(22.1) | 461(77.9) | 592 | 1 | | |
| **$\chi^2$=6.04, df=2, P=0.04** | | | | | | |

There was increasing trend in the proportion of LBW babies with the decrease in weight gain during pregancy. This observed diference was statiscitally significant (P=0.001). Out of 38 pregnant women who had ≤4Kgs weignt gain during pregnancy, 16(42.1%) had delivered LBW babies. Similarly, 46(39.0%), 72(30.9%) and 124(18.9%) LBW babies were born to the mothers who had weight gain of 4-6Kgs, 6-8Kgs and >8Kgs respectively. There was almost two times and three times higher risk of delivering LBW babies amongst the mothers who had 6-8Kgs and <6Kgs weight gain when compared those who had >8Kgs weight gain during pregancy (P=0.001). Eighteen 18(30.0%) LBW babies were born to the mothers who had hemoglobin <9gms/dl before delivery while slightly lower proportions of the mothers who had hemoglobin 9-10.99gms/dl and ≥11gms/dl had delivered 109(27.8%) and 131(22.1%) LBW babies respectively (P=0.04). This observed difference was statistically significant. However, hemoglobin level at enrollment did not have association with and the birth weight.

**Figure 4.6.1.3 : Association between weight gains during pregnancy and birth weight of newborns**

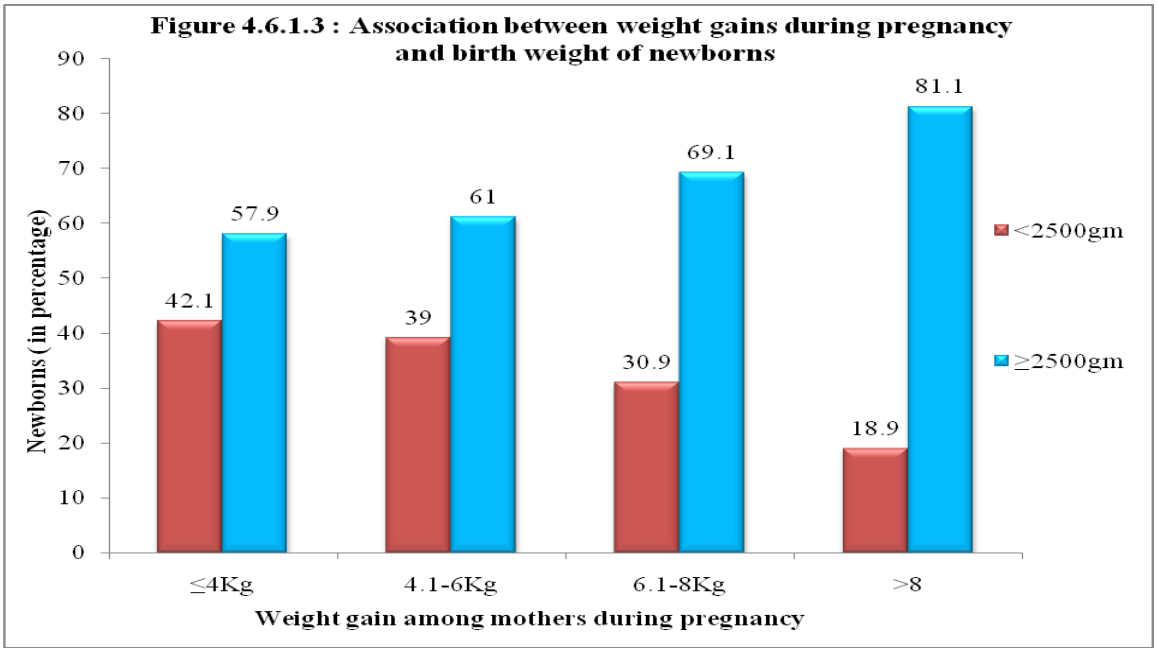


**Table 4.6.1.11: Association between types of diet and nutrition intake during pregnancy and birth weight of newborns**

| Nutrition intake (n=1044) | Birth weight | | Total | OR | CI | P value |
|---|---|---|---|---|---|---|
| | <2500gm | ≥2500gm | | | | |
| **Type of diet** | | | | | | |
| Vegetarian | 135(36.2) | 238(63.8) | 373 | 2.52 | 1.89-3.37 | 0.001 |
| Non-vegetarian | 123(18.3) | 548(81.7) | 671 | 1 | | |
| **$\chi^2$=41.11, df=1, P=0.001** | | | | | | |
| **Birth weight by Caloric intake/day** | | | | | | |
| 50-69% of RDA | 134(85.9) | 22(14.10) | 156 | 37.52 | 23.01-61.20 | 0.001 |
| >69% of RDA | 124(14.0) | 764(86.0) | 888 | 1 | | |
| **$\chi^2$=369.02,df=1, P=0.001** | | | | | | |
| **Birth weight by Protein intake/day** | | | | | | |
| 50-89% of RDA | 123(84.8) | 22(15.2) | 145 | 31.64 | 19.39-51.60 | 0.001 |
| >89% of RDA | 135(15.0) | 764(85.0) | 899 | 1 | | |
| **$\chi^2$=327.06, df=1, P=0.001** | | | | | | |

Out of 373 vegetarian pregnant women, 135(36.2%) had delivered LBW babies whereas out of 671 non vegetarians, 123(18.3%) had delivered LBW babies. This difference observed was statistically significant (P=0.001). The risk of LBW amongst the babies of vegetarian mothers was 2.52 times higher than the babies of non-vegetarian mothers. Out of 156 mothers who had consumed daily intake of calories between 50-69% of RDA, 134(85.9%) delivered LBW babies whereas 124(14.0%) of the 888 mothers who

consumed >69 percent of RDA had delivered LBW babies and the observed difference was statistically significant (P=0.001). Significantly higher risk (OR=37.52) of delivering LBW babies was observed amongst the mothers who had daily calorie consumption <69 percent as against those who had more calorie consumption (P=0.001). Birth weight increased with the increase in consumption of calories.

Proportion of LBW babies 124(84.8%) born to the mothers who had daily protein consumption between 50-89 percent of RDA were significantly higher than the babies of the mothers who had consumed >89 percent of RDA (P=0.001). Risk of LBW amongst the babies of the mothers who consumed less protein was 31.64 times more than those whose mothers had better protein consumption (>89% of RDA) during pregnancy.

**Table 4.6.1.12: Association between high risk factors, illness during pregnancy and birth weight of newborns**

| Risk /illness status (n=1044) | Birth weight | | Total | OR | CI | P value |
|---|---|---|---|---|---|---|
| | <2500gm | ≥2500gm | | | | |
| **Number of Risk factors** | | | | | | |
| 1-2 factors | 93(26.7) | 255(73.3) | 348 | 1.31 | 0.97-1.78 | 0.07 |
| ≥3 risk factors | 29(42.0) | 40(58.0) | 69 | 2.61 | 1.56-4.37 | 0.001 |
| No risk factors | 136(21.7) | 491(78.3) | 627 | 1 | | |
| **$\chi^2$=14.95, df=2, P=0.001** | | | | | | |

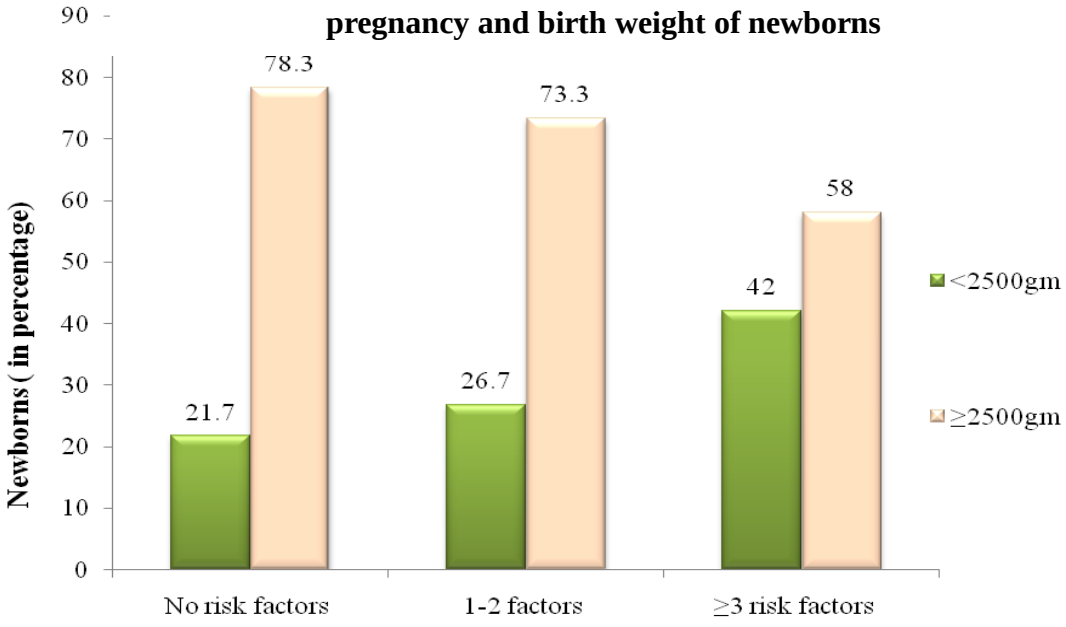
**Continue**

| Risk /illness status (n=1044) | Birth weight | | Total | OR | CI | P value |
|---|---|---|---|---|---|---|
| | <2500gm | ≥2500gm | | | | |
| **Number of Risk factors** | | | | | | |
| No risk factors | 136(21.7) | 491(78.3) | 627 | 1 | | |
| 1-2 factors | 93(26.7) | 255(73.3) | 348 | 1.31 | 0.97-1.78 | 0.07 |
| ≥3 risk factors | 29(42.0) | 40(58.0) | 69 | 2.61 | 1.56-4.37 | 0.001 |
| **$\chi^2$=14.95, df=2, P=0.001** | | | | | | |
| **Health problems during second trimester** | | | | | | |
| Medical illness | 83(35.3) | 152(64.7) | 235 | 2.22 | 1.61-3.08 | 0.001 |
| Obstetric problems | 33(37.5) | 55(62.5) | 88 | 2.44 | 1.53-3.91 | 0.001 |
| None | 142(19.7) | 579(80.3) | 721 | 1 | | |
| **$\chi^2$=31.70, df=2, P=0.001** | | | | | | |
| **Health problems during third trimester** | | | | | | |
| Medical illness | 66(30.4) | 151(69.6) | 217 | 2.04 | 1.42-2.92 | 0.001 |
| Obstetric problems | 91(35.8) | 163(64.2) | 254 | 2.60 | 1.86-3.64 | 0.001 |
| None | 101(17.6) | 472(82.4) | 573 | 1 | | |
| **$\chi^2$=36.12, df=2, P=0.001** | | | | | | |

Low birth weight was observed amongst 136(21.7%) babies of the mothers who did not have any risk factors, 93(26.7%) babies of those who had 1-2 risk factors and 29(42.0%) babies of the mothers who had ≥3 risk factors during pregnancy. A statistically significant difference was observed in the proportion of LBW babies by the presence of one or more risk factors in mothers. There was 2.61 times higher risk of

delivering LBW babies by the mothers who had ≥3 risk factors in contrast to those who did not have any risk factors (P=0.001).

**Figure 4.6.1.4: Association between high risk factors during pregnancy and birth weight of newborns**




Out of 235 mothers who had medical illness during second trimester of pregnancy, 83(35.3%) had delivered LBW babies. Similarly, 33(37.5%) mothers who had obstetric problems and 142(19.7%) who did not have any health problems had delivered LBW babies respectively. There was significant association between birth weight and existence of health problems (P=0.001). Risk of LBW amongst the babies of mothers who had medical illness and obstetric problems had 2.22 and 2.44 times higher than the babies of mothers who did not have any illness during second trimester (P=0.001). Significantly higher proportion of the LBW babies were born to the mothers who had

medical illness (OR=2.04) and obstetric problems (2.60) when compared to those mothers who did not have any illness during third trimester.

**Table 4.6.1.13: Association between pregnancy induced hypertension and birth weight of newborns**

| PIH status (n=1044) | Birth weight | | Total | OR | CI | P value |
|---|---|---|---|---|---|---|
| | <2500gm | ≥2500gm | | | | |
| **PIH during second trimester** | | | | | | |
| Present | 14(50.0) | 14(50.0) | 28 | 3.16 | 1.48-6.72 | 0.002 |
| Absent | 244(24.0) | 772(76.0) | 1016 | 1 | | |
| **$\chi$2=9.88 df=1, P=0.002** | | | | | | |
| **PIH during third trimester** | | | | | | |
| Present | 59(49.6) | 60(50.4) | 119 | 3.58 | 2.42-5.31 | 0.001 |
| Absent | 199(21.5) | 726(78.5) | 925 | 1 | | |
| **$\chi^2$=44.63, df=1, P=0.001** | | | | | | |
| **PIH at the time of delivery** | | | | | | |
| Present | 67(53.2) | 59(46.8) | 126 | 4.32 | 2.94-6.34 | 0.001 |
| Absent | 191(20.8) | 727(79.2) | 918 | 1 | | |
| **$\chi^2$=62.39, df=1, P=0.001** | | | | | | |

Significantly higher proportion of LBW babies were born to the mothers who had PIH during second trimester 14(50.0%), third trimester 59(49.6%) and at the time of delivery 67(53.2%) as against the counterpart normotensive mothers ($p<0.05$). Risk of

delivering LBW babies amongst the mothers who had hypertensive disorders during second trimester (OR: 3.16), third trimester (OR: 3.58) and at the time of delivery (OR: 4.32) was significantly higher than the normotensive mothers respectively.

**Figure 4.6.1.5: Association between PIH during pregnancy and birth weight of newborns**

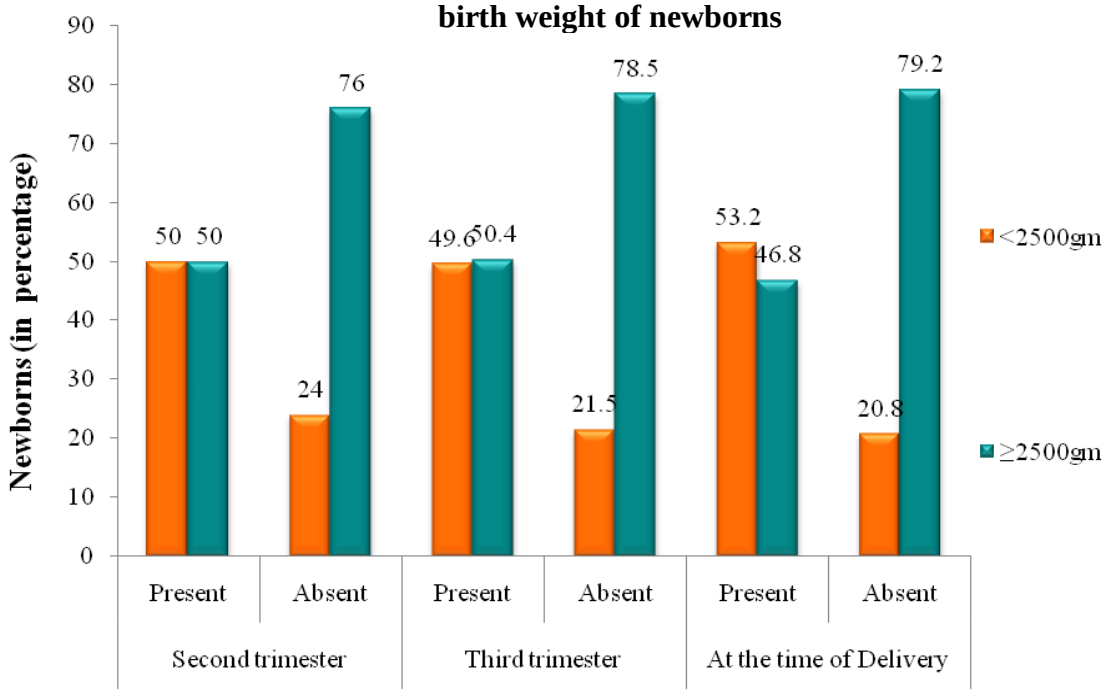


**Table 4.6.1.14: Association between maternal exposure to indoor air pollution and birth weight of newborns**

| Exposure status (n=1044) | Birth weight | | Total | OR | CI | P value |
|---|---|---|---|---|---|---|
| | <2500gm | ≥2500gm | | | | |
| **Type of fuel used** | | | | | | |
| Wood, kerosene | 179(28.8) | 443(71.2) | 622 | 1.75 | 1.30-2.36 | 0.001 |
| Gas, electricity | 79(18.7) | 343(81.3) | 422 | 1 | | |
| **$\chi^2$=13.67, df=1, P =0.001** | | | | | | |
| **Kitchen ventilation** | | | | | | |
| Absent | 85(30.7) | 192(69.3) | 277 | 1.52 | 1.11-2.06 | 0.007 |
| Present | 173(22.6) | 594(77.4) | 767 | 1 | | |
| **$\chi^2$=7.23, df=1, P=0.007** | | | | | | |

There was significant association between type of fuel used (P=0.001), kitchen ventillation and the birth weight of newborn (P=0.007). Almost 179 (28.8%) babies born to the mothers who were wood/kerosene users had LBW as against 79(18.7%) LBW babies of the mothers who were gas/electricity users. Similarly, out of 767 mothers who reported the presence of kitchen ventilation, 173(22.6%) delivered LBW babies whereas significantly higher proportion of LBW babes (30.7%) were born to the mothers who had kitchen without ventilation (P=0.007). Mothers who were the wood/kerosene users had 1.75 times higher risk of giving LBW babies as against those mothers who were gas/electricity users. Likewise, mothers who did not have kitchen ventilation had 1.52 times higher risk of giving birth to LBW babies. None of the pregnant women in the

present study were consuming tobacco and alcohol. There was no statistically significant association between passive smoking and birth weight of newborns (P>0.05).

**Table 4.6.1.15: Association between type of work, rest during pregnancy and birth weight of newborns**

| Type of work (n=1044) | Birth weight | | Total | OR | CI | P value |
|---|---|---|---|---|---|---|
| | <2500gm | ≥2500gm | | | | |
| **Type of work done during pregnancy** | | | | | | |
| Household plus office/field work | 65(46.8) | 74(53.2) | 139 | 3.24 | 2.24-4.68 | 0.001 |
| Household work | 193(21.3) | 712(78.7) | 905 | 1 | | |
| **$\chi^2$=41.90, df=1, P=0.001** | | | | | | |
| **Rest during pregnancy (out of 24 hours)** | | | | | | |
| <8 hours | 135(66.8) | 67(33.2) | 202 | 11.77 | 8.30-16.71 | 0.001 |
| >8 hours | 123(14.6) | 719(85.4) | 842 | 1 | | |
| **$\chi^2$=238.81, df=1, P=0.001** | | | | | | |

Out of 139 pregnant women who had done household plus office/field work during pregnancy had delivered significantly higher proportion of LBW babies 65(46.8%) than those who had household works 193(21.3%). Odds of delivering LBW babies by the household plus office/field worker pregnant women was 3.24 times higher than those mothers who were doing only household works (P=0.001). Out of 202 pregnant women who had taken ≤8 hours rest in a day, 135(66.8%) had delivered LBW

babies whereas 123(14.6%) of the babies born to the mothers who had >8 hours rest had delivered LBW babies. There was multifold higher risk (OR=11.77) of delivering LBW babies by the mothers who had ≤8hours rest/day when compared to those mothers taking more than 8 hours rest (P=0.001).

**Table 4.6.1.16: Association between utilization of antenatal care and birth weight of newborns**

| Utilization of ANC (n=1044) | Birth weight | | Total | OR | CI | P value |
|---|---|---|---|---|---|---|
| | <2500gm | ≥2500gm | | | | |
| **Number of ANC visits** | | | | | | |
| ≤5 | 14(58.3) | 10(41.7) | 24 | 7.54 | 2.99-19.04 | 0.001 |
| 6-10 | 221(25.3) | 652(74.7) | 873 | 1.82 | 1.14-2.92 | 0.01 |
| ≥11 | 23(15.6) | 124(84.4) | 147 | 1 | | |
| **$\chi^2$=21.24, df=2, P =0.001** | | | | | | |
| **Folic acid intake** | | | | | | |
| No | 103(34.2) | 198(65.8) | 301 | 1.97 | 1.46-2.66 | 0.001 |
| Yes | 155(20.9) | 588(79.1) | 743 | 1 | | |
| **$\chi^2$=20.54, df=1, P=0.001** | | | | | | |
| No. **of IFA intake** | | | | | | |
| <100 | 178(45.9) | 210(54.1) | 388 | 6.16 | 4.53-8.39 | 0.001 |
| ≥100 | 79(12.1) | 575(87.9) | 654 | 1 | | |
| **$\chi^2$=149.70,df=1, P=0.01** | | | | | | |
| **Calcium intake** | | | | | | |
| No | 5(55.6) | 4(44.4) | 9 | 3.86 | 1.03-14.49 | 0.03 |
| Yes | 253(24.4) | 782(75.6) | 1035 | 1 | | |
| **$\chi^2$=4.64 (Yates's correction), df=1, P=0.03** | | | | | | |

As depicted in above table, the highest proportion of LBW babies 14(58.3%) were born to the mothers who made ≤5 ANC visits followed by 221(25.3%) LBW babies were born to the mothers who had done 6-10 times ANC visits and the lowest proportion of LBW was observed amongst the babies of the mothers who had ≥11 times ANC visits. This difference observed was statistically significant (P<0.05). One hundred and three (34.2%) mothers who had not taken Folic acid had delivered LBW babies whereas 155(20.9%) of those who had taken folic acid during first trimester of pregnancy had LBW babies. The difference in the proportion of LBW babies by the maternal folic acid intake was statistically significant (P=0.001). Similarly, significantly higher proportion of LBW 178(45.9 %) babies were born to the mothers who had taken <100 tables of IFA during pregnancy as compared to those who had consumed ≥100 tablets (P=0.001). LBW was significantly higher amongst the babies of the mothers who did not take calcium during pregnancy 5(55.6%) when compared to the babies whose mothers had taken Calcium 253(24.4%). Odds of delivering LBW amongst the mothers who did not take folic acid, consumed <100 tablets of IFA and who did not take calcium during pregnancy was 1.97, 6.16 and 3.86 times higher than mothers who had taken IFA, consumed ≥100 tablets of IFA and had taken calcium respectively.

**Table 4.6.1.17: Association between regularity of IFA and Calcium intake and birth weight of newborns**

| Intake status | Birth weight | | Total | OR | CI | P value |
|---|---|---|---|---|---|---|
| | <2500gm | ≥2500gm | | | | |
| **Regularity of IFA intake (n=1042) *** | | | | | | |
| Irregular | 69(59.0) | 48(41.0) | 117 | 5.63 | 3.77-8.72 | 0.001 |
| Regular | 188(20.3) | 737(79.7) | 925 | 1 | | |
| **$\chi^2$=83.5, df=1, P =0.001** | | | | | | |
| **Regularity of Calcium intake(n=1041) *** | | | | | | |
| Irregular | 63(71.6) | 25(28.4) | 88 | 9.85 | 6.04-16.08 | 0.001 |
| Regular | 194(20.4) | 759(79.6) | 953 | 1 | | |
| **$\chi^2$=113.73, df=1, P =0.001** | | | | | | |

**Regular: Missed < 5 doses/month, Intermittent: Missed 5-10 doses/month, Irregular: Missed >10 doses/month*

There was statistically significant difference in the proportion of LBW babies by regularity of IFA and calcium intake by the mothers (P=0.001). Sixty nine (59.0%) mothers who had taken IFA irregularly had delivered LBW babies whereas only 188(20.3%) of the mothers who had taken IFA regularly had delivered LBW babies. Similarly, significantly higher proportion of the LBW babies 63(71.6%) were born to the mothers who had taken Calcium irregularly as compared to the babies born to the mothers who had taken regularly 194(20.4%). There was multifold higher risk of delivering LBW babies amongst those mothers who consumed IFA (OR=5.63) and Calcium (OR=9.85) irregularly (P=0.001) as against those who had taken IFA and Calcium regularly.

**Table 4.6.1.18: Significant predictors of birth weight by the duration of pregnancy**

| Enrollment | I$^{st}$ follow up | II$^{nd}$ follow up | At delivery |
|---|---|---|---|
| Parental height, type of family, religion, maternal age, father's education, socioeconomic status, father's occupation, gravida, type of conception, birth interval, history of preterm, low birth weight, stillbirth, neonatal death, rest, work, kitchen ventilation, folic acid intake. | Diet, calorie and protein intake, maternal weight, types of illness and PIH | Diet calorie, protein, maternal weight, types of illness and PIH | Maternal weight, BMI total weight gain gestational age, Hb, types of illness, PIH, no. of ANC, IFA intake, calcium intake, regularity of IFA and calcium intake |

As shown in the above table, 19 factors were significantly associated with birth weight at the enrollment. In addition to these factors, maternal calorie and protein intake, weight, types of illness and PIH were significant factors associated with the birth weight at first and second followed up. Maternal weight, BMI, total weight gain during pregnancy, gestational age, hemoglobin level, types of illness, PIH, number of ANC visits, IFA intake, Calcium intake; and regularity of IFA and Calcium intake had statistically significant association with birth weight at delivery in addition to the factors that were found to be significant at enrollment.

**Table 4.6.1.19: Correlation between different covariates and birth weight of newborns**

| Variables | R | P value | $r^2$ (%) | Variables | R | P value | $r^2$ (%) |
|---|---|---|---|---|---|---|---|
| Maternal Weight before delivery | 0.22 | 0.001 | 4.84 | Total weight gain during pregnancy | 0.25 | 0.001 | 6.25 |
| Maternal height | 0.20 | 0.001 | 4.00 | Rest in a day | 0.55 | 0.001 | 30.25 |
| Father's height | 0.25 | 0.001 | 6.25 | Calorie intake | 0.69 | 0.001 | 47.61 |
| Father's weight | 0.26 | 0.001 | 6.76 | Protein intake | 0.64 | 0.001 | 40.96 |
| Gestational age | 0.53 | 0.001 | 28.09 | Placental weight | 0.59 | 0.001 | 34.81 |
| No. of ANC visits | 0.21 | 0.001 | 4.41 | Length of baby | 0.81 | 0.001 | 65.61 |

The relationship between quantitative covariates and birth weight was observed by correlation coefficient (r) and the contribution of each of the factors was estimated by the coefficient of multiple determinations ($r^2$). As illustrated in the above table, length of the baby and placental weight had high degree of correlation with the birth weight. These two covariates respectively explained variations in the birth weight by 65.6 percent and 34.8 percent. All the relationships of birth weight with covariates were found to be positive; indicating that increase in the values of covariates increased the birth weight.

# Predictors and Birth weight-Multivariate analysis

### 4.6.2: Predictors and Birth Weight- Multivariate Analysis

### 4.6.2.1 Predictors of Low Birth Weight-Multivariate Logistic Regression

In the present study, out of 58 factors analyzed, 43 potential predictors had statistically significant association with birth weight of newborns in bivariate analysis. After controlling potential confounding factors by multivariate regression analysis, a total of 22 predictors of LBW were identified. All the factors with their corresponding Adjusted Odds Ratio, Confidence Interval and the P values are enlisted in the following tables.

**Table 4.6.2.1.A: Constitutional predictors of low birth weight**

| Predictors | | AOR | CI | P value |
|---|---|---|---|---|
| **Sex of child** | Female | 2.35 | 1.42-3.87 | 0.001 |
| | Male | 1 | | |
| **Maternal height** | <145 | 60.1 | 1.94-186.210 | 0.001 |
| **(in cms)** | 145-154.9 | 4.73 | 2.15-10.36 | 0.01 |
| | ≥155 | 1 | | |
| **Father's height** | ≤157.5 | 14.49 | 2.70-75.60 | 0.001 |
| | >157.5-162.5 | 2.82 | 1.76-6.80 | 0.01 |
| | >162.5 | 1 | | |
| **Maternal weight** | ≤40 | 0.63 | 0.07-5.32 | 0.6 |
| **during second** | 40-50 | 0.70 | 0.13-3.75 | 0.6 |
| **trimester** | 50-60 | 0.69 | 0.20-2.392 | 0.5 |
| | >60 | 1 | | |

**Continue**

| Predictors | | AOR | CI | P value |
|---|---|---|---|---|
| **Maternal weight** | ≤45 | 3.33 | 0.29--38.22 | 0.3 |
| **during third** | 45-50 | 2.13 | 0.25-17.90 | 0.4 |
| **trimester** | 50-55 | 1.32 | 0.22-7.83 | 0.7 |
| | 55-60 | 1.49 | 0.37-5.90 | 0.5 |
| | >60 | 1 | | |
| **Weight before** | ≤45 | 1.24 | 0.36-4.25 | 0.7 |
| **delivery** | 45-50 | 0.83 | 0.09-7.08 | 0.8 |
| | 50-55 | 0.24 | 0.01-3.72 | 0.3 |
| | 55-60 | 0.65 | 0.11-3.74 | 0.6 |
| | >60 | 1 | | |
| **Paternal** | <55 | 3.86 | 0.67-22.14 | 0.1 |
| **weight** | 55-65 | 1.47 | 0.28-7.56 | 0.6 |
| | 65-75 | 0.40 | 0.07-2.22 | 0.2 |
| | >75 | 1 | | |
| **Maternal BMI** | <18.5 | 1.23 | 06-23.31 | 0.8 |
| **before** | 18.5-23 | 0.29 | 0.06-1.41 | 0.1 |
| **delivery** | 23.0-27.5 | 0.51 | 0.16-1.60 | 0.2 |
| | >27.5 | 1 | | |

Sex of the babies and parental height were identified as significant constitutional predictors of LBW. Risk of having LBW amongst the female newborns was 2.35 times higher than male newborns (CI: 1.42-3.87). Similarly, mothers who had <145cms and

145-154.9cms height had 60.1times (CI: 1.94-186.21) and 4.73 times (CI: 2.15-10.36) higher risk of delivering LBW babies when compared to the mothers who had ≥155cms height respectively. There was multifold (AOR: 14.49, CI: 2.79-75.60) higher risk of having LBW amongst the babies whose fathers had ≤157.5cms height and almost three fold (AOR: 2.82, CI: 1.76-6.80) higher risk amongst the babies whose fathers had >157.5-162.5cms height as against those whose fathers height was >162.5cms.

**Table 4.6.2.1.B: Socio-demographic predictors of low birth weight**

| Predictors | | AOR | CI | P value |
|---|---|---|---|---|
| **Maternal Age** | <20 | 21.7 | 3.51-133.92 | 0.001 |
| **(in years )** | ≥20 | 1 | | |
| **Paternal education** | ≤ 5th grade | 2.50 | 0.50-12.40 | 0.26 |
| | 6-10th grade | 1.61 | 0.87-2.97 | 0.12 |
| | Higher Education | 1 | | |
| **Paternal occupation** | Agriculture | 1.65 | 0.91-2.97 | 0.09 |
| | Driving | 4.54 | 1.71-12.12 | 0.002 |
| | Labor | 2.94 | 1.54-5.58 | 0.001 |
| | Service/ Business | 1 | | |
| **Socio-economic status** | I and II class | 1 | | |
| | II | 0.62 | 0.25-1.48 | 0.28 |
| | IV and V class | 0.68 | 0.25-1.83 | 0.45 |
| **Religion** | Hindu | 1.40 | 0.59-3.63 | 0.40 |
| | Christian and Jain | 1.80 | 031-11.33 | 0.49 |
| | Muslim | 1 | | |
| **Type of family** | Joint | 1.97 | 0.91-6.21 | 0.08 |
| | Nuclear | 1 | | |

Risk of delivering LBW babies amongst the adolescent mothers was 21.7 times (CI: 3.51-133.92) higher than those pregnant women above 20 years of age. Those newborns whose fathers were drivers and laborers had 4.54 times (CI: 1.71-12.12) and 2.94 times (CI: 1.54-5.58) higher risk of having LBW than the babies whose fathers were service holders or business people.

**Table 4.6.2.1.C: Obstetric predictors of low birth weight**

| Predictors | | AOR | CI | P value |
|---|---|---|---|---|
| **Gravidity** | Primigravida | 6.59 | 2.82-15.38 | 0.001 |
| | Multigravida | 1 | | |
| **Gestation at delivery** | Preterm (<37 ) | 22.35 | 9.76-51.20 | 0.001 |
| | Full term (≥37 ) | 1 | | |
| **Type of conception** | ART and treatment | 3.39 | 1.26-9.09 | 0.01 |
| | Spontaneous | 1 | | |
| **History of preterm delivery** | Present | 3.99 | 1.46-10.87 | 0.001 |
| | Absent | 1 | | |
| **History of low birth weight** | Present | 5.31 | 2.81-9.78 | 0.02 |
| | Absent | 1 | | |
| **History of stillbirth** | Present | 0.6 | 0.02-1.65 | 0.09 |
| | Absent | 1 | | |
| **History of neonatal death** | Present | 6.47 | 2.03-20.64 | 0.002 |
| | Absent | 1 | | |
| **Inter-pregnancy interval** | <12 months | 0.45 | 0.04-4.67 | 0.51 |
| | 12-24 months | 0.33 | 0.09-12.75 | 0.50 |
| | >24 months | 1 | | |

Primigrvida had almost seven times higher risk of giving birth to LBW babies against the multigravida (CI: 2.82-15.38). Preterm births had 22.3 times higher risk of LBW when compared to the babies born at full term (CI: 9.76-51-20). Similarly, the odds of delivering LBW babies amongst the mothers who had conceived through artificial reproduction or conceived after medical management of sub fertility had 3.39 times (CI: 1.26-9.09) higher risk of giving birth to LBW babies as against those who conceived spontaneously. The mothers who had history of preterm delivery (AOR:3.99; CI: 1.46-10.87), low birth weight (AOR:5.31;CI: 2.81-9.78) and neonatal death (AOR:6.47; 2.81-9.78) had higher risk of delivering LBW babies as compared to those who did not have any history of these bad outcomes.

**Table 4.6.2.1.D: Nutritional predictors of low birth weight**

| Predictors | | AOR | CI | P value |
|---|---|---|---|---|
| **Weight gain during Pregnancy** | ≤4Kg | 1.64 | 0.37-7.26 | 0.5 |
| | 4.1-6Kg | 1.41 | 0.54-3.70 | 0.4 |
| | 6.1-8Kg | 1.37 | 0.69-2.74 | 0.3 |
| | >8 | 1 | | |
| **Maternal hemoglobin before delivery** | <9 | 0.58 | 0.17-1.96 | 0.3 |
| | 9-10.99 | 1.02 | 0.58-1.79 | 0.9 |
| | ≥ 11 | 1 | | |
| **Caloric intake/day** | 50-69% of RDA | 14.32 | 4.59-44.63 | 0.001 |
| | >69% of RDA | 1 | | |
| **Protein intake/day** | 50-89% of RDA | 4.11 | 1.36-12.43 | 0.01 |
| | >89% of RDA | 1 | | |
| **Type of diets** | Vegetarian | 0.79 | 0.43-1.44 | 0.4 |
| | Non vegetarian | 1 | | |

The mothers who had low calorie (<69% of RDA) and protein intake/day (<89% of RDA) had 14.32 times (CI: 4.59-44.63) and 4.11times (CI: 1.36-12.43) higher risk of delivering LBW babies respectively as against those mothers who had daily consumption of high quantity (>69% of RDA) of calories and proteins (>89% of RDA).

**Table 4.6.2.1.E: Maternal risk/illness related predictors of low birth weight**

| Predictors | | AOR | CI | P value |
|---|---|---|---|---|
| **Number of high risk factors** | 1-2 | 3.70 | 1.70-8.06 | 0.001 |
| | ≥3 | 10.43 | 3.35-32.44 | 0.001 |
| | None | 1 | | |
| **PIH at the time of delivery** | Present | 11.4 | 1.88-69.07 | 0.008 |
| | Absent | 1 | | |

Risk of LBW amongst the babies whose mothers had 1-2 high risk factors and (≥3 high risk factors was 3.70 times (CI: 1.70-8.06) and 10.43 times (CI: 3.35-32.44) higher than the babies whose mothers did not have any risk factors during present pregnancy. Similarly, those mothers who had PIH during pregnancy had 11.4 time (CI: 1.88-69.07) higher risk of delivering LBW babies than the normotensive mothers.

**Table 4.6.2.1.F: Exposures and life style related predictors of low birth weight**

| Predictors | | AOR | CI | P value |
|---|---|---|---|---|
| **Type of fuel used** | Wood, kerosene | 0.89 | 0.43-1.87 | 0.77 |
| | Wood, gas | 1.22 | 0.63-2.34 | 0.54 |
| | Gas, electricity | 1 | | |
| **Kitchen ventilation** | Absent | 1.99 | 1.17-3.37 | 0.001 |
| | Present | | | |
| **Rest during pregnancy** | ≤8 hours | 7.20 | 4.11-12.62 | 0.001 |
| **(out of 24 hours)** | >8 hours | 1 | | |
| **Work during pregnancy** | Household plus | 2.02 | 0.89-4.64 | 0.08 |
| | office/field work | 1 | | |
| | Household work | | | |

The mothers who did not have proper kitchen ventilation had almost two times (CI: 1.17-3.37) higher risk of delivering LBW babies when compared with those mothers who had appropriate kitchen ventilation (smoke vent and window). Similarly, those mothers who had ≤8 hours daily rest during pregnancy had 7.20 times (CI: 4.11-12.62) greater risk of delivering LBW babies when compared to the mothers who had taken >8 hours/day rest during pregnancy.

**Table 4.6.2.1.G: ANC service utilization related predictors of low birth weight**

| Predictors | | AOR | CI | P value |
|---|---|---|---|---|
| **Number of antenatal visits** | ≤5 | 3.80 | 0.71-20.87 | 0.11 |
| | 6-10 | 1.26 | 0.53-3.01 | 0.59 |
| | ≥11 | 1 | 1 | |
| **Folic acid intake** | No | 1.70 | 1.03-2.82 | 0.03 |
| | Yes | 1 | | |
| **Intake of IFA tablets** | <100 | 4.5 | 2.53-7.99 | 0.001 |
| | ≥100 | 1 | | |
| **Regularity of IFA intake** | Irregular | 5.61 | 2.09-15.00 | 0.001 |
| | Regular | 1 | | |
| **Calcium intake** | No | 12.45 | 1.07-144.39 | 0.04 |
| | Yes | 1 | | |
| **Regularity of Calcium intake** | Irregular | 76.9 | 6.45-91.96 | 0.001 |
| | Regular | 1 | | |

*(Nagelkerke $R^2$ (%) =74.1, -2 log likelihood = 111.81)*

Those pregnant women who did not take folic acid during first trimester of pregnancy had 1.70 times (CI: 1.03-2.82) higher risk of giving birth to LBW babies than those who had taken folic acid. Odds of occurrence of LBW amongst the babies whose mothers had taken <100 tablets of IFA and who had taken IFA on irregular basis was 4.5 times (CI: 2.53-7.99) and 5.61 times (CI: 2.09-15.00) higher than the babies whose mothers had taken ≥100 tablets of IFA and who had taken IFA regularly respectively. Similarly, there was multifold (AOR: 12.45; CI: 1.07-144.39) higher risk of LBW amongst the babies of mothers who did not take calcium during pregnancy as against

those who had taken Calcium. Amongst those who had taken Calcium tablets, there was 76.96 times (CI: 6.45-91.96) greater risk of delivering LBW babies when the intake was irregular as against those mothers who had taken Calcium supplements as prescribed.

As shown in the above tables (table 4.6.2.1.A-G), a total of 22 predictors of low birth weight such female newborn, maternal height <155cms, paternal height <162.5cms, maternal age less than 20 years, paternal occupation such as laborer and drivers, history of LBW, preterm birth and neonatal death, ART/conception after treatment, primigravida, preterm birth, Calorie consumption <69 percent of RDA, protein consumption <89 percent of RDA, presence of one or more high risk factors during pregnancy, PIH, poor kitchen ventilation, total rest <8 hours in a day, no intake of Folic acid and Calcium tablets during pregnancy, consumption of <100 tablets of IFA; and irregular consumption of IFA and Calcium were identified in this study. These 22 predictors explained 74.1 percent variation in the birth weight of newborns.

Although, maternal weight during pregnancy (second trimester, third trimester and just before delivery), father's weight and education; maternal BMI, socioeconomic status, religion, history of stillbirth, inter-pregnancy interval, weight gain during pregnancy, maternal hemoglobin level before delivery, type of diets, types of illness during pregnancy, types of fuel used, work done during pregnancy and number of antenatal visits were found to be statistically significant factors affecting birth weight of newborns in the bivariate analysis, none of these factors were found to be the real predictors of LBW by multivariate analysis (table 4.6.2.1.A-G); as the confounding factors have controlled.

### 4.6.2. 2. Combined effects of the selected predictors on birth weight of newborns- Multivariate Linear Regression

The combined effects of selected significant predictors of birth weight were estimated by multivariate linear regression analysis. A birth weight prediction formula was developed using eight significant predictors of birth weight which is mentioned in the table given below.

**Table 4.6.2.2: Birth weight by nutrition status/ IFA and Calcium intake, gestational age, rest and paternal anthropometry**

| Predictors | Beta coefficient | P Value | Confidence Interval | | Summary statistics |
|---|---|---|---|---|---|
| | | | Lower | Upper | |
| Constant | -5174.12 | 0.001 | -6004.690 | -4343.558 | $R^2$=63.3% |
| Duration of IFA intake (in months) | 5.15 | 0.66 | -18.126 | 28.433 | F=196.71, P=0.001 |
| Duration of Calcium intake (in months) | 25.31 | 0.04 | 1.120 | 49.501 | |
| Gestation age (weeks) | 77.87 | 0.001 | 66.664 | 89.085 | |
| Calorie intake (Kcal) | 0.92 | 0.001 | 0.825 | 1.024 | |
| Rest hours /day | 114.37 | 0.001 | 90.281 | 138.478 | |
| Maternal height (cms) | 6.50 | 0.001 | 2.903 | 10.112 | |
| Father's height (cms) | 3.44 | 0.10 | -.668 | 7.557 | |
| Father's weight (Kgs) | 3.83 | 0.01 | .655 | 7.013 | |

Predicted birth weight=-5174.12+5.15(duration of IFA intake) + 25.31(duration of calcium intake) + 77.87(gestation age at delivery) + 0.92(calorie) + 114.37(rest hours/day) +6.50(maternal height) + 3.44(paternal height) + 3.83(paternal weight).

As indicated in the above table, combined effects of nutrition status/IFA and Calcium intake, gestational age, rest and paternal anthropometry on birth weight was found to be 63.3 percent. The maximum contribution was by the maternal rest during pregnancy and minimum due to calorie consumption. Increase in unit calorie consumption increased birth weight by 0.92gms whereas increase by one hour rest in a day resulted in 114.37gms increase in the birth weight.

## 4.7 Development of antenatal risk scoring tool

Although, 22 predictors of LBW have been identified in this study, the antenatal risk scoring tool was developed using following 14 predictors of LBW. These predictors were selected on the basis of feasibility, simplicity and usefulness of information.

**Predictors used to develop an antenatal Risk scoring Tool**

1. Maternal age
2. Maternal height
3. Paternal height
4. Type of conception
5. Gravidity
6. Number of high risk factors
7. PIH
8. Gestation age
9. Folic acid intake
10. Calcium intake
11. IFA intake regularity
12. Calcium intake regularity
13. Kitchen ventilation
14. Rest during Pregnancy

**Table 4.7.1: Predictors of low birth weight and risk scores**

| Predictors | | AOR | Risk scores |
|---|---|---|---|
| **Maternal height** | <145 | 60.1 | 3 |
| | 145-154 | 4.73 | 2 |
| | ≥155* | | 0 |
| **Father's height** | ≤157.5 | 14.49 | 3 |
| | >157.5-162.5 | 2.82 | 1 |
| | >162.5* | | 0 |
| **Maternal age** | <20 | 21.7 | 3 |
| | ≥20* | | 0 |
| **Presence of high risk** | None* | | 0 |
| **factors** | 1-2 | 3.70 | 1 |
| | ≥3 | 10.43 | 2 |
| **Gravida** | Primi | 6.59 | 2 |
| | Multi* | | 0 |
| **Gestation age** | <37 | 22.35 | 3 |
| **(in weeks)** | ≥37 | | 0 |
| **PIH** | Present | 11.2 | 2 |
| | Absent* | | 0 |
| **Type of conception** | ART/treatment | 3.39 | 1 |
| | Spontaneous* | | 0 |

**Continue**

| Predictors | | AOR | Risk scores |
|---|---|---|---|
| **Kitchen ventilation** | Absent | 1.99 | 1 |
| | Present* | | 0 |
| **Rest (in hours)/day** | <8 | 7.22 | 2 |
| | ≥8* | | 0 |
| **Folic acid intake** | No | 1.70 | 1 |
| | Yes* | | 0 |
| **Calcium intake** | No | 12.45 | 2 |
| | Yes* | | 0 |
| **Regularity of IFA intake** | Irregular | 5.61 | 2 |
| | Regular* | | 0 |
| **Regularity of** | Irregular | 76.96 | 3 |
| **Calcium intake** | Regular* | | 0 |

*Note: Reference (*) categories of all predictors are assigned zero score.*

*(Scores: AOR: 1-3.99=1, 4-12.45=2, >12.45=3 were assigned)*

For developing the risk scoring tool, the selected predictors were assigned risk scores 0-3 depending upon adjusted odds ratio.

**Table 4.7.2: Association between maternal cumulative risk scores in the present pregnancy and birth weight of newborns**

| Cumulative risk scores | Birth weight | | Total |
|---|---|---|---|
| | <2500gm | ≥2500gm | |
| 0-3 | 10(2.7) | 366(97.3) | 376 |
| 4-7 | 89 (19.3) | 371(80.7) | 460 |
| 8-11 | 111(70.3) | 47(29.7) | 158 |
| ≥12 | 46(100.0) | 0(0.0) | 46 |
| Total | 256(24.7) | 784(75.3) | 1040 |
| **$\chi^2$ =422.77, df=3, P=0.001; Spearman's correlation coefficient = -0.62** | | | |

Cumulative risk scores were estimated after assigning risk scores to each of the variables. The risk scores ranged 0-30. These cumulative risk scores were applied to the pregnant women in the present study. The results showed that proportion of LBW babies was 2.7 percent when the maternal cumulative risk scores were 0-3. When the risk scores were 4-7, 19.3 percent mothers had delivered LBW babies and 70.3% LBW babies were born to the mothers who had cumulative risk scores 8-11. Hundred percent mothers who had cumulative risk scores ≥12 had delivered LBW babies. The difference in the proportion of LBW by the maternal cumulative risk scores was statistically significant (p=0.001) and there was high degree of negative correlation (r = -0.62) between the birth weight and the risk scores. As the cumulative risk scores increased, chances of babies being born with normal weigh decreased (p=0.001).

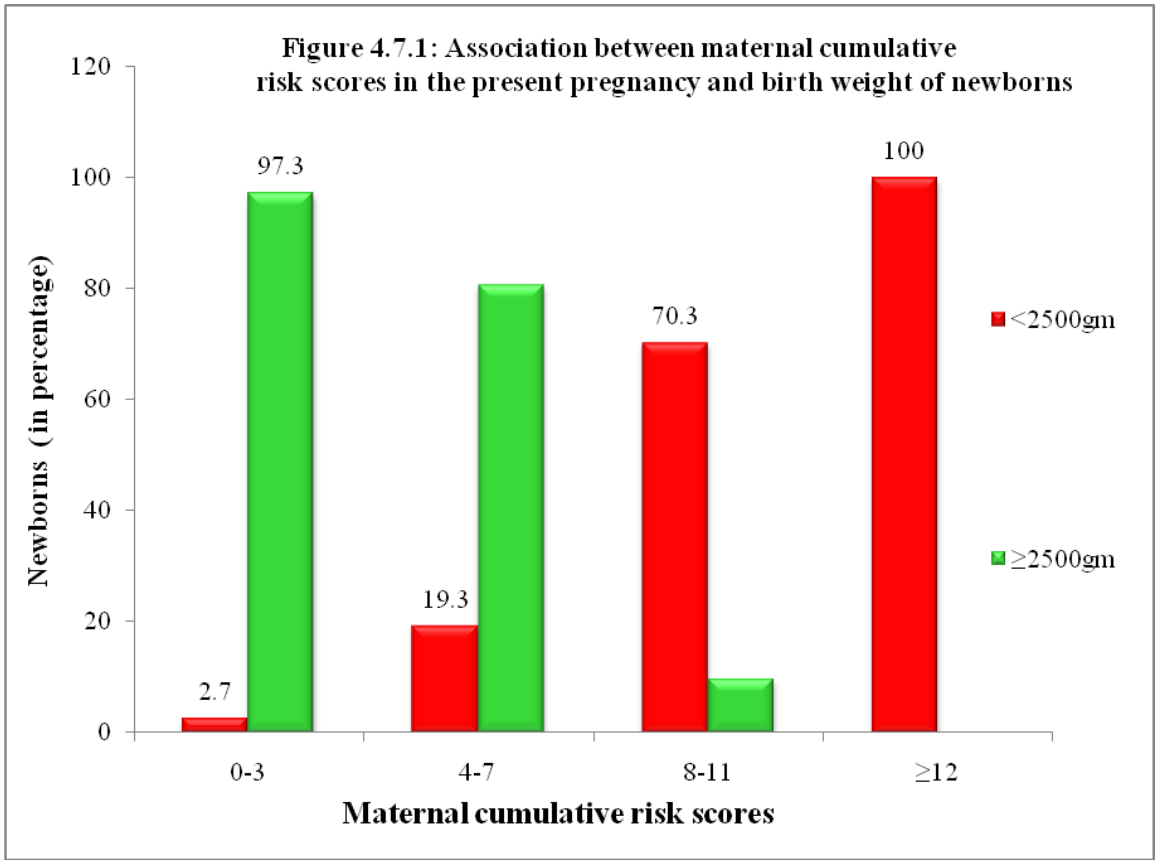



**Table 4.7.3: Validity of the antenatal risk scoring tool**

| Risk scores | TP | FP | TN | FN | Sen. | SP. | PPV | NPV | AOC (95% CI) |
|---|---|---|---|---|---|---|---|---|---|
| ≥1 | 256 | 746 | 38 | 0 | 100.0 | 4.8 | 25.5 | 100.0 | 52.4(48.5-56.4) |
| ≥3 | 252 | 557 | 227 | 4 | 98.4 | 29.0 | 31.1 | 98.3 | 63.7(60.2-67.2) |
| ≥5 | 229 | 265 | 519 | 27 | 89.5 | 66.2 | 46.4 | 95.1 | 77.8(74.8-80.9) |
| **≥6** | **211** | **159** | **625** | **45** | **82.4** | **79.7** | **57.0** | **93.3** | **81.1(77.9-84.2)** |
| ≥7 | 192 | 103 | 681 | 64 | 75.0 | 86.9 | 65.1 | 91.4 | 80.9(77.5-84.3) |

*Note: TP: True Positives, FP: False Positives, TN: True Negatives, FN: False Negatives, Sen: Sensitivity, SP: Specificity, PPV: Positive Predictive Values, NPV Negative Predictive Values, AOC: Areas under curve*

Validity of the risk scoring tool that was developed in the present study was assessed by comparing cumulative risk scores and the factual birth weight. As shown in the above table, when the cumulative risk scores were increasing, the sensitivity of the tool was decreasing and the corresponding specificity was increased. The optimum sensitivity (82.4%) and the specificity (79.7%) were obtained when the cumulative cutoff risk scores were ≥6. At the cumulative cutoff risk scores, the positive and NPV of the tool were 57.0 percent and 93.3 percent respectively wherein the maximum area under Receiver's Operating Characteristic curve (ROC) was 81.1 percent (CI: 77.9-84.2%). The optimum cutoff risk score was estimated by plotting sensitivity in Y axis and the 1-specificity in the x-axis which is shown in figure 4.7.2.

**Figure 4.7. 2: ROC curve showing sensitivity, specificity and Area under curve**

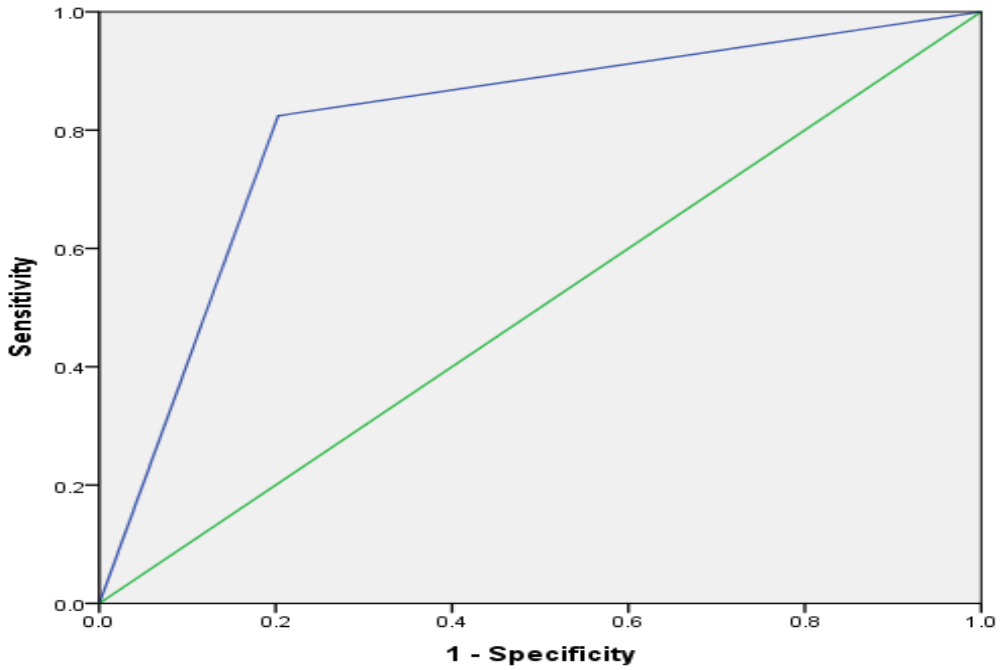


**Figure 4.7.3: Risk scoring tool developed in the present study**

**Name of pregnant woman:** **Date:**

| Particulars | Score category | Score Assigned | Risk scores and color Zone | |
|---|---|---|---|---|
| | | | ≥12 | |
| Age | ≥20 years =0, <20=3 | | | |
| Height | >155=0, 145-155=2, <145=3 | | 11 | |
| Husband's height | >162.5=0, 157.5-162.5=1, ≤157.5=3 | | 10 | |
| Gravida | Multi=0, Primi=2 | | 9 | |
| Gestational age | ≥37 weeks=0, <37 weeks=3 | | 8 | |
| High Risk factors * | None=0, 1-2 factors =1 ≥3 factors =2 | | 7 | |
| PIH | No=0, Yes=2 | | 6 | |
| Type of Conception | Spontaneous=0, ART/treatment =1 | | 5 | |
| Kitchen ventilation | Yes=0, no=1 | | 4 | |
| Rest during pregnancy/day | ≥8 hours=0, <8 hrs=2 | | 3 | |
| Folic acid taken | Yes=0, no=1 | | 2 | |
| Calcium intake | Yes=0, no=2 | | 1 | |
| Regularity of IFA | Regular/intermittent=0 Irregular=2 | | 0 | |
| Regularity of Calcium | Regular/intermittent =0, irregular=3 | | ↑ CRS | 5+ 6+ 7+ 8+ Gestation Period (in months) |
| Total Scores Obtained | | | | |

*Note: CRS: Cumulative risk scores*

* *APH, Hypermesis, spotting/PV bleeding, oligo/polyhydramnios, Hemorrhoid, UTI, gastritis, toxoplasmosis, hypothyroidism, viral infection (hepatitis, chickenpox), seizures, , systematic diseases(renal, cardiac, respiratory), Hemoglobin<7gm%, Primi<18 years, height<140 cm, elderly primi and Grand-Multiparity*

# DISCUSSION

# DISCUSSION

A research entitled "Predictors of birth weight: a prospective study at tertiary care hospital of Belgaum, Karnataka, India" was conducted at Dr. Prabhakar Kore Charitable Hospital (DRPKCH), Belgaum to identify predictors of birth weight and to develop an antenatal risk scoring tool to identify the maternal risk of delivering LBW baby. A total of 1,235 eligible pregnant women were attending the ANC OPD of DRPKCH before twenty weeks of gestation. Out of them, 1,044 mothers delivered singleton live births in the study hospital; and the data of these mother-newborn pairs were analyzed. Findings of the study are discussed in the light of objectives.

## 5.1 Socio-demographic and anthropometric characteristics of pregnant women

In the present study, almost nine out of every ten pregnant women were of 20-29 years old with majority (57.2%) being 20-24 years and their mean age was 23.5±3.4 years (table 4.1.1). These findings are consistent with several Indian and international studies.[36, 81,106,120,128] A study from Belgaum, India has reported that 95 percent of the mothers who delivered at Primary Health Center were 20-29 years old.[145] The proportion of pregnant women who were of 20-24 years old in our study were higher than that reported in the studies from Nigeria, Malawi; and two studies from Dehradun and Jaipur India.[100,111,139,150] The mean age of the pregnant women in our study was almost 4 years lesser than that reported by a Nigerian study and slightly lesser than the findings of a study conducted in Dehradun, India; whereas it is similar to a study conducted in Belgaum, India.[100,120,128] Almost 99 percent of the pregnant women in the present study were literates; out of which majority (61.5%) had secondary education and almost a

quarter of them had studied upto Pre-University level (table 4.1.1). Similar educational status was observed among the pregnant women in a Nigerian study where almost all pregnant women were literates and half had tertiary education.[100] Literacy level of participants in the present study was higher than that reported in several studies from Pakistan and India.[94,122,128,142,145,148-150] Higher literacy status in our study could be because of the high level of female literacy in Karnataka (68.1%) when compared with the average of India (65.4%).[167]

Almost all pregnant women (97.0%) were housewives. These findings are in agreement with several studies conducted in Nigeria, Pakistan, Bangladesh and India where most of the pregnant women were housewives.[94,100,106,128,139,142,149] Moreover, these results are consistent with the studies conducted at Pune and Dehradun where, the percentage of housewives was more than 90 percent.[139,149] This could be because more than sixty percent of the pregnant women in the present study were from rural areas and majority belonged to $IV^{th}$ and $V^{th}$ class. Amongst these people, it is a cultural norm for the women to remain at home.

Most of the pregnant women (84.6%) were Hindus (table 4.1.2). This finding is similar to that of a Belgaum study.[128] Similarly, studies conducted in West Bengal and Belgaum, India showed majority of Hindus whereas more than 94 percent pregnant women attending ANC were Muslims in Bangladesh.[106,122,145] Majority of the population in Karnataka are Hindus whereas Muslims were in majority in Bangladesh. This could be because of religious differentiation. Majority of the pregnant women

(85.3%) were from joint families. This was higher when compared with the studies conducted in different parts of India.[102,122,128,150] Almost a quintile of the pregnant women reported a consanguineous marriage which is endorsed by the findings of a study conducted in Belgaum.[128] Almost three-fifths of the pregnant women were from rural and two-fifths were from urban areas. Proportion of pregnant women who were from rural area in a Meerut study (71.0%) was higher than our study and lower than that reported in Dehradun (50.0%).[139.142] This variation could be due to the difference in the preferences and access to tertiary care hospital for ANC and delivery services; and the catchment area of health facility. Majority of the pregnant women (67.7%) in the present study were from low SES belonging to IV$^{th}$ and V$^{th}$ class according to the BG Prasad's classification system (table 4.1.3). This finding upholds the results of several other studies undertaken in Meerut, Mysore and Belgaum, India and a study conducted in Bangladesh.[106,128,142,148] Although it is a private hospital, as it is charitable, the services are utilized by people from low socioeconomic status.

In the present study, almost equal number of pregnant women (32%) were of height between 145-150cms and 150-155cms. Eight percent of the pregnant women had ≤145cms height. Mean height of pregnant women was 152.7±5.3cms (table 4.1.4). Almost ten percent of the pregnant women in a Bangladesh study were of height less than 145cms.[106] This difference could be because of nutritional or constitutional factors. Mean height of the participants was slightly higher than that reported in Bangladesh and was almost two centimeters lesser than that observed in Manglore study.[106,117] More than seventy percent pregnant women in our study had ≤50Kgs weight at enrollment

and a quintile weighed ≤40Kgs. The mean weight at the enrollment was 46.98±7.5Kgs. Almost four out of every five pregnant women had ≥50Kgs weight before delivery while 5.7 percent mothers had weight <45Kgs before delivery. Proportion of mothers who had more than 45Kgs weight before delivery was higher than that observed in Belgaum.[128] Higher proportion of mothers who had ≥45Kgs weight might be due to the compliance to ANC and relatively better nutritional status during pregnancy. Mean weight of participants before delivery was 56.27±7.9Kgs which is similar to the findings of Belgaum study.[128] About two-thirds (65.9%) of the pregnant women at enrollment had normal or higher BMI whereas almost all pregnant women (98.6%) before delivery had normal or higher BMI. On the other hand, more than one-third of the pregnant women at enrollment and 1.4 percent women before delivery were underweight (table 4.1.5 and figure 4.1.1). Proportion of underweight pregnant women at the enrolment was higher than that reported in a study from Belgaum, whereas it was almost equal before delivery.[128] It indicates that there was higher proportion of mothers who had normal weight gain during pregnancy as compared to the study from Belgaum. Increase in BMI was due to the weight gain during pregnancy.

In the present study, 62.7 percent of the pregnant women had total weight gain more than 8Kgs during pregnancy (table 4.1.6 and figure 4.1.2). Although, on an average, a pregnant woman should gain 11Kgs weight during pregnancy[9]; mean weight gain in our study was 9.28±2.8Kgs. This weight gain during pregnancy in our study was better when compared with two studies from Karnataka.[116,128] Better weight gain during

pregnancy in the present study could be due to the better in the nutritional status and better utilization of ANC services.

Majority of the participant's husbands (78.6%) were of 25-34 years old and their mean age was 30.1±4.5 years. This could be due to the fact that most of the males in India get married at the age of 25 to 30 years. More than 95 percent of the participant's husbands had secondary and higher education (table 4.1.7). This finding is in agreement with a study from Belgaum where majority of the participant's husbands had secondary and higher education.[128] The higher level of educational achievements among husbands than the wives was because of preference for male education and early bearing of household responsibilities among females in India. About 52.8 percent of the husbands were either doing service or business (including personal Auto-rickshaw driving) whereas remaining 47.3 percent were laborers or farmers. This cosmopolitan distribution of the husband's occupation could be due to the diversity in work skills, literacy and personal preferences. Females were shouldering household responsibilities and their husbands were breadwinners in the family.

Slightly less than half of the participant's husbands had 165-175cms height (table 4.1.8). The mean height of husbands was 166.85±5.19cms which is almost similar to the height of Indian reference man (1.7meters).[51,55] Almost three-fifths (59.8%) of the husbands had more than 60Kgs weight whereas two-fifths of them had lower weight than the weight of an Indian reference man (60Kgs).[51,55]

## 5.2 Exposures and Life style of pregnant women

Almost three-fifths of the pregnant women were biomass fuel (wood/cow dung) users which is consistent with the findings of a study carried out in Belgaum.[128] Only 29.3 percent of the pregnant women in the present study reported the existence of smoke vent in the kitchen and almost three-fourths (73.7%) of them reported presence of window in the kitchen. Belgaum study showed that almost 56 percent mothers had poor kitchen ventilation.[128] Absence of smoke vent and window in kitchen results in poor ventilation.[128]

None of the pregnant women were consuming tobacco. This finding is consistent with the institution based studies from Nepal; however, it differs from the findings of a study carried out in Belgaum where 4.3 percent of the pregnant women were consuming tobacco.[128] Passive smoking was reported by 23.4 percent pregnant women in the present study which is similar to that of Belgaum study.[128]

Although 97 percent were housewives, 86.7 percent were limiting the household activities during pregnancy as it is customary in Indian families. Almost seventy percent pregnant women were having more than two hours rest during day time whereas almost three percent were not taking any rest in the afternoon. The rest taking practices observed in our study was better than that reported in a study from Belgaum where majority had taken less than two hours rest and 17.4 percent did not have any rest in the afternoon.[128] The improved rest taking practices observed in our study could be because

of participant's residential differences and domestic help which they might have obtained as majority were from joint families

.

### 5.3 Reproductive and obstetric characteristics of pregnant women

In the present study, about one–third of the multigravida pregnant women had history of Cesarean section, 23.2 percent had abortion, 17.8 percent had delivered LBW babies and 16.8 percent had preterm delivery in earlier pregnancy and childbirth. Similarly, one in every ten mothers had history of delivery of stillbirth and another almost equal number of pregnant women reported the history of deaths of their neonates (table 4.3.1). These figures are notably higher than that observed in Belgaum study.[128] This observed difference could be because of the differences in data sources where data from tertiary care hospital show higher proportion of risk factors as the high risk pregnant women are referred to these hospitals. Further, the mothers who had poor pregnancy outcomes in preceding childbirth had higher tendency to deliver at tertiary care hospital whereas majority of the low risk group mothers deliver at PHC in Karnataka. Despite the above different observations, similar outcomes were reported among the pregnant women in a hospital based study from Dehradun.[120]

Slightly less than half (48.5%) of the pregnant women in our study were married before the age of 20 years and 43.8 percent were married when they were of 20-24 years old (table 4.3.2). Amongst those who had early marriage (<20 years), almost fifty percent become pregnant before 20 years of age. Likewise, amongst all pregnant women, more than three-fifths (62.7%) had first conception during 20-24 years of age.

Mean age at marriage and first pregnancy was 20.1±2.7years and 21.3±2.7years respectively. Average age at marriage in our study was more than that of Jaipur (median age: 17.2 years) and Belgaum (18.9±2.1 years) studies.[128,150] Higher age at marriage in our study could be due to improved female literacy, enactment of legal age at marriage and social transformation in urban areas. Age at first pregnancy has been similar to that of Belgaum and Mysore studies and higher than Jaipur study.[128,148,150]

In the present study, about two-fifths of the pregnant women were primigravida. Similar observations were made in Dehradun, Belgaum and Jaipur.[120,128,145] As against this, more than 60 percent pregnant women in Nagpur study and more than fifty percent in an Ethiopian study were primigravida.[36,112] About 3.4 percent of the pregnant women in our study conceived either by ART or after the treatment of sub fertility. Amongst the multigravida pregnant women, about one-third had inter-pregnancy interval of 13-24 months and almost a quarter had ≤ 12 months interval. A study from Belgaum reported that 22.7 percent of the mothers had less than 24 months inter-pregnancy interval.[128] The higher proportion of short inter-pregnancy interval observed in our study could be because of history of high pregnancy wastage (abortion and stillbirths) and neonatal deaths.

Almost forty percent pregnant women had one or more high risk factors during present pregnancy. The most common high risk factors were short inter-pregnancy interval (38.2%), obstetric problems (24.3%) such as hyperemesis, spotting and oligo/polyhydramnios and medical illness (20.8%) like hemorrhoid, UTI, gastritis,

toxoplasmosis, hypothyroidism, viral infection (hepatitis, chickenpox), seizures and the diseases of renal, cardiac and respiratory systems. PIH was present among 12.1 percent pregnant women (table 4.3.3). As against this, most commonly reported high risk factors in a Belgaum study were bad obstetric history (21.7%), cesarean section (15.4%), PIH (11.4%), short stature (9.7%) and adolescent pregnancy before the age of 18 years (7.4%).[128] Slightly higher proportion of the pregnant women in our study had reported the presence of high risk factors than that of Belgaum study; however, types medical illness and occurrence of PIH was almost similar to the studies from Bangladesh, Dehradun and Belgaum.[106,128,139] Meanwhile, proportion of pregnant women who had <45Kgs weight before delivery (5.7%), adolescent pregnancy before the age of 18 years (<1%), short maternal stature (1%) and total weight gain from enrollment till delivery (3.6%) were lower than the results of studies from Belgaum and Bangladesh.[106,128] Proportion of Rh Negative mothers in the present study were equal to that of Belgaum study.[128] Higher proportion of short stature mothers in Bangladesh (9.9%) could be due to the genetic influences and the higher proportion of poor weight gain during pregnancy in the Belgaum study (22.5%) could be because of poor nutritional status of the pregnant women who were from rural areas.[106,128]

### 5.4 Utilization of ANC services and nutritional status of pregnant women

In our study, more than eighty percent of the pregnant women had made 6-10 ANC visits and the mean number of visits being 8.84±1.9. These figures are reasonably higher than that reported in the Ethiopian and Indian studies.[112,128] The higher frequency of ANC visits in this study as against Ethiopian and Indian studies was due to the

difference in ANC care practices in tertiary hospital. In hospitals, pregnant mother is entitled to visit multiple times; usually once in a month up to seventh months of pregnancy and more frequently thereafter till delivery. Hundred percent pregnant women had TT immunization which is similar to that of an Indian study.[128]

Almost seven out of every ten pregnant women had taken Folic acid tablets during first trimester of pregnancy. Amongst those who did not take Folic acid tablets, lack of awareness of pregnancy and late ANC registration are the possible reasons. Almost all pregnant women (99.8%) had taken IFA during pregnancy; however, only 13.8 percent had taken them regularly. Out of all those who had taken IFA, 62.8 percent had taken ≥100 tablets. Although, prophylactic IFA tablets are distributed to all the pregnant women free of cost[173-174] there was low compliance in the intake of IFA in the present pregnancy. Among those who did not take IFA regularly, majority were due to negligence (74.2%) followed by intolerance (9.7%) and rumors (8.1%) in the community. Almost all (99.1%) the pregnant women had taken calcium tablets; however, only 8.8 percent had taken them regularly as prescribed. A study from Belgaum reveal that 98.8 percent pregnant women had taken IFA and 68 percent of them had taken >100 tablets.[128]

About 45.8 percent of the pregnant women at enrollment had normal hemoglobin level (≥11gms/dl). By the time of delivery, 56.7 percent had normal hemoglobin level. Although the proportion of pregnant women with mild and moderate anemia has decreased, there has been slight increase in the number of severely anemic mothers from

1(0.1%) at enrollment to 5(0.4%) at the time of delivery. Mean hemoglobin level at the enrollment and delivery was 10.65±1.3gms/dl and 10.96±1.3gms/dl respectively. Average increase in hemoglobin level from enrolment to delivery was 0.3gms/dl. Although the proportion of pregnant women who had normal hemoglobin level at enrollment was higher than that observed in Belgaum study (27.2%), slightly lesser proportion of mothers in our study had normal hemoglobin level at delivery as against the findings of Belgaum study (62.3 %).[128] Inspite of the increase in mean hemoglobin level from enrollment to the time of delivery, the observed increase in hemoglobin level was lesser than that reported in a Belgaum study (1.1±0.6gms/dl).[128] The difference observed could be because of the important role played by Female Health Workers (FHW) and Accredited Social Health Activists (ASHA) in the communities.

Nearly sixty four percent of the pregnant women were non-vegetarians (table 4.4.2). This proportion of pregnant women was lesser than that reported in Bangalore where 82.0 percent used to take mixed diet during pregnancy. Higher proportion vegetarian pregnant women in our study were because of religious belief where majority of the Jains and Lingayats (Hindus) do not take non-vegetarian diets. Majority of the pregnant women (86.1%) have been consuming proteins whereas only 16.2 percent have been consuming >89 percent of RDA of calories. The mean calorie and protein consumption among the pregnant women was 2010.88±224.3Kilocalories and 70.22±10.3gms respectively. According to ICMR, the minimum of >89 percent of RDA of calories and proteins consumption is considered normal during pregnancy. A total of 2525Kilocalories and 65gms proteins are considered as normal RDA for the pregnant

women who are doing moderate work.[172] Mean calorie consumption among pregnant women was lesser than the RDA whereas the mean protein consumption was more than RDA. The proportion of mothers who had taken >89 percent of RDA of calories and proteins were considerably higher in our study when compared to a study conducted in Belgaum.[128] Comparatively, higher proportion of pregnant women consuming >89 percent of RDA of proteins could be due to their cultural norms followed in this part of country where pulses are important items of daily diets.

### 5.5 Characteristics of newborns

In this study, 64.8 percent were vaginal births and remaining 35.2 percent were born by Cesarean sections. Vaginal birth rate in our study was higher than that observed in a tertiary care hospital at Bangalore.[122] A greater proportion of vaginal births in our study could be because most of the women rely on the obstetrician's decision to perform Cesarean section when indicated. Female babies (50.6%) were slightly more than the male babies (49.4%) which yielded the sex ratio of 1023:1000 in the present study. As against this, sex ratio has been 840-980:1000 in other studies from Uttar Pradesh, Karnataka, Madhya Pradesh and Maharashtra, India.[127,129,145,149.] Improved sex ratio of the newborn could be due to the effective implementation of Pre-natal Diagnostic Techniques (PNDT) Act and Rules and no gender bias.[175] Almost eleven percent were premature babies. This proportion of premature births was more than that observed in the studies from Nagpur, India; studies from Germany and Bangladesh where it ranged from 7-18.5 percent; however, it was lower than a hospital based study from Bangladesh.[36, 88,106,113]

About two-thirds of the newborns were 45-50cms in length and the mean length was 47.63±2.6cms. Mean length of male babies (47.93±2.6cms) was significantly more than that of female babies (47.34±2.6cms). Almost a quarter of the newbons had birth weight <2500gms (table 4.5.1and figure 4.5.1). Several international studies reveal large variations in the magnitude of LBW; ranging from 1.2 percent in central China to the highest in Bangladesh (24.0%).[24,41,68,77,79,81-,83,87,92,93,95,97,100,105-106,108-109] Indian studies also showed a large variation in the proportion of LBW babies (7% in Mizoram and 45.2% in Shivaji Nagar, Mumbai).[18,28,38,40,44-45,119-120,123,125,127-130,132-136,138-139,142-143,145,147-148,150] Finding of this study is almost similar to the results reported from Nashik, Dehradun and Delhi, India.[45,120,125] The observed magnitude of LBW in this study was noticeably lower than that identified in different Indian states.[28,38,40,44,119,123,127,130,134-135,136,139,142,147,150]; and higher than that reported in several other studies.[18,40,45,120,128,129,136,143,145,148] Four babies had macrosomic weight ( ≥4000gms) in our study. Similar few number of macrosomia have been reported in India.[27] The magnitude of macrosomia is considerably low in this study when compared to the Iranian and a Nigerian study (5.0%).[24,100] Mean birth weight of newborns was 2720.28±475.94gms and male babies were significantly heavier (100gms) heavier than female babies. Several international and Indian studies affirm that male babies had heavier birth weight than the female babies.[44,68,131,150] The mean birth weight in the international studies ranged from 2900gms to the 3345gms.[83,112] Amongst the Indian studies, there was variation in the mean birth weight from 2520gms to 2970gms.[44,105-106,108,112,116,119-120,128,130,-131,136,138]

## 5.6 Predictors of birth weight

In the present study, association between 58 potential predictors and birth weight of newborns was observed. Out of these, 43 factors had statistically significant association by bivaraite analysis while 22 predictors had statistically significant association with LBW by multivariate analysis.

### 5.6.1. Predictors of Birth Weight-Bivariate analysis

On bivariate analysis, **eight constitutional factors** like sex of the newborns, father's height and weight; mother's height and weight at second trimester, third trimester and before delivery; and maternal BMI before delivery (table 4.6.1.1-3 and figure 4.6.1.1-4.6.1.2); **six socio-demographic factors** such as religion, family type, maternal age, paternal education, paternal occupation, socioeconomic status (table 4.6.1.4-8); **eight obstetric factors** like gravidity, gestational age, history of delivery of LBW babies, preterm, stillbirth, neonatal death, inter-pregnancy interval, type of conception (table 4.6.1.9); **five nutritional factors** like weight gain during pregnancy, maternal hemoglobin during pregnancy, protein, calorie, food habit (table 4.6.1.10-11and figure 4.6.1.3); **six maternal high risk and illness related factors** such as presence of high risk factors, illness during pregnancy and pregnancy induced hypertension (table 4.6.1.12-13 and figures 4.6.1.4-5); **four exposure and life style related factors** like types of fuel used, presence of smoke vent and window in kitchen, rest during pregnancy, work during pregnancy (table 4.6.1.14-15) and **six antenatal service utilization related factors** such as number of ANC visits, Folic acid intake during first trimester, number of IFA tablets taken, Calcium intake status; and regularity of IFA and Calcium intake had significant

association with birth weight (table 4.6.1.16-17). Similarly, there was positive correlation between the birth weight of newborns and the various covariates such as parental height and weight, gestational age, number of ANC visits, duration of IFA and Calcium intake; total time of rest/day, calorie and protein consumption; placental weight, length of baby and the total weight gain during pregnancy (table 4.1.19). Unlike the above associations, factors such as maternal weight at enrolment, father's age, mother's BMI at enrolment, place of residence, consanguinity, maternal age at marriage and first pregnancy; maternal education and occupation; history of abortion, maternal hemoglobin at enrollment, presence of health problems during first trimester and passive smoking were not associated with the birth weight of newborn. Therefore, effects of confounding factors have been ruled out by multivariate analysis to identify the real predictors of LBW.

### 5.6.2 Predictors of Low Birth Weight-Multivariate analysis

Proportion of LBW was significantly high among female newborns (29.0%) as against the male newborns (20.3%). An odd of LBW among female babies was two times higher than that of male babies. Several International and Indian studies have also reported similar association between sex of the baby and LBW.[4,13,34,53, 127,129,134,143-144,147] The higher birth weight among male baby could be because of relatively large size internal organs and the bones.

Babies born to the mothers who had <145cms and 145-155cms height had significantly lower birth weight than the babies of the mothers who had >155cms height. There was multifold (AOR: 60.1 and 4.73) higher risk of delivering LBW babies among

the mothers who had <145cms and 145-154.9cms height when compared to the tall mothers (≥155cms) respectively. Present study results are consistent with the several studies conducted in India and other countries.[4,28,34,35,38,40,53,67-68,81,89,92,118,120,126,128,138,144,147] Increased risk of delivering LBW babies amongst the short mothers could possibly be due to the genetic inheritance, constitution and poor nutritional status. Similarly, proportion of LBW was significantly higher amongst the babies whose fathers had short height <162.5cms when compared to the babies of tall fathers (table 4.6.2.1.A). Although, these results are similar to those of the studies conducted in California, Bangladesh, New Zealand, Iran and some of the developing countries[4,34,75,88,103,105]; it seems that none of the Indian studies had attempted to observe the association between father's height and birth weight of newborns. Such association between father's height and the birth weight of newborns could be due to the influence of genetic and constitutional make up of the fathers.

Several studies reported statistically significant association between birth weight of newborn and the maternal weight during second trimester, third trimester and before delivery[4,28,34,53,81,89,101,105,113,115,118,120,126,135-138,143,147]; whereas our study did not show such associations (table 4.6.1.1.A). Perhaps this could be because of less number of pregnant women weighing <40Kgs. Although, there are some evidences of association between father's weight, BMI and the birth weight of newborns in studies conducted at Canada, New Zealand and Germany[4,34,88-894,34,88-89]; These had no significant association in our study. The observed difference could be due to the genetic variations between Indian males and others.

Risk of delivering LBW babies amongst the adolescent mothers <20 years was 21.7 times higher than those who conceived after twenty years of age. Multiple studies from India and abroad also affirm that young maternal age has bearing on low birth weight.[4,15,28,34,35,38,40-41,44-45,66,68,82,85,87,90,97,99,102-103,105,108,118,119,122-123,125,127,129,132,134-136, 139,142,144-145,147.] Perhaps, this could be because the young mothers are incapable to maintain the growing needs of fetus because of poor maturation of reproductive system.

Father's occupation had statistically significant association with reduced birth weight of babies. Those newborns whose fathers were drivers and laborers had 4.54 times and 2.94 times higher risk of having LBW than the babies whose fathers were service holders or business workers respectively (table 4.6.2.1.B). A systematic review from Canada and some research studies from Sweden, Iran and Pakistan also reveal similar associations between father's occupation and the birth weight of newborns. Babies of the farmers, laborers and waiters were found to have lower birth weight in their studies.[64,92-94] This could be because of low socioeconomic status of the families where fathers are laborers or farmers in which case the pregnant women is likely to be malnourished. Maternal occupation did not have any association with the birth weight of newborns in the present study. Several Indian and international studies have shown maternal occupation as one of the determinants of birth weight as against the findings of the present study.[44,64,72,93,95-96,113,116,130,144,147] This could be due to the homogenous occupational profile of the mothers in the present study where almost all pregnant women were housewives.

In many of the studies, maternal and paternal education reported as the factors affecting birth weight of newborn; however, present study did not show comparable evidences. Antenatal visit practice among the expectant mothers was good in our study which could be due to the wide spread network of ASHA and FHWs in the community. Socioeconomic status of the pregnant women was not associated with LBW in the present study; although, it was associated several other studies.[4,34,35,38,44-45,53,78,85,93,98,102,111,114,123,126,136,138,143] The observed difference might be due to the free availability of safe-motherhood services in India after implementation of National Rural Health Mission and the Janani Surakshya Yojana.[173-174] Several controversial associations have been observed between birth weight and the religion of mothers. Some studies argue that Muslim mothers are more at risk of delivering LBW babies while others show Hindus, Jains and Christians are at higher risk of delivering LBW babies. The present study did not observe any association with birth weight and the religion; however, the studies from Agra, West Bengal and Sweden revealed such associations.[93,127,144]

Maternal gravidity was statistically associated with the birth weight of newborn. Primigrvida had almost seven times higher risk for giving birth to LBW babies as against the multigravida. Results of this study are concurrent to multiple studies.[4,15,34-35,38,63,67-68,77, 82,89,95,101,111,113,115,116,118-120,122,129] Increased risk of LBW amongst babies of primigravida mothers could be due to the poor physiological and physical adaptation; and the higher incidence of hyperemesis resulting in refusal of foods, which eventually result in poor maternal nutrition; and higher pregnancy related anxiety. Although, some of the

studies reported that birth weight of newborns have association with the grand multiparity[4, 34,115, 38,116,118-119]; it was not evident in the present study. This could be because of the proportion of grand multiparity being less than one percent in our study. Significantly higher proportion of LBW babies belonged to the preterm births (80.7%) when compared to the babies who were born at full term (17.8%). There was 22.3 times higher risk of LBW among the preterm babies when compared to the babies born at full term. Similar observations were made in several international and national studies.[4,28,34-35,77,79,93,113,127,129,134,141,142,150] Higher incidence of LBW among the premature babies could be due to the short gestational period or the higher tendency of SGA babies born before reaching to the full term.[9-10,52] Similarly, odds of delivering LBW babies amongst the mothers who had conceived through artificial reproduction or conceived after medical management of sub fertility was more than three times higher when compared to those who conceived spontaneously. Similar evidences have been reported from Canada, California and Thialand.[35,67,82] Although definite explanations are ambiguous, the increased chances of LBW could be because of diminished performance of reproductive organs and its physiology.[67]

The mothers who had history of preterm delivery, low birth weight and neonatal death had 3.99 times, 5.31 times and 6.47 times higher risk of delivering LBW babies respectively as compared to those who did not have any history of these earlier bad outcomes (table 4.6.2.1.C). Several studies have reported that earlier unfavorable pregnancy outcomes are the predictors of LBW.[4,34-36,41,43,53,72,76,87,89,90,95,97,99,101,107,109,114-116,120,124,128,131,136,150] Similarly, history of neonatal death had statistically significant

association with low birth weight in many studies.[4,34,120,136,150] Present study findings concur with these literature. History of unfavorable pregnancy outcomes might have genetic and physiological attribution for LBW.

Although several studies have reported association between birth weight and the history of abortion, stillbirth and inter-pregnancy interval[4,24,34,35,38,42,53,67-68,72,76-77,79,82,89-91,97,101,114,120,124,128,132,139,143,147-148,150]; the same was not observed in the present study. This difference could be due to the risk modifications attributed to the relatively better antenatal care in our study.

Maternal nutrition status during pregnancy is one of the most important determinants for the regulation of normal physiology of pregnancy and good pregnancy outcomes. In the present study, the mothers who had taken <69 percent of RDA of calories and <89 percent of RDA of proteins had 14.32 times and 4.11times higher risk of delivering LBW babies as compared to the higher intake of calories and proteins (table 4.6.2.1.D). Systematic reviews and studies from Bangladesh and India also reported poor maternal nutrition as a risk factor for LBW.[4,34,103,113,128,130,132,138,150] Poor consumption of calories and proteins during pregnancy result in maternal malnutrition which might have affected the intrauterine growth of the fetus.

In the present study, weight gain during pregnancy and maternal hemoglobin level before delivery did not have significant association with birth weight of newborns whereas several studies have reported significant association between birth weight and

these factors.[4,24,34,35,38,42,53,67-68,72,76-77,79,82,89-91,97,101,114, 120,124,128,132,139,143,147-148,150] This could be due to the inclusion of pregnant women who had good ANC from the study hospital and eventually delivered in the same hospital. The regular monitoring of the pregnancy by the obstetricians might have resulted in timely modifications of maternal risk conditions in our study. Type of diets did not show any association with the birth weight in our study whereas in studies conducted at Bangalore and Lucknow, the mothers who had mixed diet had delivered the babies with higher birth weight.[122,132]

In our study, the pregnant women who had 1-2 high risk factors and ≥3 high risk factors had 3.7 times and 10.4 times higher risk of delivering LBW babies respectively when compared with those who did not have any high risk factors during present pregnancy. A study from Belgaum, Karnataka reported that increase in the number of high risk factors had strong statistical association with the delivery of LBW babies.[128] Presence of one or more maternal morbidities as high risk factors during pregnancy was also found to be associated with the delivery of LBW babies in our study. This finding is consistent with the findings of several national and international studies.[4,34,35,42,44,53,76,78,89,97,105,107,113,114,132,144,147-148,150.] Similarly, those mothers who had PIH during pregnancy had 11.4 times higher risk of delivering LBW babies than the normotensive mothers (table 4.6.2.1.E). Similar observations have been made in several Indian and international studies.[4,34,36,45,69,87,89-90,97,99,103,107,112,114-115,124,126,128,142,144,150.] The higher risk of delivering LBW babies amongst the mothers who had PIH could possibly be due to the placental insufficiency.

The mothers who had poor kitchen ventilation had almost two times higher risk of delivering LBW babies than those having proper kitchen ventilation (smoke vent and window). This finding is consistent with the several studies conducted in India and abroad.[4,35,53,86,133] Poor kitchen ventilation results in prolonged exposure to Carbon monoxide by the pregnant women which might have adversely affected the fetal growth. Similarly, those mothers who had <8 hours rest per day during pregnancy had 7.2 times greater risk of delivering LBW babies when compared to the mothers who had >8 hours daily rest (table 4.6.2.1.F). Present study findings are in agreement with the results of several studies wherein less duration of daily rest (<2 hours rest in day and six hours rest in the night) was found to be associated with the reduced birth weight of newborns.[4,34,35,53,130,144] This practice of taking less rest during pregnancy could lead to relatively increased expenditure of energy and poor intrauterine fetal development. Types of fuel used for coking[61,73,86,149] and the nature of work done during pregnancy were statistically significant factors affecting birth weight of newborns in several studies[4,15,28,35,40, 53,132,143,147,150]; however, our study did not show such associations.

Those pregnant women who did not take Folic acid during first trimester of pregnancy had almost two times higher risk of delivering LBW babies than those who had taken folic acid. Odds of occurrence of LBW amongst the babies whose mothers had taken <100 tablets of IFA and who had taken IFA tablets on irregular basis was 4.5 times and 5.61 times respectively higher when compared with those mothers who had taken ≥100 tablets of IFA and who had taken IFA regularly. Similarly, there was multifold (12.45 times) higher risk of LBW amongst the babies of the mothers who did not take

calcium during pregnancy when compared to those who had taken Calcium (table 4.6.2.1.G). Present study findings are consistent with several Indian and international studies.[4,34,53,74,84,112,114,128] Since the Folic acid supports the proper growth and development of fetus during first trimester, the Folic acid consumption was favorably associated with the increased birth weight of babies. Similar observations have been reported from India and other countries as regards to the quantity of IFA intake.[4,28,34,39,53,84,112,114,137,143,144,147,148,150] As the intake of IFA during pregnancy helps in maintaining normal maternal hemoglobin level and calcium intake supports in different dimensions of fetal growth; there was increased chances of normal birth weight among the babies of the mothers who had taken IFA and Calcium during pregnancy. Number of antenatal visits was statistically significant factor affecting birth weight in many studies; nevertheless, there was no similar association in the present study. The observed differences could be because majority of the pregnant women in the present study had 6-10 ANC visits.

Although 43 predictors had statistically significant association with birth weight in bivariate analysis; only twenty two factors were identified as real predictors of LBW by multivariate analysis. These predictors are female newborn, maternal height <155cms, paternal height <162.5cms, maternal age less than 20 years, father's occupation such as laborer and drivers; history of LBW, preterm birth and neonatal death; ART/conception after treatment, primigravida, preterm birth, Calorie consumption <69 percent of RDA, protein consumption 89 percent of RDA, presence one or more high risk factors during pregnancy , PIH, poor kitchen ventilation, total rest <8 hours in

a day, no intake of Folic acid and Calcium tablets during pregnancy, consumption of <100 tablets of IFA; and irregular consumption of IFA and Calcium. These 22 predictors have explained the variations in the birth weight by 74.1 percent.

### 5.6.3 Combined effects of the selected predictors on birth weight of newborns

Various linear regression models were developed to estimate the birth weight of newborns using significant predictors of birth weight. Out of these, a model which comprised of eight assessable factors such as duration of IFA and calcium intake, gestation age, calorie consumption, rest time, parental height and father's weight had the highest combined predictive effects (63.3%) on the birth weight. The maximum contribution was observed due to the mother's rest status during pregnancy. Similar birth weight estimation models were developed in Udipi district of Karnataka using maternal height, weight gain during pregnancy and the gestation at delivery. Their model had predictive ability of 32 percent.[117] Another birth weight estimation model was developed in United Kingdom using five covariates such as gestational age, parental height, maternal BMI, parity and maternal smoking status which had prediction capacity of 38 percent.[75] Similarly, models developed in Kolkota and Ahmedabad had explanatory accuracy of 2.2-42 percent respectively.[81,115] The higher explanatory capacity of our model was due to the inclusion of the predictors of birth weight having higher impacts as against other studies.

## 5.7 Development of antenatal risk scoring tool

In the present study, an antenatal risk scoring tool was developed to indentify maternal risk of delivering LBW babies using 14 easily assessable predictors of LBW. These predictors are maternal age, parental height, type of conception, gravidity, number of high risk factors in the present pregnancy, pregnancy induced hypertension, gestation age at delivery, kitchen ventilation, rest during pregnancy, Folic acid intake during pregnancy, IFA and Calcium intake during pregnancy; and regularity in the consumption of these two prophylactic supplements. A 10 factorial risk prediction tool was developed in Guatemala City; 28 factorial model in Belgaum, India, another 20 factorial model in Guatemala City and 29 factorial models in Manitoba were developed.[49,128, 155,158] Except a model developed in Guatemala City which included 10 factors, a relatively small number of risk factors were included in the present study to develop a risk scoring tool when compared with other studies. This has made our risk scoring tool to be simple to understand and easy to operate.

In the present study, identified predictors of low birth weight were converted into risk score based on odds ratio (table 4.7.1). Risk score for each of the pregnant woman was cumulated and then the relationship between cumulative risk scores and birth weight of the newborns was observed. As shown in table 4.7.2 and figure 4.7.1, there was inverse relationship between birth weight and the cumulative risk scores. Proportions of LBW babies had statistically significant association with the maternal cumulative risk scores. Similar relationships were observed in Indian and international studies.[46-47,49,152-153,155-160-163.] Such agreements could be due to the evaluation of risk factors meant for the

LBW in all these studies. Furthermore, low proportion of LBW babies (2.7%) were born to the mothers who had low risk scores (≤3). LBW babies were found to be significantly increased with increase in the maternal cumulative risk scores. Seven out of every ten (70.3%) mothers who had 8-11risk scores had delivered LBW and hundred percent mothers with the risk scores ≥12 had delivered LBW babies. Almost 70 percent babies with LBW were born to the mothers who had ≥3 cumulative scores in Guatemala. About 43 percent mothers who had ≥7 cumulative risk scores had delivered LBW babies in an Indian study and seven out of every ten mothers who had cumulative risk scores 11-15 had delivered LBW babies in Belgaum, Karnataka.[128,152,155,164.] Despite the proportional variations in the LBW babies by the cumulative risk scores, increasing trends of LBW babies was seen with the increase in cumulative risk scores in all the studies. The variations in the score levels could be due to the variability in allotment of risk scores among these studies.

The validity of our risk scoring tool was assessed by comparing cumulative risk scores and the factual birth weight. The optimal sensitivity (82.4%) and the specificity (79.7%) were witnessed at cumulative cutoff risk scores of ≥6. Positive and negative predictive values of the tool were 57.0 percent and 93.3 percent respectively; and area under the ROC curve was 81.1 percent. Wide range of sensitivity (39%-96.1%) and specificity (19.6-81.3%) of the tools have been reported in several other studies. The tools with high sensitivity had low specificity and vice–versa.[46-49,151,153-155,158,160-161,165] Some studies have shown improved sensitivity and specificity.[160,165]; however, these tools also did not have high predictive accuracy to be used in the clinical practices to predict the

maternal risk for delivering LBW babies. Similarly, PPV and NPV of the risk scores ranged from 11.9-45.3 percent and 60.9-92.7 percent respectively in other studies.[46,48,128,153,158,160] The optimum sensitivity, specificity and predictive values of present risk scoring tool was because of the rational allotment of risk scores to each of the predictors of LBW on the basis of adjusted odds ratio. The area under curve observed in the present study was also higher than other studies.[161,165] The better quality of predictive accuracy of our tool might be useful in the antenatal risk screening to identify the mothers likely to deliver LBW babies to take appropriate remedial measures.

# SUMMARY

# SUMMARY

This prospective study was carried out at Dr Prabhakar Kore charitable hospital, Belgaum to identify the predictors of birth weight and to develop an antenatal risk scoring tool to identify maternal risk of delivering LBW babies. The study was carried out from July 2012 to August 2013 among 1044 pregnant women. Ethical clearance was obtained from ethical committee of KLE University, Belgaum and informed consent was obtained from each of the pregnant women prior to the data collection. Data was collected by trained personnel using structured questionnaire.

**6.1 Socio-demographic and Anthropometric characteristics of pregnant women**

- Mean age of the pregnant women was 23.58±3.47 years and majority (57.2%) of them were of 20-24 years old.
- About 61.5 percent of the pregnant women had secondary level education.
- Almost all the pregnant women (97.0%) were housewives.
- Majority (84.6%) of the participants were Hindus, 85.3 percent belonged to joint families and 20.2 percent had consanguineous marriage. About 58.2 percent of the pregnant women were from rural residence.
- More than one third (34.8%) of the pregnant women belonged to $IV^{th}$ class socio-economic status and another 32.9 percent had $V^{th}$ class socioeconomic status.
- Almost one-third (32.5%) of the pregnant women had the height of 150-155cms and the mean height was152.78±5.35cms.
- Fifty one percent of the pregnant women had 40-50Kgs weight at the time of enrollment whereas 50.5 percent of them had 50-60Kgs weight before delivery.

- About two-thirds of the pregnant women had normal BMI at enrolment whereas almost all (98.6%) had normal BMI before delivery.
- More than three-fifths (62.7%) of the pregnant women had >8Kgs weight gain during pregnancy and the mean weight gain was 9.28±2.89Kgs.
- Almost half (49.0%) of the participant's husbands were educated up to secondary level.
- About 46.0 percent of the participant's husband's occupation was either service or business.
- Mean age of the participant's husband was 30.04±4.56 years.
- Forty eight percent of the participant's husbands had height of 165-175cms and the mean height was166.85±5.19cms.

### 6.2 Exposures and life style of pregnant women

- Almost three-fifths (59.6%) of the pregnant women were using biomass fuels for cooking.
- None of the pregnant women were consuming tobacco and alcohol.
- Four out of every five (80.7%) pregnant women had taken more than eight hours rest and sleep every day.

### 6.3 Reproductive and obstetric characteristics of pregnant women

- History of cesarean section, abortion, low birth weight, preterm delivery, stillbirth and neonatal death was reported amongst 34.5 percent, 23.2 percent, 17.8 percent, 16.8 percent, 10.5 percent and 10.4 percent multigravida mothers respectively.

- Slightly less than half (48.5%) of the pregnant women get married before the age of 20 years and 23.8 percent conceived for the first time before 20 years.
- Mean age at marriage and first pregnancy were 20.1±2.7 years and 21.32±2.7 years respectively.
- Majority of the pregnant women (58.2%) were multigravida and the median numbers of gravida was 2.
- About one-third (33.6%) of the pregnant women had inter-pregnancy interval of 13-24 months and the median inter-pregnancy interval was 24 months.
- Almost forty percent of the pregnant women had one or more high risk factors during present pregnancy.
- Nearly a quarter (24.3%) of the pregnant women reported at least one of the obstetric problems and a quintile of them reported medical illnesses during pregnancy.
- About 12.1 percent of the pregnant women had PIH at the time of delivery and 4.7 percent had gestational diabetes mellitus.

**6.4 Utilization of antenatal services and nutritional status of pregnant women**

- More than four out of every five (83.6%) pregnant women had made 6-10 ANC visits and the mean number of ANC visits was 8.84±1.97.
- Hundred percent of the pregnant women had TT immunization and 71.2 percent had taken folic acid tablets during first trimester of pregnancy.
- Almost all the pregnant women (99.8%) consumed IFA; however, only 13.8 percent had taken them regularly.
- More than 60 percent of those who consumed IFA had taken ≥100 tablets.

- Almost all (99.1%) had taken calcium during pregnancy; nevertheless, only 8.8 percent had taken it as prescribed.
- About 45.8 percent of the pregnant women had normal hemoglobin level at the time of enrollment whereas 56.7 percent had normal hemoglobin level before delivery.
- Only 16.2 percent of the pregnant women had taken >89 percent RDA of calories whereas 86.1 percent pregnant women had consumed >89 percent RDA of proteins.

### 6.5 Characteristics of newborns

- About 64.8 percent were vaginal births and almost 11.0 percent were preterm births.
- Mean length of newborn was 47.63±2.6cms. Average length of male newborns (47.93±2.6cms) was significantly more than female newborns (47.34±2.6cms).
- Almost a quarter (24.7%) of the newbons had birth weight weight <2500gms. Four babies were macrosomic births (≥4000gms).
- Mean birth weight of newborns was 2720.28±475.94gms. Male babies were slightly heavier than female babies.

### 6.6 Predictors of low birth weight

- There was positive correlation between birth weight and the parental height and weight; gravidity, length of baby and placental weight; gestational age, duration of IFA and calcium intake; rest during pregnancy, calorie and protein intake during pregnancy; and weight gain during pregnancy.
- On multivariate analysis, a total of 22 predictors of LBW were identified. These predictors were female newborn, maternal height <155cms, paternal height

<162.5cms, maternal age < 20 years, paternal occupation such as laborer and drivers, history of LBW, preterm birth and neonatal death; ART/conception after treatment, primigravida, preterm birth, calorie consumption <69 percent of RDA, protein consumption <89 percent of RDA, presence one or more high risk factors during pregnancy, PIH, poor kitchen ventilation, total rest <8 hours in a day, no intake of Folic acid and Calcium tablets during pregnancy, consumption of <100 tablets of IFA; and irregular consumption of IFA and Calcium.

### 6.7 Development of antenatal risk scoring tool

- An Antenatal risk scoring tool was developed using 14 predictors of LBW such as maternal age, maternal height, paternal height, type of conception, gravidity, number of high risk factors, PIH, gestation age, Folic acid intake, Calcium intake, number of IFA tablets intake, regularity of IFA and Calcium intake; kitchen ventilation and rest during pregnancy.
- The optimum sensitivity (82.4%) and the specificity (79.7%) of the tool were observed at the cumulative cutoff risk scores of ≥6 where the maximum area under Receiver's Operating Characteristic curve was 81.1percent.

# CONCLUSION

# CONCLUSION

## 7.1 Conclusion

Proportion of LBW babies in the present study was 24.7 percent. Following twenty two predictors of low birth weight were identified.

1. Female newborn
2. Maternal height (<155cms)
3. Paternal height (162.5cms)
4. Maternal age (<20 years)
5. Paternal occupation (laborer/drivers)
6. History of LBW,
7. History of preterm birth
8. History of Neonatal death,
9. ART/conception after treatment
10. Primigravida
11. Preterm birth
12. Calorie intake (<69% of RDA)
13. Protein consumption (<89% of RDA)
14. Number of high risk factors (≥1)
15. PIH
16. Poor kitchen ventilation,
17. Rest in pregnancy (< 8 hours /day)
18. No folic acid intake
19. No calcium intake
20. IFA intake (<100 tablets)
21. Irregular consumption of IFA
22. Irregular consumption of Calcium

The combined effects of 22 predictors of LBW were estimated to be 74.1%. Out of these 22 predictors, 11 factors are modifiable factors.

An antenatal risk scoring tool was developed in the present study using 14 easily assessable predictors of LBW such as maternal age, maternal height, paternal height, type of conception, gravidity, number of high risk factors, PIH, gestation age, Folic acid intake, Calcium intake, IFA intake regularity, calcium intake regularity, kitchen ventilation and rest during pregnancy. A risk scoring tool that developed in the

present study was 82.4 percent sensitive and 79.7 percent specific to predict chances of delivering LBW babies at the cutoff risk scores of ≥6.

## 7.2 Recommendations

- Delaying the age at conception (>20 years) is required to reduce the magnitude of LBW attributable to the early conceptions through well planned health education program directed at adolescent and young women.
- Improving the quality of antenatal care services to ensure regular intake of IFA and Calcium.
- A well planned periodic training programme has to be organized for ANC service providers including Female Health Workers focusing on predictors of LBW and their prevention.
- Community based studies are needed to test the feasibility and acceptability of the risk scoring tool by the health workers and pregnant women.

## 7.3 Limitations of the study

- Placental and fetal predictors of birth weight are not studied.
- Since, the study is hospital based, there is a possibility of selection bias.
- Extrapolation of the results cannot be done as it is institution based study.

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# REFERENCES


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# ANNEXURE

## ANNEX I: INFORMED CONSENT FORM

**Title: Predictors of Birth Weight: A Prospective Study at Tertiary Care Hospital of Belgaum, Karnataka, India**

INVESTIGATOR: DAMARU PRASAD PANERU
Ph.D. Scholar, KLE University, Belgaum, Karnataka

Introduction

This study is intended to identify the predictors of birth weight and developing a risk scoring tool to identify mothers likely to deliver low weight baby. Identification of a woman at risk of delivering low weight baby (in advance before delivery) with the help of risk scores will be useful to take risk mothers under medical surveillance. This will be useful to improve maternal health.

Explanation of procedures

In this study, you will have to answer some questions related to your social and demographic aspects, reproductive and child birth, exposures and life styles and health services use during pregnancy. You will be followed during the pregnancy period, starting from enrolment (as early as at registration) to the delivery. During the follow up visits, changeable parameters will be recorded and you will be requested to complete the dietary information sheet for a period of 7 days in second and third trimester, which you will be submitting to me after completion. I will meet you in your routine visits and encourage for the compliance to ANC visits. Soon after delivery, I will take the weight of your newborn baby.

Possible Benefits

It could be useful to extend the maternal health care during pregnancy and childbirth.

Possible harms

This study does not involve any interventions. Due to your involvement in this study, there will be no harmful effect on your health status and it will not affect your health outcomes or treatment success.

Privacy and Confidentiality

Your identity and results of tests will be maintained confidential.

Withdrawal

Your participation in this study is voluntary. You can withdraw any time if you feel to withdraw.

Costs of participation

There will be no additional cost to you for participating in this study.

Payment for participation

There will be no incentives to you for participating in this study.

Questions

If you have any questions about this study, you can contact to Mr. Damaru Prasad Paneru (Cell: 8880666807) or Professor (Dr.) Vijaya A. Naik (Guide), Department of Public Health, Jawaharlal Nehru Medical College (JNMC), KLE University, Professor (Dr.) B.R. Nilgar, Department of Obstetrics and Gynecology, JNMC; and Dr. P. V. Patil, Chairman-Ethical Committee (Human subjects), KLE University, Belgaum (Phone: 0831-2444444/2493779).

Legal rights

By signing this consent form, we are not waiving any of your legal rights.

Consent statement

I am making voluntary decision to participate in this study. I have read the consent or it has been read to me in my own language. The study has been fully explained to me. I have had the opportunity to ask questions about it and any questions that I have asked have been answered to my satisfaction.

Authentication of publication

Results will be used for the teaching and medical publication however participant's identity will be kept confidential.

| | |
|---|---|
| Signature or Left Hand Thumb Impression (Volunteer Subject) | Date |
| Signature of Investigator | Date |
| Signature of Witness | Date |

## ANNEX II: QUESTIONNAIRE

# Title: Predictors of Birth Weight: A Prospective Study at Tertiary Care Hospital of Belgaum, Karnataka, India

***Pregnant women:*** ***Non diabetic (known) pregnant women < 20 (Below 4.5 Months) weeks of gestation who have a plan to deliverer in the same hospital***

***ID No……*** ***Enrolment Date ……..*** ***Date of interview ……..***

## Part I-a: Socio-demographic Information

| SN | Variables (encircle selected response/specify) | SN | Variables (encircle selected response/specify) | Remarks |
|---|---|---|---|---|
| 1.1 | Name : | 1.2 | Husband's Name : | |
| 1.3 | Address: …….. | 1.4 | Residence e: 1. City 2. Village | |
| 1.5 | Contact Phone/Mobile: | 1.6 | Religion: …… | |
| 1.7 | Age (completed years): | 1.8 | Husband's Age : | |
| 1.9 | Age at marriage | 1.10 | Age at first pregnancy | |
| 1.11 | Education : | 1.12 | Husband's Education: | |
| 1.13 | Occupation: | 1.14 | Husband's Occupation: | |
| 1.15 | Type of family:<br>1. Nuclear 2. Joint | 1.16 | No. of Family members | |
| 1.17 | Family Income/month (Indian currency) : | 1.18 | Marital relation: 1. consanguineous<br>2.non- consanguineous | |

## Part I-b: Exposures and Lifestyle related factors

| | | | | |
|---|---|---|---|---|
| 2.1 | Does somebody in your family use tobacco?<br>1. Yes 2. No | | | if no, skip to 2.8 |
| 2.2 | If yes, who consume tobacco in your family?<br>1. Husband 2. Self 3. Others…… | | | |
| 2.3 | What Kinds of tobacco product do you/your husband use?<br>1. Smoking 2. Chewing tobacco 3. Tobacco used in pan 4. Others……. | | | |
| 2.4 | If smoker/s, mention duration of smoking ……..yrs | 2.5 | If chewer/s, mention duration of chewing :…… …..….yrs | |
| 2.6 | Frequency of tobacco product use:<br>1. Daily 2. Weekly 2. Occasional | 2.7 | How many times do you/ your husband use tobacco products/smoking in a day? : …… times | |

| | | | | |
|---|---|---|---|---|
| 2.8 | Does somebody in your family consume Alcohol?<br>1. Yes 2. No | | | if no, skip to 2.12 |
| 2.9 | If yes, who consume Alcohol in your family? 1. Husband<br>2. Self 3. Others…… | | | |
| 2.10 | If yes, Duration of Alcohol use<br>…… Years | 2.11 | Frequency of alcohol use: 1.daily 2. Weekly 2. Occasional | |
| 2.12 | Type of cooking fuel used during pregnancy: 1. Wood/cow dung 2. Cooking Gas<br>3. Electricity 4. Kerosene stove | | | report all |
| 2.13 | Is there smoke vent in your Kitchen?<br>1. Yes 2. No | 2.14 | Is there any window in your Kitchen?<br>1. Yes 2. No | |

## Part I- c: Reproductive and Obstetric History (for Multigravida)

| | | | | |
|---|---|---|---|---|
| 3.1 | Have you ever delivered stillbirths (SB)? 1. Yes 2. No | 3.2 | If yes, how many times have you delivered SBs? …… | |
| 3.3 | Have you ever delivered low birth weight? 1. Yes 2. No | 3.4 | If yes, how many babies have you delivered LBWs? …… | |
| 3.5 | Have you ever delivered twin/Triplet birth?1. Yes 2.No | 3.6 | Have you had APH in earlier pregnancy/ies? 1. Yes 2. No | |
| 3.7 | History of preterm birth (≤37wks) 1.Yes 2. No | 3.8 | If yes, how many times have you delivered pre-terms? … | |
| 3.9 | Is there any history of neonatal deaths? 1. Yes 2. No | 3.10 | If yes, state the numbers of neonatal deaths…… | |
| 3.11 | How did you delivered babies in earlier pregnancy?<br>…….. | | | report all |

## Part I-d: Pregnancy related information

| | | | | |
|---|---|---|---|---|
| 4.1 | Type of conception:<br>1. Spontaneous 2. ART | 4.2 | Inter-pregnancy interval for last pregnancy (in months) …….. | |
| 4.3 | Obstetric History (GP AL) G …….. P ……<br>A (Type and No.)…… L ( No. and age differences) | | | |
| 4.4 | LMP | 4.5 | EDD | |
| 4.6 | EDD by USG | 4.7 | Past history of health problems/surgery ( if any ): | |
| 4.8 | Systemic examination: Respiratory system: | | | |
| 4.9 | Systemic examination: Cardiovascular system: | | | |
| 4.10 | Risk factor/s (if any)…….. | 4.11 | Existing health problems (specify)…… | |
| 4.12 | Weight (in Kg) at the enrolment…… | 4.13 | Gestation age at enrolment ( POG)<br>…… weeks | |
| 4.14 | Height of Husband……..cm | 4.15 | Weight of Husband… ……Kg | |

## Part II: Form to be filled by the pregnant women during Pregnancy

**ID No……**

1. Name of the Participant:
2. Husband's Height (ft/inch or cm) :
3. Husband's Weight : ……..Kg
4. Husband's Blood Group ( e.g. A+):
5. Food Habit of the Participant: 1.Vegetarian 2. Non Vegetarian

6. **24 hours (=one day) Calorie Intake Chart (Any seven consecutive days during 6-7 months of pregnancy – (*To be filled during 26/27 weeks of gestation)***

| **Days** | **Date** | **Items and quantity of food consumption (e.g. tea- 1 cup, chapatti - 2)** |
|---|---|---|
| Monday | | |
| Tuesday | | |
| Wednesday | | |
| Thursday | | |
| Friday | | |
| Saturday | | |
| Sunday | | |

7. **Sleep/rest and works during second trimester of pregnancy (out of 24 hours of a day)**

| Sleep and rest time ( in hours) | | What kinds of work did you do during pregnancy (specify): |
|---|---|---|
| Day time | Night time | |
| ……. | …….. | ……... |

8. Do you have any health problems during 4-7 months of gestation 1. Yes 2. No

9. If yes, (specify) ……

10. Any other health services used during pregnancy (specify) ……

***11.*** **Fill this form during 28 weeks to 36 weeks (third trimester) of gestation**

***(Please keep this form filled and carry while at the time of admission to hospital for delivery)***

| **Days** | **Date** | **Items and quantity of food consumption (e.g. tea- 1 cup, chapatti - 2)** |
|---|---|---|
| Monday | | |
| Tuesday | | |
| Wednesday | | |
| Thursday | | |
| Friday | | |
| Saturday | | |
| Sunday | | |

**12. Sleep/rest and works during Third trimester of pregnancy (out of 24 hours of a day)**

| Sleep and rest time ( in hours) | | What kinds of work did you do during pregnancy (specify): |
|---|---|---|
| Day time | Night time | |
| …… | …… | …….. |

13. Do you have any health problems after 28 weeks (after 7 months) of gestation 1. Yes 2. No

14. If yes, (specify) ……

15. Any other health services used during pregnancy (specify)……..

## Part III: Follow up Questionnaire

**ID No……** Name of the participant:

1. **Details of the ANC visits and findings during pregnancy**

| Date | Complaints | POG | Wt. | Edema | Pallor | B.P. | Remarks |
|---|---|---|---|---|---|---|---|
| | | | | | | | |
| | | | | | | | |
| | | | | | | | |
| | | | | | | | |
| | | | | | | | |
| | | | | | | | |

2. Total numbers of ANC visits :

3. TT injection received status: 1. None 2. One 3. Two

4. **Laboratory Findings (During pregnancy)**

| **Investigations** | Date | | **Investigations** | | **Date of investigation and Values** | | |
|---|---|---|---|---|---|---|---|
| Blood Group and Rh : | …./…../…… | | RBS : | Date | | | |
| HIV: | | | | Value | | | |
| HBSAg: | | | Hemoglobin (gm %) | Date | | | |
| Others ( if any) | | | | Value | | | |

5. **USG findings ( Second and Third Trimester – latest)**

| Trimester | Date | BPD | FL | AC | AGA | EFW | AFI |
|---|---|---|---|---|---|---|---|
| II | | | | | | | |
| III | | | | | | | |

6. **Iron, Folic acid and Calcium consumption status**

| | | |
|---|---|---|
| 6.1 | Have you taken folic acid tablets during I trimester of pregnancy 1. Yes 2.No | |
| 6.2 | If no, why? 1. Late registration 2. Others : | |
| 6.3 | Have you taken Iron and Folic acid (IFA) during pregnancy (after 3 months)?<br>1. Yes 2. No | if no, skip to 6.9 |
| 6.4 | If yes, how many times did you take IFA in a day? …….. times | |
| 6.5 | If yes, how many IFA tablets did you take in a day? …… tablets | |
| 6.6 | If yes, what is the duration of IFA intake?<br>……. ….. Months of conception to …….. months of pregnancy | |
| 6.7 | How was the regularity in IFA intake? | |

| | | |
|---|---|---|
| | 1. Taken regularly 2. Missed some doses 3. Irregular (missed >7 consecutive days) | |
| 6.8 | If missed/irregular, state the reasons for irregularity?<br>1. Due to intolerance 2. Due to vomiting 3. Others: | |
| 6.9 | Have you taken calcium tablets during pregnancy? 1. Yes 2.No | |
| 6.10 | If yes, how many times did you take calcium in a day? …….. times | |
| 6.11 | If yes, how many calcium tablets did you take in a day? …… tablets | |
| 6.12 | What is the duration of calcium intake?<br>…… ….. Months of conception to …….. months of pregnancy | |
| 6.13 | How was the regularity in Calcium intake?<br>1. Taken regularly 2. Missed some doses 3. Irregular (missed >7 consecutive days | |

**7. Details of the Delivery (Delivery and Birth Register)**

| SN | Variables and responses | SN | Variables and responses | Remarks |
|---|---|---|---|---|
| 7.1 | Date of Admission: ..… /……/….. | 7.2 | Date of Delivery: …./……/….. | |
| 7.3 | Sex of newborn 1. Male 2. Female | 7.4 | Weight of newborn (Kg or Grams): ….. | |
| 7.5 | Length of Baby : ……. Cm | 7.6 | Risk category: 1. High risk 2. Low Risk | |
| | Obstetrics history (months of gestation, previous SB, ND, Preterm, mode of delivery, health problems)<br>…… | | Provisional Diagnosis (Parity, gestational age, presentation and AL/LL labor) …… | |
| 7.7 | Problems in current Pregnancy (e.g. PIH, DM, PROM):…… | | | |
| 7.8 | Hemoglobin ( at delivery) : | 7.12 | Method: 1. spontaneous | |
| 7.9 | HBSAg: | | 2. Induced | |
| 7.10 | Sugar: | 7.13 | Term: 1. Preterm (< full 37 wks) | |
| 7.11 | Other investigations:……. | | 2. Term (38-41) 3. Post dated (>41) | |
| 7.14 | Mode of delivery | | | |
| | 1. Vaginal: a. Normal b. ventouse Applied c. forceps 4. Episiotomy<br>2. LSCS: a. Emergency b. Elective [Indication:……..……..] | | | |
| 7.15 | Placental weight: | 7.16 | Placental delivery: 1. Normal 2.CCT | |
| 7.17 | Birth: 1. Live 2. Stillbirth 3. MSB 4. NICU admission | | | |
| 7.18 | APGAR Score:1 Minute : 5 Minute: | 7.19 | Congenital Anomalies ( if present): | |
| 7.20 | Final Diagnosis (Parity, Live births, term/mode of delivery)……. | | | |

**8. Baby examination/Complications in baby ( Baby register/chart)**

**……..**

**9. Any others (report if any remarks)……...**

## ANNEX III: ETHICAL CLEARANCE LETTER


# KLE UNIVERSITY

(Formerly known as KLE Academy of Higher Education & Research, Belgaum)
[Declared as Deemed-to-be-University u/s 3 of the UGC Act, 1956 vide Government of India Notification No.F.9-19/2000-U.3(A)]
'Accredited **'A' Grade** by NAAC
Office of the Registrar, KLE University,
*JNMC Campus, Nehru Nagar, Belgaum-590 010, Karnataka State, India*
☎: 0831-2444444/2493779 **FAX:** 0831-2493777 **Web:** http://www.kleuniversity.edu.in **E-mail:** info@kleuniversity.edu.in


Ref.No.KLEU/Ethic/2012-13/2453(A) Date:20th Sept. 2012

To,
Damaru Prasad Paneru
Ph.D. Scholar 2011-12
K.L.E. University, ,
Belgaum.

Dear Research Scholar,

The KLE University Ethics Committee on Human Subjects for Ph. D Research Project considered your application for approval of the research project " **PREDICTORS OF BIRTH WEIGHT: A PROSECTIVE STUDY AT TERTIARY LEVEL HOPSITAL OF BELGAUM DISTRICT KARNATAKA** ."

After review of the documents submitted by you the committee had suggested to modify the consent form. After reviewing the modified consent form, the committee has provided approval for this research project.

You are requested to report to Ethical Committee of the following:

1. Any deviation from or change of the protocol.
2. Any changes in study documents.

**(Dr. Hema Dhumale)**
**Member Secretary,**
**Ph.D. Ethical Committee(Human),**
**K.L.E. University,**
**Belgaum.**

**( Dr.P.V.Patil)**
**Chairman**
**Ph.D. Ethical Committee(Human),**
**K.L.E. University,**
**Belgaum.**

Cc to : - The Director Research Foundation, KLE University
- The Director Academic Affairs, KLE University
- The Registrar, KLE University
- Special Officer to Hon. Vice Chancellor, KLE University

# ANNEX IV: PERMISSION LETTER

From
Damaru Prasad Paneru
PHD Scholar, 2011-12 batch

Date: 2 April 2012

To
Principal
KLE University's Jawaharlal Nehru Medical College, Belgaum, Karnataka

Through Proper Channel

Subject: Permission to conduct the study on **"Predictors of Birth weight: A Prospective study at Tertiary Level Hospital of Belgaum District, Karnataka"** in the Dr Prabhakar Kore Charitable Hospital and Medical Research Centre.

Respected Sir,
Most respectfully, I would like to state that I have enrolled here in KLE University to persue PHD in Public Health in the academic year 2011-12.

I will be conducting my research study on "Predictors of Birth weight: A Prospective study at Tertiary Level Hospital of Belgaum District, Karnataka". I wish to do this study at Dr Prabhakar Kore Charitable Hospital and Medical Research Centre among the women attending in the OPD of Obstetrics and Gynecology. The registered pregnant women will be followed upto delivery. Dr (Mrs) Vijaya A. Naik (Professor and Head, Department of Community Medicine) and Dr BR Nilgar (Professor, Obstetrics and Gynecology and Director, Academic Affairs) are my research Guide and Co-Guide respectively.

Hence, I request you to kindly give me permission to do the study at Dr Prabhakar Kore Charitable Hospital and Medical Research Centre.

Thanking you

Sincerely yours

Damaru Prasad Paneru

- Permitted
To see Dr Mrs

Principal / Sir
Forwarded

PRINCIPAL
Jawaharlal Nehru Medical College
BELGAUM

Professor & Head
Dept. of Community Medicine
J. N. Medical College, Belgaum

Permitted

Medical Superintendent
K.L.E. Dr. P. K. Charitable Hospital,
BELGAUM - 590010

# ANNEX V: RELEVANT PHOTOGRAPHS

**Orientation to Team**

**Measuring height and weight at OPD**

**Team member interviewing a participant**

**Research scholar collecting data at OPD**

**Team member estimating period of gestation using a POG calculator**

## Continue (Photographs)

**Screening for HIV at Antenatal Clinic**

**Labor and PNC ward data collection team**

**Taking birth weight at Labor Room**

**Measuring Length of Newborn at PNC**

**ANNEEX VI: CERTIFICATE OF PAPER PRESENTATIONS AT CONFERENCES**

1. **Certificate of paper presentations at Pune Public Health Conference, 2013**

UNIVERSITY OF PUNE

Certificate of Participation

Pune Public Health Conference 2013

Pregnancy loss, birth defects and genetic disorders in India:
Epidemiology, social costs and health system needs

This is to certify that Dr./Mr./Ms. Panern Damru Prasad

has given a poster presentation

entitled Obstetric risk factors for low [illegible] A retrospective study from a

tertiary care hospital of Belgaum Dist. at the Pune Public Health Conference 2013 held by the

Interdisciplinary School of Health Sciences, University of Pune on 11th & 12th February, 2013

Dr. Anita Kar
Convenor

Dr. Bhushan Patwardhan
Director

## 2. Certificate of paper presentations at IPHACON, 2014

58th Annual National Conference of Indian Public Health Association

21st - 24th January 2014, S.V. Medical College, Tirupathi.

22nd State Joint Conference of IPHA & IAPSM, Andhra Pradesh Chapter

Certificate

This is to certify that Dr/Mr/Mrs. Jamary Prasad Pandey

has participated as a Delegate in the 58th Annual National Conference of Indian Public Health Association held at Sri Venkateswara Medical College, Tirupathi, Andhra Pradesh, from 22nd - 24th January 2014 and delivered a Guest Lecture/Chaired a Session/Presented a Paper entitled Bio-social predicters of low Birth Weight - A Prospective study

The Andhra Pradesh Medical Council has awarded accreditation of 15 Credit hours for this programme.

K. Satyanarayana Murthy, Registrar, Andhra Medical Council

Dr. E. Ravindra Reddy, Chairman, Andhra Medical Council

Dr. D. Shankar Reddy, Chairman, Scientific Committee

Dr. K. Ashok Kumar Reddy, Organising Secretary, IPHACON-2014

Dr. M.S. Sridhar, Organising Chairperson, IPHACON-2014

# ANNEX VII: STUDY TIMELINE

| Duration of the study (in months) | 1 | 2 | 3 | 4 | 5 | 6 | 8 | 10 | 12 | 15 | 18 | 21 | 24 | 27 | 30 | 33 | 36 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Study plan and preparation** | | | | | | | | | | | | | | | | | |
| Protocol development | | | | | | | | | | | | | | | | | |
| Development of data collection tools | | | | | | | | | | | | | | | | | |
| Manual of operation | | | | | | | | | | | | | | | | | |
| Approvals | | | | | | | | | | | | | | | | | |
| Training of study team and pretesting | | | | | | | | | | | | | | | | | |
| Procurement of equipments/stationery | | | | | | | | | | | | | | | | | |
| Meeting- Progress, **Reporting** & Review | | | | | | R | | | R | | R | | R | | R | | R |
| **Study implementation** | | | | | | | | | | | | | | | | | |
| **Data management, analysis and presentation** | | | | | | | | | | | | | | | | | |
| Publication and report writing | | | | | | | | | | | | | | | | | |
| Final report submission | | | | | | | | | | | | | | | | | |

R= reporting

# ANNEX VIII: PUBLICATIONS

ORIGINAL ARITICLE

# Bio-social predictors of low birth weight- a prospective study at a tertiary care hospital of north Karnataka, India

Paneru DP[1], Naik VA[2], Nilgar BR[3], Javali SB[4]

[1]MPH, Ph.D. Scholar, [2]Professor, Community Medicine, Department of Public Health, [3]Professor, Obstetrics and Gynecology, Jawaharlal Nehru Medical College, KLE University Belgaum, Karnataka, [4]Associate Professor, Statistics, Department of Community Medicine, USM-KLE International Medical Programme, Belgaum, Karnataka.



## Article Cycle

**Address for Correspondence:** Damaru Prasad Paneru, Department of Public Health, JN Medical College, KLE University Nehru Nagar, Belgaum , Karnataka.
E Mail ID: damaru.paneru@gmail.com

## Citation

Paneru DP, Naik VA, Nilgar BR, Javali SB. Bio-social predictors of low birth weight- a prospective study at a tertiary care hospital of north Karnataka, India. Ind J Comm Health, 25(4); 422 - 431
**Source of Funding :** Nil, **Conflict of Interest:** None declared

## Abstract

**Background**: Low Birth Weight is a multi-factorial problem of health and social concern Worldwide. India accounts for 40 % of Low birth weight (LBW) babies of the developing World and more than half of those in Asia. Despite the multitude of services rendered to improve maternal health care, LBW remains a public health problem in India. **Objective:** To determine bio-social predictors of low birth weight amongst the institutional births in North Karnataka, India. **Methods:** A prospective hospital based study was conducted in Belgaum district of north Karnataka during July 2012-March 2013. A total of 426 pregnant women registered within 20 weeks of gestation during July–September 2013; eventually delivered in the same hospital were included in the study. Birth weight was measured by a digital weighing scale of 100 gram accuracy. Data were collected through individual interviews using pretested questionnaire. Data were analyzed by SPSS (16.0 Version). Descriptive statistics and multivariate regression were applied. P value < 0.05 considered significant. **Results:** Mean age of the subjects was 23.2254±3.09 years. About 96.7% were literates. Mean age at first pregnancy was 21.37±2.70 years. Low birth weight was observed amongst 22.5% new borns (Mean weight: 2089.58±268.31Gram). Almost 10.0% were preterm births. Paternal education and occupation, socio-economic status, religion, maternal blood group and gestation age at delivery were found to be the independent and significant bio-social factors predicting the low birth weight. About 68.0% variations in the birth weight were explained by these predictors. **Conclusion:** Low paternal education and occupation (farmers/laborers), low socio-economic status, maternal blood group (A is protective) and prematurity were found to be independent bio-social predicators of LBW. Programme targeting paternal education may be useful and study of biological plausibility associated with the maternal blood group is recommended.

## Key Words

Bio-Social, predictors, Low Birth Weight, prospective, North Karnataka

## Introduction

Worldwide, estimated 130 million babies born annually(1); out of whom 15.5% born with weight less than 2500 Gram (gm).(2) Major mass (95.6%) of Low birth weight (<2500gm) babies born in developing countries.(2,3) India accounts for 40% of Low birth weight (LBW)

babies of the developing World and more than half of those in Asia.(2) National Family Health Survey-3 reported that the prevalence of LBW was 23% in rural and 19% in urban areas in India.(4) There is the wide range of variation in the prevalence of LBW amongst Indian states; where 7.6% was reported in Mizoram and 32.7 % in Haryana. Proportion of the LBW in Karnataka (18.7%) was lower than the national average (21.5%).(4,5)

LBW is a sensitive indicator for predicting the chances survival, childhood growth and cognitive development and a reflector of the obstetrics and peri-natal care. It is one of the leading causes of early neonatal death and predisposes cardiovascular and metabolic disorders in the adult life.(3,6) Although, LBW is an issue of social and health concern, specific interventions targeting the reductions of LBW are scanty. A multi-centric study from India revealed that multiple micronutrient supplementations during pregnancy do not make significant impact to improve the birth weight.(7) Complexity in determination and quantification of predictors for LBW remain challenges to reduce LBW below 10% in India.(8)

Systematic reviews on LBW identified that LBW is a multi-factorial problem of health and social concern Worldwide.(9) Estimation of relative effects of predictors is an important researchable issue. It will be eventually useful to prioritize them according to their relative importance during the designing of LBW reduction strategies.

## Aims & Objectives

In this context, an attempt has been made to determine bio-social predictors of low birth weight amongst the institutional births in North Karnataka, India.

## Methods

A prospective study was conducted in Belgaum district of North Karnataka during July 2012 to March 2013. It was conducted at the 1000 bedded tertiary care charitable hospital; attached to the KLE University's Jawaharlal Nehru Medical College. All pregnant women registered within 20 weeks of gestation in the antenatal Outpatient Department (OPD) of Obstetrics and Gynecology during July–September 2013; were included in the study. All enrolled subjects were followed up till delivery. The birth weight was recorded using standardized digital weighing machine with 100 gm accuracy. Abortions, twin deliveries, still births and follow up lost subjects were excluded. Data were collected through individual interview at OPD and maternity wards using pretested questionnaire. Data were analyzed by Statistical Package for Social Sciences (SPSS-16 version) software and the results were presented in narrative and tabular forms. Percentage, mean, standard deviation, Chi square, Fisher's Exact Test and Odds ratio were calculated; and p value <0.05 considered significant. Ethical clearance was obtained from Ethical Committee of KLE University, Karnataka and written informed consent was taken from study subjects.

A total of 712 pregnant women (gestational age <20 weeks) were registered in the antenatal OPD during study period; out of whom, 137 were excluded due to their plan to deliver outside or refused to participate. Out of the 575 enrollments, 36 were excluded as they had abortion, still births or twin delivery and 113 (19.65%) were lost to follow up. Hence, the complete information pertinent to 426 subjects was analyzed for further statistical treatment.

## Result

Socio-demographic characteristics: About two–fifth (40.8%) subjects were from urban areas whereas majority (59.2%) was from rural

residences. Municipal corporation and contentment boards were considered urban areas. Majority (57.3%) of the study subjects were 20-24 years (Mean age: 23.22±3.09 years). Mean age of urban residents was higher than those who were from rural residence (24.09±3.09 Vs 22.62±2.80 years). Overall, 96.7 % were literates where the large number of subjects (69.5%) had 5-10 years of formal schooling. Almost all subjects were housewives and 83.6% belonged to joint family. Almost 71.0% had e”5 members in a family (median: 6). Majority (85.4%) were Hindus. A great majority had d”4th class and negligible proportion (0.5%) had 1st class socioeconomic status according BG Prasad’s classification for 2013.10 More than three-fifth (62.9%) subjects had first pregnancy during 20-24 years of life with more than a quintile (21.6%) conceived during their adolescent ages (Mean age: 21.37±2.70) as shown in Table 1.

Magnitude of Low birth weight and preterm births: Almost a quarter (22.5%) of the new born had birth weight less than 2500 gm. The mean birth weight of new born was 2699.53±443.86 gram. Mean birth weight of male newborn was higher than the females. Similarly, babies born from urban mothers and Multi-gravida mothers had higher mean birth weight than the babies born from rural and primi-gravida mothers. Mean birth weight amongst the low birth weight baby was 2089.58±268.31. Mean duration of the gestation at delivery was 38.6432±2.05 weeks with almost one-tenth delivered prematurely (Table 2).

Bio-Social predictors of Low Birth Weight: In bivariate analysis, parental age, educational status and occupation, socio-economic status, type of family, numbers of members/family, religion, gravida and gestational age at delivery were found to be significant factors associated with the birth weight of a new born while there was no statistical relationship between birth weight of newborns and maternal residence, sex of newborn, marital relationship and age at first pregnancy (Table 3).

Proportion of LBW was higher amongst the babies born to adolescent mothers (62.5%) as against e”25 year’s old mothers. The higher proportion of LBW was observed amongst those newborns whose father was <30 years, had low education and occupation (farmers, labors, services holders) as against the > 30 years old, high education and private/business workers respectively. Similarly, subjects who had poor socio economic status, joint families, e”5 members/family, Hindu and Jain, blood group AB, primi-gravida and premature delivered higher proportions of LBWs as against those having better socio-economic status, nuclear families, Muslims, blood group O, multi-gravida and full terms.

The variables which were found to be statistically significant Chi square test were further subjected for multivariate regression analysis. After controlling all the potential confounders, paternal education and occupation, socio-economic status, religion, blood group and gestational age at delivery were found to be independent significant bio-social predictors of LBW. Odds of occurrence of LBW was 3.5 times more likely amongst the babies whose father had d” tenth standard education as compared those who had higher education. Higher paternal education perhaps plays an enabling role in decision making in relation to the maternal health care. The mothers with low socio-economic status had more than 59 times higher odds of delivering LBW baby. Hindu and Jain had multiple times (OR: 11.14, 235.98) higher odds of favoring LBWs as compared to the Muslim births, nevertheless; the association may be due to the variations in subjects under each category. The mothers having Blood Group ‘A’ were found to be significantly less at risk of delivering LBW babies as against ‘O’ group

mothers. Risk of having LBW amongst preterm births was multifold higher than full term births (Table 4). Almost 68 % prediction was explained by the model which shows good model fit (p=0.89).

## Discussion

In our study, majority (59.2%) of the subjects were from rural areas. Similar findings are reported from Tamil Nadu and North India where more than seventy percent subjects were from rural areas.(11,13) Almost 90.0 % subjects were 20-29 years old. Findings of this study corroborates with a study from Maharastra, India and an Ethiopian study where more than 90 % subjects were above 20 years.(12,14,15) As against this, majority (58.5%) of the subjects in Uttarakhand, India were <20 years.(13) Higher numbers of adolescents in their study might be due to the higher incidence of early marriage followed by subsequent early conception. Mean age of the subjects was 23.22±3.09 years which is consistent with the studies from Tamil Nadu, Maharashtra, and Ahmadabad, India while it was lower than the Ethiopian findings. (11,13, 14,16) Almost all were housewives/agriculture workers and almost seven out of every ten subjects had d"4th class socio-economic status. Similar observations were made by Agrawal et al.(12) More than a quintile (21.6%) subjects conceived during their adolescent ages. The proportion of adolescent pregnancies was lower than that was reported in Nagpur (41.9%) in 1994.(17) This variation might be due to the increased level of awareness, improved access to health services and education services and enactment of law regarding the minimum age at marriage in India.

The mean birth weight of newborn was 2699.53±443.86 gram. It was lower than that was reported in a study from Haryana, India, Nigeria, Bangladesh and Ethiopia and higher than that was observed in Ahmadabad and Kolhapur, India.(14,16,18-22) Low birth weight was prevalent amongst 22.5 %. Wide variations was observed with the 11.8 % in Tamil Nadu and the highest in Uttrarakhand (40%) in hospital based studies.(11,12,14-16,18,23,24,25,26,27) NFHS-3 also reported the wide variations in the proportion of LBW, ranging from 7.7 % in Mizoram to the highest (32.5%) in Haryana, 18.5 % in Karnataka with 21.5 % national averages.(4) Mean birth weight amongst the low birth weight baby was 2089.58±268 gram. It was lower than the two studies conducted in Mumbai and Kolhapur and higher than that was reported from western Maharastra.(14,18,24) Mean duration of the gestation at delivery was 38.64±2.05 weeks with almost ten percent being preterm deliveries. Mean gestation observed in a study from Ahmadabad was almost similar to our findings. However, proportion of preterm deliveries in their study was almost 20.0 % higher than our findings.(16)

Paternal Education and occupation were found to be the significant predictors for LBW. The Newborns whose father was farmers/laborers or service holders had higher odds of having LBW as against the private workers/business workers. Our findings are concurrent to the findings of Deshpande and Som.(14,28) Significantly higher proportion of the mothers belonging in low socioeconomic status delivered LBW babies as compared to those mothers with higher SES. This finding is in agreement with the several national and international studies.(12,16-18,24,26,30) Chances of delivering LBW amongst the mothers having Blood group was 'A' significantly low when compared with the mothers of 'O' blood group. Preterm births had multifold higher risk of LBW as compared to full term births which is consistent with the several national and international studies.(14-16,18)

## Conclusion

The proportion of LBW amongst the mothers delivering in a tertiary hospital was 22.5%. Low paternal education and occupation (farmers/laborers), low socio-economic status, maternal blood group (A is protective) and prematurity were found to be independent bio-social predicators of LBW. Programmes targeting on paternal education may be useful and investigations of biological plausibility associated with the maternal blood group is recommended.

## Acknowledgement

Authors are thankful to KLE University, JN Medical College, all staffs of Dr PK Charitable Hospital and the study subjects.

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## Tables

**TABLE 1: SOCIO-DEMOGRAPHIC CHARACTERISTICS**

| Variables | Numbers | % |
|---|---|---|
| Residence | | |
| Urban | 174 | 40.8 |
| Rural | 252 | 59.2 |
| Age ( in years) | | |
| <20 | 32 | 7.5 |
| 20-24 | 244 | 57.3 |
| 25-29 | 124 | 29.1 |
| ≥30 | 26 | 6.1 |
| Mean age : Urban - 24.09±3.09 | Rural : 22.62±2.80 | Total : 23.2254±3.09 |
| Education | | |
| Illiterate and primary | 14 | 3.3 |
| Lower secondary and secondary | 296 | 69.5 |
| Pre- University and university | 116 | 27.2 |
| Occupation | | |
| Housewife | 414 | 97.2 |
| service holders/business | 12 | 2.8 |
| Type of family | | |
| Nuclear | 70 | 16.4 |
| Joint | 356 | 83.6 |
| Numbers of Family members in a family | | |

| | | |
|---|---|---|
| ≤ 4 | 124 | 29.1 |
| ≥5 | 302 | 70.9 |
| Median numbers of family members - 6.0, Minimum-Maximum (2-36) | | |
| Religion | | |
| Hindu | 364 | 85.4 |
| Muslim | 50 | 11.7 |
| Jain | 12 | 2.8 |
| Socioeconomic status (monthly per-capita income) | | |
| I | 2 | 0.5 |
| II | 50 | 11.7 |
| III | 72 | 16.9 |
| IV | 148 | 34.7 |
| V | 154 | 36.2 |
| Age at first pregnancy ( in years) | | |
| <20 | 92 | 21.6 |
| 20-24 | 268 | 62.9 |
| ≥25 | 66 | 15.5 |
| Mean age = Urban : 21.87±3.02 | Rural : 21.03±2.41 | Total : 21.37±2.70 |

**TABLE 2: MAGNITUDE OF BIRTH WEIGHT AND PRETERM BIRTHS**

| Variables | Numbers | % |
|---|---|---|
| Birth weight ( in Gram) | | |
| Low Birth Weight (< 2500gram) | 96 | 22.5 |
| Normal Birth Weight ( ≥2500gram) | 330 | 77.5 |
| Weeks of gestation at delivery (completed weeks) | | |
| Preterm (<37) | 44 | 10.3 |
| Full term ( ≥37) | 382 | 89.7 |
| Mean birth weight | | |
| Male : 2721.34±467.89 | Female : 2678.715±419.67 | Overall Mean birth weight: 2699.53±443.86 |
| Urban: 2713.90±448.97 | Rural: 2689.60±440.91 | |
| LBW: 2089.58±268.31 | Normal : 2876.96±305.89 | |
| Primi-gravida: 2693.19±503.11 | Multi-gravida: 2704.82±388.49 | |
| Mean gestation at delivery : | | 38.64±2.05 weeks |

**TABLE 3: RELATIONSHIP BETWEEN SOCIO-DEMOGRAPHIC CHARACTERISTICS AND BIRTH WEIGHT**

| Predicting Factors | | Birth weight | | Statistics |
|---|---|---|---|---|
| | | <2500gm | ≥2500 gm | |
| Residential place | City | 36 | 138 | χ2=0.57, p>0.05, df=2 |
| | Village | 60 | 192 | |
| Maternal Age | <20 | 20 | 12 | χ2=32.18 , p=0.001*, df=2 |
| | 20-24 | 50 | 194 | |
| | ≥25 | 26 | 150 | |
| Paternal Age | <30 | 66 | 178 | χ2=6.66, p=0.01*, df=1 |
| | ≥30 | 30 | 152 | |
| Education | Illiterate and primary | 2 | 12 | χ2=6.59, p=0.01*, df=1 |
| | up to secondary | 58 | 238 | |
| | PUC and University | 36 | 80 | |
| | (category I and II were clubbed together for the calculation of χ2 ) | | | |
| Paternal education | ≤ secondary | 64 | 176 | χ2=5.37, p=0.02*, df=1 |
| | PUC and University | 32 | 154 | |
| Occupation | Housewife | 96 | 318 | |

| | Services | 0 | 12 | Fisher's Exact Test =3.59, p >0.05 |
|---|---|---|---|---|
| Paternal Occupation | Farmer | 40 | 84 | χ2=21.44, p =0.001* df=3* |
| | Service | 12 | 28 | |
| | Private works/business | 18 | 146 | |
| | Laborers | 26 | 72 | |
| Socio-economic Class | I-III Class | 4 | 120 | χ2=37.35, p=0.01*, df=1 |
| | IV-Vth Class | 92 | 210 | |
| Family type | Nuclear | 6 | 64 | χ2=9.35, p =0.002*, df=1 |
| | Joint | 90 | 266 | |
| No. of Family Members | ≤ 4 | 20 | 104 | χ2=4.11, p=0.04*, df=1 |
| | ≥5 | 76 | 226 | |
| Religion | Hindu and Muslim | 88 | 326 | χ2= 12.55 p=0.001*, df=1 (Yate's correction) |
| | Jain | 8 | 4 | |
| New born sex | Male | 50 | 158 | χ2=0.52, p>0.05, df=1 |
| | Female | 46 | 172 | |
| Maternal Blood group | A | 28 | 114 | χ2=29.93, p=0.001*, df=3 |
| | B | 20 | 86 | |
| | AB | 22 | 16 | |
| | O | 26 | 114 | |
| Consanguinity | Consanguineous | 20 | 76 | χ2=0.20, p>0.05, df=1 |
| | Non- Consanguineous | 76 | 254 | |
| Gravida | Primi | 54 | 140 | χ2=5.32, p=0.01*, df=1 |
| | Multi | 42 | 190 | |
| Maternal age at first pregnancy | <20 | 26 | 66 | χ2=3.79, p>0.05, df=1 |
| | 20-24 | 60 | 208 | |
| | ≥25 | 10 | 56 | |
| Gestational age at delivery | Preterm( <37) | 42 | 2 | χ2=147.46, p=0.001* df=1 (Yate's correction) |
| | Full term ( ≥37) | 328 | 54 | |

* Statistically significant (p<0.05)

**TABLE 4: ESTIMATION OF LEVEL OF RISK FOR LBW ASSOCIATED WITH INDEPENDENT PREDICTORS**

| Variable/ category | No. of LBW (%) | Unadjusted Odds ratio | | | Adjusted Odds ratio | | |
|---|---|---|---|---|---|---|---|
| | | OR | 95% CI | p Value | OR | 95% CI | p value |
| Maternal age | | | | | | | |
| <20 | 20(62.5) | 7.94 | 3.46-18.25 | 0.001* | 3.22 | 0.69-14.93 | 0.13 |
| 20-24 | 50(20.5) | 1.22 | 0.72-2.07 | 0.44 | 0.42 | 0.16-1.06 | 0.06 |
| ≥25 | 26(17.3) | 1 | ref | - | 1 | ref | - |
| Paternal age | | | | | | | |
| <30 | 66 (27.0) | 1.87 | 1.15-3.04 | 0.01* | 2.35 | 0.93-5.92 | 0.20 |
| ≥30 | 30(16.5) | 1 | ref | | 1 | ref | - |
| Maternal Literacy (Academic Grade) | | | | | | | |
| ≥Pre/University (≥11th) | 36 (31.0) | 1.87 | 1.56-3.04 | 0.01* | 1.75 | 0.62-4.90 | 0.28 |
| ≤Secondary (10th) | 60 (19.4) | 1 | ref | | 1 | ref | - |
| Paternal education (formal schooling) | | | | | | | |
| ≤ 10th | 64 (26.7) | 1.75 | 1.08-2.81 | 0.02* | 3.57 | 1.28-9.97 | 0.01* |
| ≥11th | 32(17.2) | 1 | ref | | 1 | ref | - |
| Paternal Occupation | | | | | | | |
| Farmer | 40 (32.3) | 3.86 | 2.08-7.16 | 0.001* | 1.32 | 0.46-3.76 | 0.62 |
| Service | 12(30.0) | 3.47 | 1.50-8.01 | 0.003* | 12.48 | 2.76-56.41 | 0.001* |

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| Laborers | 26(26.5) | 2.92 | 1.50-5.68 | 0.002* | 1.74 | 0.57-5.28 | 0.32 |
| Private works/business | 18(11.0) | 1 | ref | - | 1 | ref | - |
| Socioeconomic Classification | | | | | | | |
| I-III Class | 4 (3.2) | 1 | ref | 0.001* | 1 | ref | - |
| IV-V Class | 92 (30.5) | 13.14 | 4.71-36.66 | | 59.14 | 10.08-346.76 | 0.001* |
| Family Type | | | | | | | |
| Nuclear | 6(8.6) | 1 | ref | 0.004* | 1 | ref | - |
| Joint | 90 (25.3) | 3.60 | 1.51-8.61 | | 1.825 | 0.33-9.81 | 0.48 |
| Family Members | | | | | | | |
| ≤ 4 | 20(16.1) | 1 | ref | 0.04* | 1 | ref | - |
| ≥5 | 76(25.2) | 1.74 | 1.01-3.01 | | 0.74 | 0.26-2.01 | 0.57 |
| Religion | | | | | | | |
| Hindu | 86(23.6) | 7.42 | 1.76-31.18 | 0.006* | 11.27 | 1.76-72.16 | 0.01* |
| Jain | 8(66.7) | 48.0 | 7.5-306.82 | 0.001* | 235.98 | 7.46-7462.48 | 0.002* |
| Muslim | 2(4.0) | 1 | ref | - | 1 | ref | - |
| Maternal Blood Group | | | | | | | |
| A | 28(19.7) | 1.07 | 0.59-1.95 | 0.80 | 0.12 | 0.03-0.39 | 0.001* |
| B | 20 (18.9) | 1.02 | 0.53-1.94 | 0.95 | 0.75 | 0.28-1.98 | 0.56 |
| AB | 22 (57.9) | 6.02 | 2.78-13.04 | 0.001* | 2.18 | 0.35-13.41 | 0.40 |
| O | 26 (18.6) | 1 | ref | - | 1 | ref | - |
| Gravida | | | | | | | |
| Primi | 54 (27.8) | 1.75 | 1.10-2.76 | 0.01* | 2.195 | 0.90-5.32 | 0.08 |
| Multi | 42 (18.1) | 1 | - | | 1 | ref | - |
| Gestation at delivery (in weeks) | | | | | | | |
| Preterm (<37) | 42(95.5) | 127.56 | 29.99-542.38 | 0.001* | 1285.87 | 127.93-12924.05 | 0.001* |
| Full term ( ≥37) | 54(14.1) | 1 | ref | | 1 | ref | - |

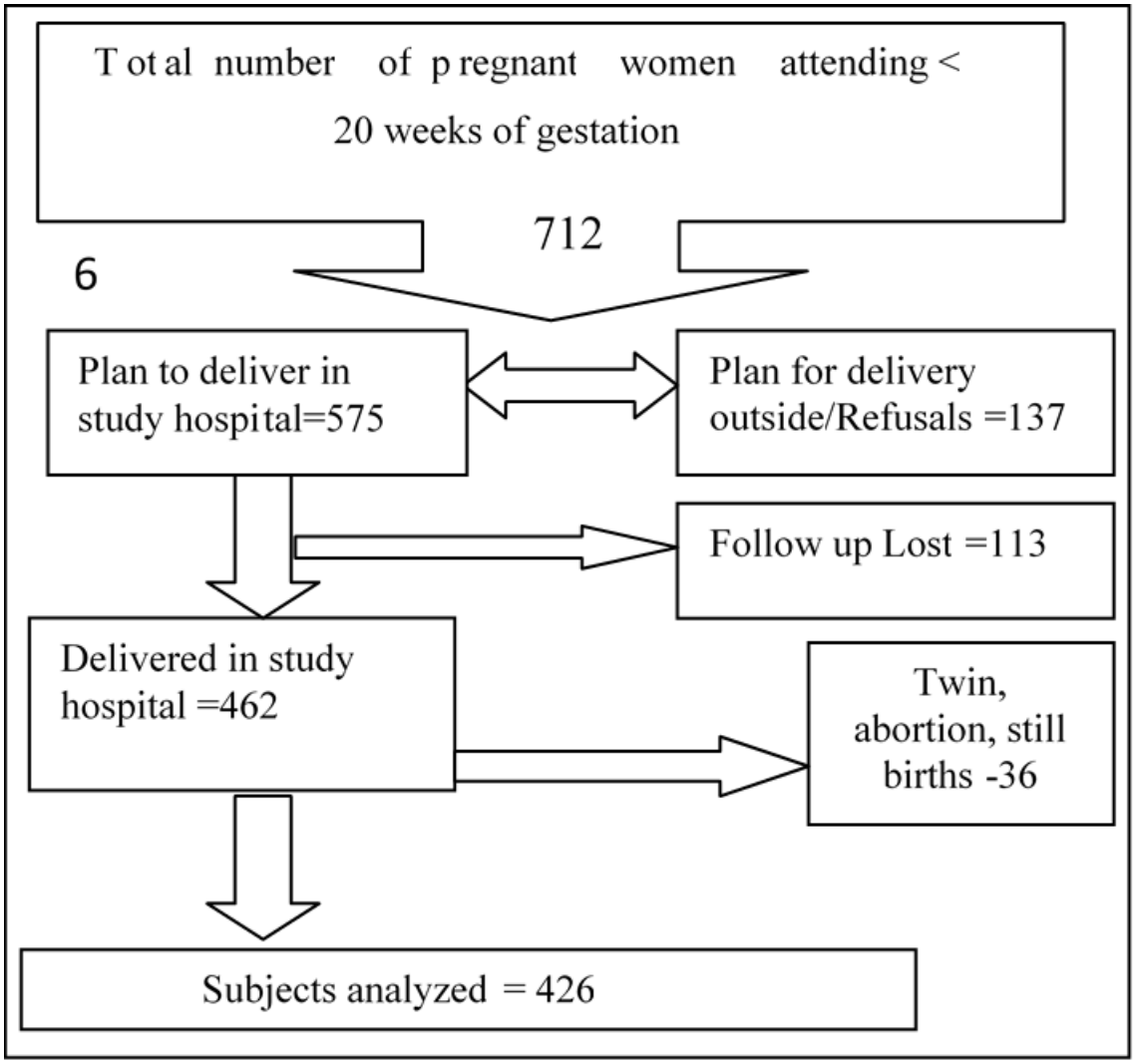
Variables entered on step 1: age, paternal age, maternal and paternal education, paternal occupation, socio-economic status, type of family, No. of member/family, religion, maternal blood group, gravida and gestation age.

Final model had following statistics: -2 Log likelihood = 202.42, Nagelkerke $R^2$=0.68.

Hosmer and Lemeshow Test: p=0. 89

## Figures

**FIGURE 1: FLOW CHART FOR SELECTION OF STUDY SUBJECTS**


T ot al number of p regnant women attending < 20 weeks of gestation
712
6
Plan to deliver in study hospital=575
Plan for delivery outside/Refusals =137
Follow up Lost =113
Delivered in study hospital =462
Twin, abortion, still births -36
Subjects analyzed = 426

**Original Article**

# OBSTETRIC RISK FACTORS FOR LOW BIRTH WEIGHT AMONGST FULL TERM BABIES BORN AT A TERTIARY CARE HOSPITAL OF BELGAUM DISTRICT, SOUTH INDIA

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**Financial Support:** None declared

**Conflict of interest**: None declared



**How to cite this article**:
Paneru DP, Naik VA, Nilgar BR, Mallapur MD. Obstetric Risk factors for Low Birth Weight amongst Full Term Babies Born at a Tertiary Care Hospital of Belgaum District, South India. Natl J Community Med 2014; 5(1): 81-84.

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**Date of Submission:** 12-12-13
**Date of Acceptance:** 30-03-14
**Date of Publication:** 31-3-14

## ABSTRACT

**Introduction**: Low Birth Weight is a multifaceted socio- medical and public health problem, especially in developing countries where Intrauterine Growth Retardation remains major manifestation. This study was carried out to identify obstetric risk factors for Low Birth Weight amongst full term babies born at a tertiary care hospital.

**Methodology**: This was the retrospective record-based study, carried out at the Dr P.K Charitable Hospital of Belgaum district, South India. Records of all consecutive full term (≥37 weeks of gestation) singleton live births occurring during the period from 1st April–September 31, 2012 was examined to obtain relevant information.

**Results:** A total of 1299 women delivered singleton live births at full term during the stipulated time period. Mean maternal age was 23.28±3.39 years, 53% were primi-gravida and 48.8% were high risk pregnancy. Low birth weight (LBW) was prevalent amongst 19.3% new born. Among the independent significant factors associated with the LBW, primigravida, hypertensive mothers, non cephalic presentation, female baby had 1.31, 1.96, 2.89 and 1.33 times higher odds of delivering/having LBW as against multigravida, normotensive mothers, cephalic presentation and male baby respectively.

**Conclusions:** Primigravida, hypertensive disorders during pregnancy, fetal presentation at delivery and sex of the new born were significantly associated with the LBW. Early identification, monitoring and management of hypertensive disorders during pregnancy eventually reduce the LBWs attributable to hypertension.

**Key-words**: Obstetrics, Risk factors, Low birth weight, Full term, Tertiary care, South India

## INTRODUCTION

Low Birth Weight is a multifaceted socio- medical and public health problem.[1] It is one of the reliable indicator to measure the success of maternal and child health programs. [2] It is estimated that every year 15.5% of all global live births born with the Low Birth Weight (LBW); out of which more than 95% LBW infants born in developing countries.[3] South Central Asia has the highest prevalence (almost 50% of all global LBW babies) of LBW [3,4]; wherein India contributes (40% of all Asian low birth weight) to the highest proportion amongst all the Asian counties.[3] There is the large state-wide variation (lowest in north east and highest in north) [5] in the prevalence of LBW in India with the average national estimate remains as high as 28%.[6]

LBW is a multi-factorial phenomenon of enormous medical, societal and financial problem.[5,7,8] It may results either due to the baby is born prematurely (<37 weeks of gestation) or due to Intrauterine Growth Retardation (IUGR).[3] Evidences suggest that the low weights at birth in majority of the developing countries are due to IUGR as against the preterm births in developed countries.[9,10] There are more than forty three factors known to have detrimental effects on birth weight; out of them maternal environment is one of the most important predictor. [9,11]

In spite of the special attention has been paid to the maternal and child health care, India has been lagging behind in achieving the target of Millennium Development Goal-4 of reducing the infant mortality.[12,13] Although, LBW is one of the major contributor of the

prenatal survival, physical and mental growth and a strong predictor of adulthood morbidities; [4,14] Indeed, it has not been designated as the indicator to monitor progress of MDG 4. This may be due to the paucity of reliable data pertaining to the birth weight and its specific determinants. In this context, this study was carried out to identify the obstetrics risk factors for Low Birth Weight amongst full term babies born at a tertiary care hospital in Belgaum, South India.

## MATERIALS AND METHODOLOGY

A retrospective record-based study was carried out at the department of Obstetrics and Gynaecology, Dr P.K. Charitable Hospital of Belgaum district, Karnataka. It is the largest, multi facility tertiary care hospital of Belgaum district which is a constituent organization of the Jawaharlal Nehru Medical College of Belgaum, Karnataka, South India. After taking permission from hospital authority, records of all consecutive full term (≥37 weeks of gestation) singleton live births occurring during the period from 1st April–September 31, 2012 were examined to obtain information regarding new born weight and pregnancy related factors from the delivery and birth registers. Data were analyzed using SPSS 20.0 trial version. Descriptive statistics, Chi-square and Odds Ratio were calculated. Multivariate regressions were applied to infer the risk associated with each of the factors. P value <0.05 was considered statistically significant.

## RESULTS

This record based review made known that 1758 women delivered in the study hospital during April–September 2012. Out of those hospital deliveries, 1299 (73.89%) delivered the singleton live birth at full term. Mean gestational age at delivery was 39.08±1.61 weeks.

**Background characteristics:** Almost two-third (63%) pregnant women were 20-24 years and their mean age at delivery was 23.28±3.39 years. Majority women were from urban area (53.7%), Hindus (92.2%) and more than half of them were primi-gravida. Almost three-quarters had taken antenatal care (ANC) and almost half of all were high risk pregnancies. Amongst the new born, male (52.7%) were more than female (47.3%) as shown in table-1.

**Distribution of birth weight (n=1299):** Out of all 1299 full term singleton live births, almost one-fifth (19.3%) babies had low birth weight (<2500gm). Of total 251 LBW babies, 9(3.58%) had very low birth weight (birth weight <1500gm) and 241(96.41%) had birth weight between 1500-2499 gm.

**Association between birth weight and covariates:** Higher proportions of LBW babies were born to the adolescent and elderly mothers as compared to the mothers of 20-24 years age (p=0.08). Babies born to the rural women (residents of out of municipal and cantonment boards) (p=0.1), mothers with the previous history of still birth (p=0.08) and LBW (p=0.4) had delivered slightly higher numbers of LBW babies; however, none of these factors are statistically significant. Primi-gravida had delivered significantly higher proportion of LBWs as against the multigravida (p=0.02). On the contrary, mothers with the previous history of caesarean section had delivered significantly lower proportion of LBW (p=0.03). History of abortion did not show any statistical association with the occurrence of low birth weight (table 2).

**Table 1: Background characteristics (n=1299)**

| Variables | Numbers (%) |
|---|---|
| **Age( in years)** | |
| ≤19 | 86 (6.6) |
| 20-24 | 819 (63) |
| 25-29 | 320 (24.6) |
| 30-34 | 60 (4.6) |
| ≥35 | 14 (1.1) |
| Mean age ± SD=23.28±3.39 | |
| **Residence** | |
| Rural | 601 (46.3) |
| Urban | 698 (53.7) |
| Religion | |
| Hindu | 1198 (92.2) |
| Muslim | 98 (7.5) |
| Christians | 3 (0.2) |
| **Gravida** | |
| 1 | 688 (53) |
| 2 | 390 (30) |
| 3 | 179 (13.8) |
| ≥4 | 42 (3.2) |
| **Antenatal registration** | |
| Unregistered | 338 (26) |
| Registered | 961 (74) |
| **Maternal risk category** | |
| High risk | 634 (48.8) |
| Low risk | 665 (51.2) |
| **Sex of the new born** | |
| Female | 615 (47.3) |
| Male | 684 (52.7) |

Figures in the parenthesis indicate the percentage

An association between present pregnancies related variables and the low birth weight is depicted in table 3. There was small numerical difference in the proportion of low birth weight babies born to the mothers who had and had not ANC care during the pregnancy (p=0.5). Meanwhile, high risk mothers (p=0.008) and the mothers those who had hypertensive disorders during the current pregnancy had delivered significantly higher portion of low birth weight babies (p=0.001). Premature Rupture of membrane (PROM) did not make any statistical difference in the occurrence of LBW (p=0.2). Additionally, significantly higher proportions of the LBW babies were born to a mother who had other than cephalic presentation (p=0.002). Significantly, LBW was more frequently observed among the female child as against the male new born (p=0.01).

**Table 2: Association between participant's characteristics and birth weight (n=1299)**

| Obstetric Factors | Birth weight (in grams) | | Statistics |
|---|---|---|---|
| | LBW (≤2499) | Normal (≥2500) | |
| **Maternal age** | | | |
| ≤19 | 24(27.9) | 62(72.1) | p=0.08 |
| 20-24 | 161(19.7) | 658(80.3) | (df=4) |
| 25-29 | 55(17.2) | 265(82.8) | |
| 30-34 | 7(11.7) | 53(88.3) | |
| ≥35 | 4(28.6) | 10(71.4) | |
| **Residence** | | | |
| Rural | 127(21.1) | 474(78.9) | p=0.1 |
| Urban | 124(17.8) | 574(82.2) | |
| **Gravida** | | | |
| primi-gravida | 149(21.7) | 539(78.3) | p=0.02* |
| multi-gravida | 102(16.7) | 34(83.3) | OR=1.37 |
| **History of Still birth (n=611)** | | | |
| Yes | 5(33.3) | 10(66.7) | p=0.08 |
| No | 97(16.3) | 499(83.7) | |
| **History of delivery of LBW (n=611)** | | | |
| Yes | 7(21.2) | 26(78.8) | p=0.4 |
| No | 95(16.4) | 483(83.6) | |
| **History of caesarean section (n=611)** | | | |
| yes | 25(12.2) | 180(81.8) | p=0.03*, |
| No | 77(19) | 329(81) | OR=0.53 |
| **History of abortion (n=611)** | | | |
| yes | 17(15) | 96(85) | p=0.6 |
| No | 85(17.1) | 413(82.9) | |

Figures in the parenthesis indicate the percentage, Reference category: Multi-gravida, no history of Caesarean section

Level of risk associated with each of the significant factors identified for LBW was estimated by the Odds Ratio. Univariate analysis revealed that previous history of caesarean section had an inverse association with the LBW. Except maternal risk status, which was significant at the univariate analysis, primigravida, hypertensive disorders, foetal presentation, and the sex of new born were found to be the independent risk factors associated with the LBW i.e. hypertensive mothers had more than two times risk of delivering LBW baby, foetal presentation other than cephalic had 2.89 times higher risk of LBW and the female child carried 1.33 times higher risk of having LBW than the male child respectively (table 4).

**Table 3: Associations between current pregnancy related variables and low birth weight**

| Status | Birth weight (grams) | | Statistics |
|---|---|---|---|
| | LBW (≤2499) | Normal (≥2500) | |
| **Registration status** | | | |
| Unregistered | 69(20.4) | 269(79.6) | p=0.5 |
| Registered | 182(18.9) | 779(81.1) | |
| **Risk status** | | | |
| High risk | 140(22.1) | 494(77.9) | p=0.008*, |
| Low risk | 111(16.7) | 554(83.3) | OR=1.41 |
| **Maternal haemoglobin before delivery** | | | |
| Anaemic(<11 mg/dl) | 1459(19.7) | 585(80.1) | p=0.1 |
| Normal (≥11 mg/dl) | 106 (18.6) | 463(81.4) | |
| **Hypertensive disorders** | | | |
| Yes | 32(33) | 65(67) | p=0.001* |
| No | 219(18.2) | 984(81.8) | OR=2.21 |
| **PROM** | | | |
| Yes | 19(24.4) | 59(75.6) | p=0.2 |
| No | 232(19) | 989(81) | |
| **Foetal presentation** | | | |
| Other than cephalic | 14(40) | 21(60) | p=0.002*, |
| Cephalic | 237(18.8) | 1027(81.2) | OR=2.88 |
| **Sex of the new born** | | | |
| Female | 136(22.1) | 479(77.9) | p=0.01*, |
| Male | 115(16.8) | 569(83.2) | OR=1.4 |

Figures in the parenthesis indicate the percentage; Reference category: low risk, absence of hypertensive disorders, cephalic presentation and male sex of the baby.

**Table 4: Multivariate logistic regression analysis**

| Variables | B | S.E. | Wald | df | Sig. | Exp(B) | 95% C.I. for EXP(B) | |
|---|---|---|---|---|---|---|---|---|
| Primi Vs multi-gravida | .323 | .149 | 4.720 | 1 | 0.030* | 1.381 | 1.032 | 1.848 |
| High risk Vs Low risk | .229 | .155 | 2.176 | 1 | 0.14 | 1.257 | .928 | 1.705 |
| Hypertensive disorders | .675 | .245 | 7.587 | 1 | .006* | 1.963 | 1.215 | 3.173 |
| Fetal Presentation | 1.003 | .362 | 7.690 | 1 | 0.006* | 2.726 | 1.342 | 5.537 |
| Female Vs male baby | .329 | .143 | 5.277 | 1 | 0.022* | 1.389 | 1.049 | 1.839 |
| Constant | -3.129 | .889 | 12.393 | 1 | 0.001* | .044 | - | |
| Omnibus Tests | | | | | 0.001* | Nagelkerke R Square=0.39 | | |
| Hosmer Lemeshow | | | | | 0.973 | | | |

**Reference OR=1, Variables entered in final model:** Gravida, risk status, hypertensive disorders, foetal presentation and sex of the new born.

## DISCUSSION

Low weight at birth amongst the full term new born has paramount importance in the clinical practices and research. Understanding the etiological differences of premature and full term low birth weight might be the useful guide in clinical case management. In pertinent to the clinical significance, present study was carried out with an aim to estimate the occurrence of low birth weight and to evaluate the potential obstetric risk factors responsible LBW amongst the full term new born.

In the present study, mean maternal age at delivery was 23.28±3.39 years which is lower than that was reported in an Iranian study conducted at the maternity hospitals of Tehran (25.7± 5.3 years).[1] Slight variations in the average age might be due to higher proportion of the subjects below 25 years in our study as against Iranian study.

Mean gestational age at delivery was 39.08±1.61weeks. This finding corresponds with an Iranian study (39.03±1.36 weeks). [1] Almost one-fifth (19.3%) babies born at full term had low birth weight. Our findings are lower than the Sachin et al observed in Maharastra (26.8%)[7] and 21.5% observed in Indian National Family Health Survey-3;[15] while about 5% of term births

were LBW in the studies conducted in Iran and Pakistan.[1,16] These differentiations indicate the needs to identify the determinants of such variations. Primigravida had delivered significantly higher proportion of LBWs as against the multigravida which are in agreement with other Indian studies.[7,11] Significantly low proportion of LBWs were born to the mothers with the earlier history of caesarean section (p=0.03). High risk mothers and the mothers those who had hypertensive disorders during the current pregnancy had delivered significantly higher portion of low birth weight babies. Similar findings were reported from Iran, India, Pakistan and Tanzinia.[1,7,11,16,17] Similarly, significantly higher proportions of the LBW babies with were born to the mothers who had other than cephalic presentation and more frequently observed among the female child as against the male new born.[17]

Although, maternal age at delivery and anaemia have been reported to be the significant factors affecting the birth weight,[1,7,11,16,17] our study did not show the independent effects of these factors over the birth weight.[7] Primigravida, hypertensive disorders, fetal presentation, and the sex of new born were found to be the independent risk factors associated with the LBW. Hypertensive mothers had almost two times risk of delivering LBW baby. Findings of the present study corroborate with similar studies conducted at the national and international level i.e. Mothers with the hypertensive disorders during pregnancy carries more than double fold risk for delivering low birth weight consistently.[1,7,11,16,17] Fetal presentation other than cephalic carried 2.89 times higher odds for LBW. Female child carried 1.33 times higher risk of having LBW than the counterpart male child which are in agreement with the Tanzanian study (OR, 1.35).[17]

## LIMITATIONS

Limitations of the retrospective study are inherent in this study and only well recorded selected risk factors were studied.

## CONCLUSIONS

Low birth weight was observed amongst 19.3 percent full term new born. Primigravida, presence of hypertensive disorders during pregnancy, fetal presentation at delivery and the fetal sex were the found to be significantly associated with the LBW. Early identification, monitoring and management of hypertensive disorders during pregnancy will eventually reduce the LBWs attributable to these conditions during pregnancy.

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