

Original Research Article


Maternal hemoglobin concentration in relation to neonatal birth weight

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Abstract

Background: The birth weight of an infant is the most important determinant of its chance of survival health growth and development. The prevalence of low birth weight (LBW) is higher in Asia than elsewhere. Low birth weight is a major determinant of mortality, morbidity and disability in infancy and childhood and has a long term impact on health outcomes in adult life.

Objective: The purpose of this study was to assess the relationship between maternal hemoglobin concentration with neonatal birth weight.

Material and methods: The maternal Hb concentration and birth weight parameters were obtain randomly in 100 women delivered from the Department of Obstetrics and Gynecology, Central Referral Hospital, Tadong 5th mile Sikkim. Out of 100 cases, 35 cases were maternal Hb (<10 gm%), 35 were maternal Hb (10-13 gm%) and 30 were maternal Hb (>13 gm%) and all the maternal age ranging from 20-45 years. All data analysis was done using SPSS V 16 statistical software. The data were presented mean ± SD, and statistical analysis was carried out using student-T test.

Results: Analysis of the data shows that anemia (Hb< 10 g/dl) was associated with a significantly increase risk of low birth weight (< 2500 g) and even same for high maternal hemoglobin (> 13 g/dl). The minimum incidence of low birth weight occurs in association with maternal hemoglobin concentration of 10-13 g/dl.

Conclusion: Maternal Hb concentration of 10-13gm% should be regarded as optimal for fetal growth and well-being associated with the lowest risk of low birth weight.

Key words

Maternal, Hemoglobin, Neonatal, Birth weight.

Introduction

The birth weight of an infant is the most important determinant of its chance of survival, health growth and development. The prevalence of low birth weight (LBW) is higher in Asia than elsewhere. Low birth weight is a major determinant of mortality, morbidity and disability in infancy and childhood and has a long term impact on health outcomes in adult life [1].

Low birth weight (LBW) is the dominating risk factor for infant morbidity and mortality (36% of all mortality in children <5 years of age), constituting about 4 million deaths per year.

According to WHO, “babies with a weight of 2,500 grams or less should be designated as low birth-weight babies. Micronutrient deficiencies during pregnancy have shown to have serious implications on the developing foetus. Birth weight is a strong indicator not only of the mother’s health and nutritional status but also of the newborn’s chances for survival, growth, long-term health and development [1, 2].

Globally an estimated 15% of births (over 20 million newborns) result in low birth weight babies [2]. There are two main group of LBW babies - preterm (28 to 37 weeks) and those with fetal growth retardation also called as small for term gestational babies. Majority of LBW babies are small for gestational age.

In India according to national family health survey-3 (NFHS-3) prevalence of low birth weight babies is 21.5%. LBW is major cause of infant mortality and is considered as a sensitive index of nation health and development.

The low birth weight neonates are predisposed to a number of neonatal problems like hypothermia, inability to suckle the breast, asphyxia, sepsis, infection, hypoglycemia etc. Intrauterine growth is now considered an important determinant of both short and long-term outcomes for an individual [3, 4]. Maternal Hb is one of the

important factor that influence birth weight. There is striking association of birth weight with hemoglobin concentration, both low and high Hb concentration show adverse effect. The shape of the relation of hemoglobin concentration to birth outcome will probably depend on when the hemoglobin is measured, although this has not been fully described. The normal hemoglobin (Hb) concentration in the body is between 12-14 gm%. During pregnancy, plasma volume increases by 50 per cent, there is a consequent fall in Hb concentration, hematocrit and red cell count because of hemodilution, sometimes called physiological anaemia of pregnancy.

The Indian Council of Medical Research has categorized anemia as per **Table – 1**.

Tale – 1: Category of anemia as per ICMR.

Anaemia severity	Hemoglobin level (g/dl)
Mild	10.0-10.9
Moderate	7.0-9.9
Severe	4.0-7.0
Very severe	<4.0 (Fatal)

Studies have demonstrated a strong association between low haemoglobin before delivery and LBW babies perhaps this is not only the story but also very high hemoglobin concentration (>13gm/dl) cause high blood viscosity, which results in both compromised oxygen delivery to tissues and cerebro-vascular complications. Epidemiologic studies have also found an association between high maternal hemoglobin concentration and an increased risk of poor pregnancy outcome. Concentration of 95–115 g/L with a normal mean corpuscular volume (84–99 fL) should be regarded as optimal for fetal growth [5].

Magnitude of low birth weight neonates

Low birth weight (LBW) has been recognized worldwide as one of the commonest causes of neonatal mortality. Low birth weight, a common cause of infant death in rural areas, is also the leading factor linked with infants' death in Pune, states the latest child death audit report of the Pune Municipal Corporation (PMC) [6].

According to WHO, a newborn baby weighing less than 2500g at birth is designated as low birth weight (LBW) neonate. According to UNICEF, the incidence of LBW neonates is 30% in India [7, 8]. Low birth weight neonates are further classified as very low birth weight (VLBW <1500 g) and extremely low birth weight (ELBW<1000 g) infants [4].

The National Family Health Survey (NFHS)-3 reported that 23.7% of all children had LBW in Madhya Pradesh. The magnitude of LBW babies in developing world is enormous. Out of a total of 22million such infants in the world, 21 million belong to the developing countries. India's share is quite substantial: 7-10 million. Majority of LBW neonates in our country weigh between 2000-2499 gms [9].

Causes of low birth weight neonates

An adequate supply of nutrients is essential for the normal progression of healthy fetal growth and development. Studies on low birth weight and prematurity, as well as neural tube defects and other non-genetic congenital abnormalities are important cause of fetal morbidity and mortality. Several factors that can help identify nutritional risk in a pregnancy include: adolescence, anemia, abnormal pre-pregnancy weight, multiple gestation, medical illness or medication that interferes with absorption of vitamins and minerals, cigarette smoking, alcohol abuse, and low socioeconomic status [5].

Anemia with hemoglobin level less than 6 g/dl is associated with poor pregnancy outcome. Maternal hemoconcentration is often attributed to decreased plasma volume expansion, also an identified risk factor for poor prenatal outcome [10, 11].

Iron deficiency may increase the stress hormones norepinephrine and cortisol, low hemoglobin concentrations may cause chronic hypoxia, which can activate the body's stress response and thus increase circulating levels of corticotrophin releasing hormone, and iron deficiency may increase oxidative stress of the placenta [3, 12].

Anemia (Hb< 10 g/dl) was associated with a significantly increased risk of birth weight (<2500), High hemoglobin (> 13 g/dl) increased the risk of low birth weight. The minimum incidence of low birth weight occurs in association with a hemoglobin concentration of 10-13 g/dl [13].

Risk of Mortality and morbidity among the low birth weight neonates

Low birth weight leads to an impaired growth of the infant with its attendant risks of a higher mortality rate, increased morbidity, impaired mental development, and the risk of chronic adult disease. Infants who weight 2,000-2,499 g at birth have a four-fold higher risk of neonatal death than those who weight 2,500-3,499 g.

A study reveals that about 18 million infants died in the year 2007 because of low birth weight. Developed market economies had only 12.9 infant deaths per 1000 live births, while this no rises to 106.2 infant deaths per 1000 in the least developed countries. A study conducted at Indira Gandhi Medical College, Shimla reveals that neonatal morbidity is directly related to birth weight, as the functional immaturity of various systems result in different clinical problems [14]. The major concern about the adverse effects of anemia on pregnant women is the belief that this population is at greater risk of perinatal mortality and morbidity. Babies who are undernourished in the womb face a greatly increased risk of dying during their early months and years. Those who survive have impaired immune function and an elevated risk of disease. They are likely to remain undernourished, with reduced muscle strength, throughout their lives, and face a higher incidence of diabetes and heart disease.

Children born underweight also tend to have cognitive disabilities and a lower IQ, affecting their performance in school and their job opportunities as adults [15].

As it is estimated that about 7.3 million perinatal deaths occur annually in the world, most of these are developing countries especially Asia. LBW

neonates are prone to long-term disorders like infections, malnutrition, and neurodevelopment disabilities. Babies who are small or disproportionate at birth also have an increased risk of developing coronary heart disease, non-insulin dependent diabetes mellitus, stroke, hypertension during adult life [4, 16].

Relation between maternal Hb and birth weight

In several studies, a U-shaped association was observed between maternal hemoglobin concentrations and birth weight [15]. A strong relationship was found between maternal anemia and low birth weight babies.

Abnormally high hemoglobin concentrations usually indicate poor plasma volume expansion, which is also a risk for low birth weight [5, 17]. Normal pregnancy is associated with a 45 – 50% increase in plasma volume between 6 and 24 weeks of gestation [1, 18]. There is an accompanied linear increase in red cell mass of approximately 25 – 30%, leading to a physiologic anemia of pregnancy. This is reflected in reduced hemoglobin levels, which generally fall through 20 week's gestational age, and remain relatively constant between 20 – 30 weeks gestation before rising slightly near term [5,19]. Clinical and epidemiological evidence have revealed that high hemoglobin concentrations may be due to maternal complications such as pregnancy induced hypertension or pre-eclampsia, which are causally associated with perinatal morbidity and mortality.

The birth weights of babies whose mothers have hemoglobin less than 11 g/dl were normal and may underscore the relative importance of plasma expansion relative to increased red cell mass in the subsequent determination of specific fetal outcomes. The importance of an adequate plasma volume expansion in allowing adequate foetal growth is attested by several investigations that showed an increased frequency of low birth weight in association with either a high

hematocrit [2, 8]. The mechanism by which this effect is mediated is unknown but may be related to the blood viscosity.

The disorders of plasma volume expansion and associated high hemoglobin concentration are more important than is the anemia in the genesis of low birth weight.

Materials and methods

The maternal Hb concentration and birth weight parameters were obtained randomly in 100 women delivered from the Department of Obstetrics and Gynecology, Central Referral Hospital, Tadong 5th mile Sikkim. Out of 100 cases, 35 cases were maternal Hb (<10 gm%), 35 were maternal Hb (10-13 gm%) and 30 were maternal Hb (>13 gm%) and all the maternal age ranging from 20-45 years.

All data analysis was done using SPSS V 16 statistically software package. The data are presented mean \pm SD, and statistical analysis is carried out using student-T test.

Results and Discussion

Analysis of the data showed that low maternal Hb concentration (<10 gm%) was associated with birth weight of less than or equal to 2500 gm (**Figure – 1**).

Analysis of this data showed that maternal Hb concentration (10-12 gm%) is associated with a mean birth weight ranging from 2700-4700gm (**Figure – 2**).

Analysis of this data showed that high Hb concentration (>12 gm%) is associated with a low birth weight outcome i.e.(<2500) as per (**Figure – 3**).

Maternal Hb concentration in relation to birth weight was as per **Table – 2**.

The statistical analysis showed significant with *p* value -0.000, which show U-shaped relation.

Figure - 1: Relation between low maternal Hb concentration i.e. (<10 gm%) and it birth outcome.

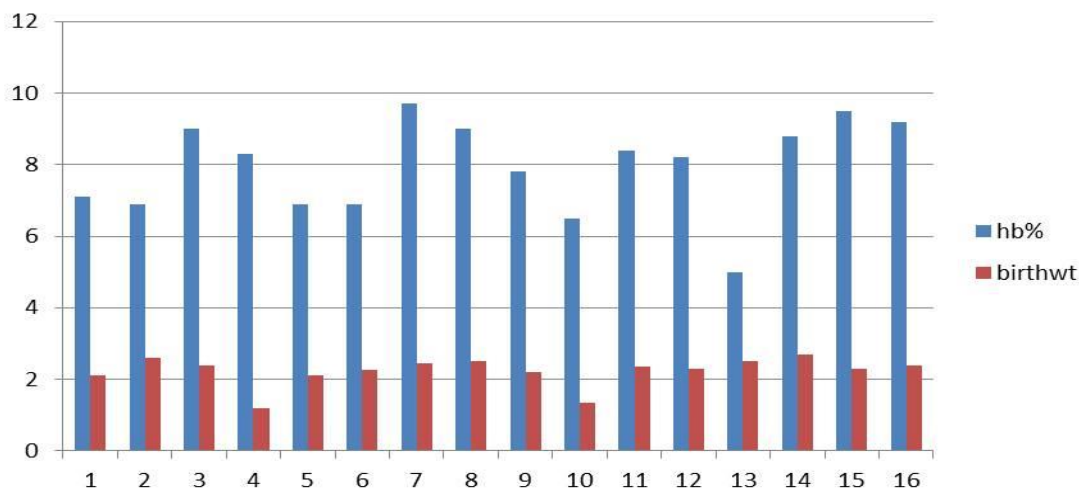


Figure - 2: Relation between maternal Hb (10-12gm%) with it birth outcome.

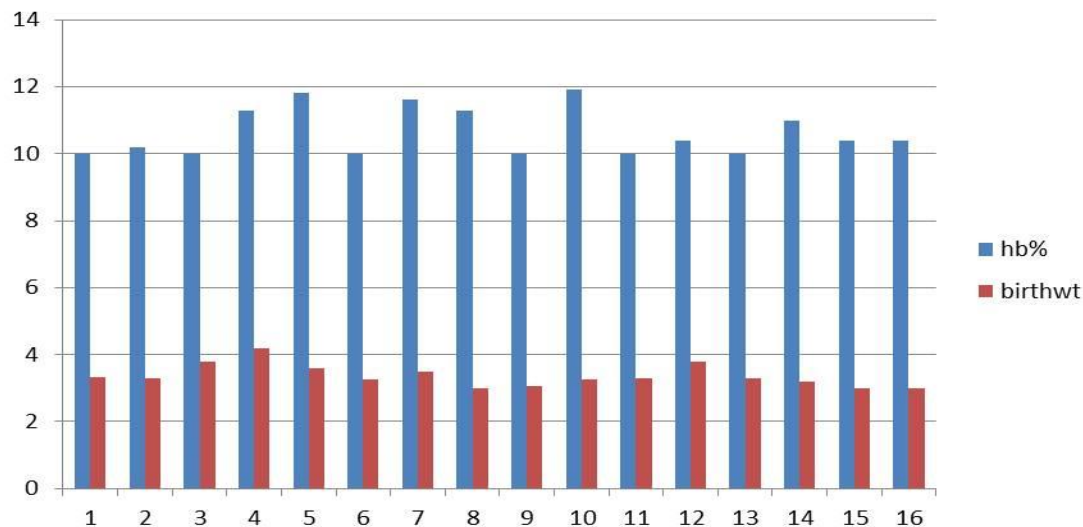


Figure - 3: High maternal Hb concentration with it birth outcome.

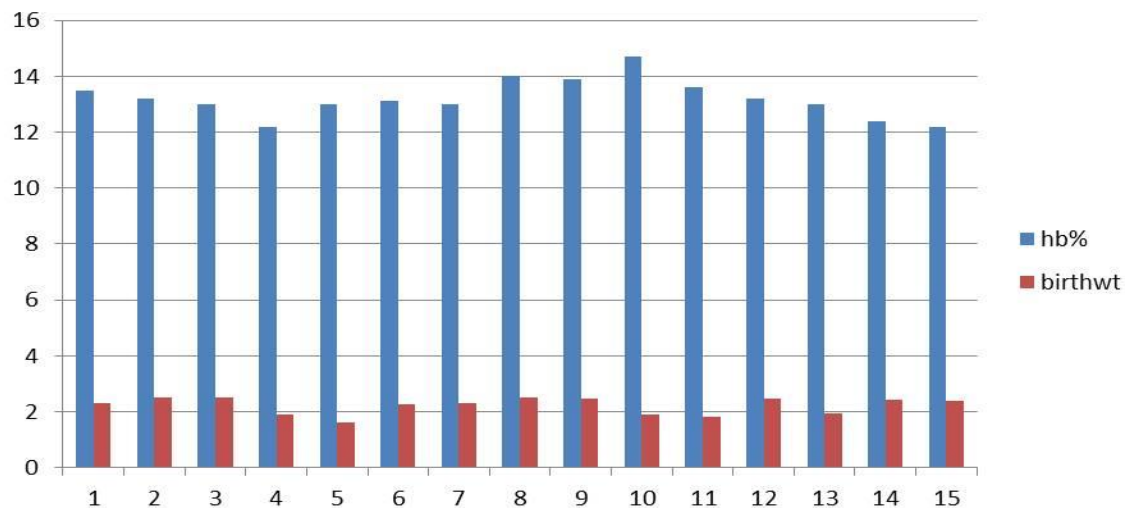


Table – 2: Maternal Hb concentration in relation to birth weight.

Hemoglobin (gm%)	Birth weight of foetus		Total	χ^2 , df, p
	<2.5 kg	> 2.5kg		
Less than 10 gm%	35	00	35	$\chi^2 = 100.00$, $df=2$ $p=0.000^*$
10-13 gm%	00	35	35	
More than 13 gm %	30	00	30	
Total	65	35	100	

This study showed a striking association of birth weight with hemoglobin concentration. Low birth weight is found both in high maternal Hb (>13 gm%) and low maternal Hb (<9 gm %). Hemoglobin concentration from (9 to 11 g/dl) seems to be optimal. Steer and colleagues [20, 21] studied a large population of 153,602 pregnancies and reported that the lowest hemoglobin concentration during pregnancy (85–105 g/L) is associated with maximum mean birth weight and the lowest incidences of LBW and preterm delivery. Malhotra, et al., for example, observed that the mean birth weight was highest in babies with maternal haemoglobin concentration between 9.6 and 10.5 gm% [22, 23]. Many authors have drawn attention to the fact that we should be more concerned about high rather than low concentrations of haemoglobin in pregnancy [23], and some have decried the routine use of iron supplementation in pregnancy. There is a theoretical risk that increasing hemoglobin concentration might actually reduce birth weight and do harm, although the meta-analysis of the controlled trials does not support this hypothesis [24]. Rather, routine supplementation seems simply to be unnecessary. It has been suggested that high levels of hemoglobin or serum ferritin reflect a failure in adequate plasma volume expansion or increased blood viscosity as a result of macrocytosis which would impair uteroplacental blood flow. This, in turn, might adversely affect fetal growth. The statistical analysis of this study shows significant result denoting that both high and low Hb concentration shows adverse effect on birth weight. Several studies reveals that LBW babies are at higher risk of hypoglycemia, asphyxia, sepsis, hypothermia, and feeding problems, etc. in these neonates

Early hypoglycemia is also seen, due to the diminished hepatic and skeletal muscle glycogen content and reduced alternate energy substrates along with deficient counter regulatory hormones. There should be frequent monitoring of blood glucose of these babies and the concentration should be maintained above 50 mg/dL. Early enteral feeds or intravenous glucose for those with clinical problems must be instituted, preferably within half an hour of life. Although hypoglycemia is a major problem of LBW neonates, yet a contrast situation may result in hyperglycemia due to low insulin secretion rates or iatrogenically due to high rates of glucose infusion. This condition is usually noted in ELBW (preterm) neonates or stressed neonates [4].

Conclusion

Maternal Hb concentration of 10-13 gm% should be regarded as optimal for fetal growth and well-being associated with the lowest risk of low birth weight.

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