 DOI: 10.18231/2394-6377.2016.0006

Influence of maternal nutrition status during pregnancy on developmental outcome in first 30 days of independent neonatal life

Dhiraj J. Trivedi[1,*], Vijayalaxmi Shindhe[2], Chandramati J. Rokhade[3]

[1]Professor, Dept. of Biochemistry, [2]Nursing Tutor, Dept. of Nursing, [3]Sr. Dietician, Dept. of Dietetics, SDM College of Medical Sciences & Hospital, Dharwad, Karnataka

***Corresponding Author:**
Email: dhiraj99trivedi@gmail.com

Abstract

Introduction: Birth weight is an important determinant of infant mortality. Two third of all deaths occurring in first twenty eight days of life happen due to low birth weight. LBW infants suffer higher risk of health complications at adult life. Maternal nutrition maybe the major intrauterine environmental, non-genetic, controllable factor which influences the growth of the fetus.

Aim: To evaluate the influence of maternal nutritional status on developmental achievement of neonates in the first thirty days of independent life.

Objective: 1. To study the nutritional status of mothers during pregnancy. 2. To evaluate birth weight, 5 min Apgar score, developmental outcome of newborn. 3. To correlate birth weight with health and developmental achievement of neonates in the first 30 days of independent life.

Materials and Method: 121 mother-neonate pairs formed study population. Serum total protein, Albumin and Hemoglobin were evaluated for mother's nutritional status. Gestational age, Birth weight, APGAR score and Cord blood Albumin were analyzed for neonates. The overall developmental outcomes were observed for the first 30 days of neonatal life.

Results: Mean Birth weight of neonates was in the acceptable range, 39.67% LBW was observed at our hospital. LBW frequency was higher among female infants and small for gestational age. 5min Apgar score was good among ABW, but poor among LBW infants. LBW deliveries were high among mothers having poor nutritional status. LBW babies had low cord albumin levels & had higher frequency of health related problems. Overall developmental growth was poor amongst LBW, low cord albumin level and infants having a low Apgar score.

Conclusion: Nutritional status of the mother during pregnancy influences the health and overall development of the newborn observed during first 30days of independent life. Promotion of optimal nutrition may ensure optimal fetal development and reduces the risk of chronic diseases in adulthood.

Keywords: Maternal nutrition, Pregnancy, Low birth weight, Cord Albumin

Introduction

Maternal nutrition is the most influential, nongenetic environmental factor for the growth of the fetus during the course of pregnancy. Growth of the fetal tissue imposes metabolic alterations in the mother's body, resulting in an increased demand for nutritional requirement. Though the human fetus synthesizes its own carbohydrates, fats and proteins from glucose, amino acids and other short chain metabolites supplied from the maternal circulation through placenta[1,2]. The total amount of nutrients transferred ultimately depends on its levels in maternal blood, intake of calories and protein rich diet by the mother during pregnancy. The malnourished mother may deliver low birth weight baby (LWB)[3] or infant with hypo-albuminemia. Presently, there is a lot of disparity over the mother's nutritional status and birth weight of newborn[3,4,5]. In developing countries, maternal malnutrition is common factor which could be resulting in intrauterine growth retardation and low birth weight of newborn. An infant having low albumin levels is a source of concern as it may lead to decreased oncotic pressure and deficient carrier proteins. Such infants are at risk of developing intravascular volume contraction and metabolic impairments. Maternal nutrition and birth weight have a role in infant mortality worldwide[6]. Underweight newborns have markedly reduced chances for survival, low intelligence and poor coordinated movement. A report from the U.S. Department of Health, Education and Welfare in 1972 detailed that "two-thirds of total deaths occurring in the first twenty-eight days of life happen due to low-birth weight". This death rate is thirty times higher than the death rate in infants with normal birth weight. Intact survival of LBW infant depends on availability of proper advanced antenatal and neonatal care support.[7]

Also, there is mounting evidence that babies born underweight when survive, suffer from an increased risk of NIDDM, high blood pressure, obstructive lung diseases or renal damage in their adult age[8]. Thus birth weight, the most accurate indicator of an infant's health and future mental and physical development is a controllable factor influenced by maternal nutrition. Serum albumin and hemoglobin levels are considered as indirect indicators of nutritional status of the mother. Hence the present study was undertaken in the interest of public health to evaluate the impact of maternal nutrition status on birth weight and correlation of birth weight with infants' health in the first thirty days of life under observation.

Materials and Method

The present study was carried out at the Department of Biochemistry in association with the Department of Pediatrics and Department of Nutrition of a teaching medical Hospital in Karnataka, (India). The prospective cohort study was carried out on mother-neonate pairs selected randomly from the deliveries done at labor room of our hospital during the period of June 2012 to December 2015. The study protocol was reviewed and approved by the Institutional Ethical Committee on the agreement that patient anonymity must be maintained, the finding would be treated with utmost confidentiality and for the purpose of this research only.

A total of one hundred and twenty one (n=121) mother- neonate pairs were followed up at the time of birth and prospectively for the first 30 days of the infant's life with daily clinical examination. Infants with Rh incompatibility, congenital malformation, major systemic disease evident at birth and any unrelated complications arising during hospital stay were excluded from the study.

Recording of weight at the time of birth was measured to the nearest 10g using electronic scale. Apgar score was recorded within 5 min of birth for all newborns by a single examiner.

After obtaining informed consent from parent, 3 to 5 ml of cord blood was collected immediately after birth in the labor room. Neonates' Blood groups were detected by Blood group typing antisera from Ortho diagnostics. Cord blood hemoglobin estimation was performed by Drabkin's reagent supplied by Nice Company and Cord Serum-Albumin (CSA) estimation by BCG dye binding method on Shimadzu-UV17000-spectrophotometer. Record of mother's Serum Albumin and hemoglobin levels were obtained from the prenatal checkup files.

The neonates were followed up clinically for 30 post-natal days by our trained final year undergraduate student in either neonatal ward or at home for recording of their developmental parameters like weight gain, feeding habits, motor and nervous developments.

The data obtained was analyzed using Medcalc program, correlations of various parameters were statistically looked for and P value <0.05 was considered statistically significant.

Results and Discussion

- **Relationship of birth weight and gender of neonates: Table 1** shows the relationship of birth weight and gender of neonates. As per WHO (2005) standards Birth weight <2500g was considered as low birth weight (LBW) whereas >2500g birth weight was considered adequate birth weight (ABW). In the present study out of 121 infants, 55 (44.63%) were male and 66(55.37%) were female. Though mean birth weights of neonates (male &female together) in the study population were in the ABW range (2950±360g), we observed 39.67% LBW babies at our center. Frequency of LBW was higher in female infant 33(68.75%) as compared to males 15(31.25%). Frequency of ABW was higher among male infants. Also mean birth weights of male neonates (3742±236) were greater than female (2362±168). Birth weight difference between male and female infants was significant ($P< 0.05$). Globally LBW babies make only 14 to 16% of newborn population, but LBW is a common occurrence in the developing countries like India, where it ranges from 30% to 50%. LBW rate of 39.67% observed at our center in south India match with the finding of KE Elizabeth (2008).[9] This group also reported that birth weight may even differ from the same country depending on the general standard of health and socioeconomic level of community. Our observation of difference in birth weight between gender correlates with reports of various centers, which identifies that the male grow faster than female from an early stage of gestation[10,11].

Table 1: Relationship between Birth Weight and Gender of Neonates (N=121)

Variable	Birth weight < 2500gm		Birth weight >2500gm		Birth weight (gm)		Total number of cases
	n	%	n	%	Mean	± SD	
Male	15	31.25	40	54.79	3742	236	55 (50.41%)
Female	33	68.75	33	45.21	2362	168	66 (49.58%)
Total	48	39.67	73	60.33	2950	360	121
M/F ratio	0.45 :1		1.2 :1				0.83 : 1.0

- **Relation between birth weight and gestational age of mother:** As per guidelines of American Congress of Obstetricians and Gynecologists, gestational age is determined during physical examination in first trimester. Gestational age <37 weeks is labeled as preterm and gestational age > 37 weeks is considered full-term. As in **Table 2**, the effect of gestational age on birth weight shows 37 (30.58%) neonates were preterm whereas 84 (69.42%) were full term. Among 121 neonates enrolled in the present study. The incidence of LBW was nearly one and half times higher in preterm as compared with full term infants. The results of gestational age and birth weight was highly significant between the group (P<0.001). Birth weight of neonates exhibited a positive

correlation with gestational age, the observed result deduces that the growth rate of the fetus increases exponentially in the last trimester and hence preterm babies suffer from LBW correlates with the reports from other studies.[12] Infants born preterm or LBW have shown significantly decreased motor developments. Poor to very poor developmental outcome was noted among neonates born before 35 weeks of gestation.

Table 2: Relationship between Birth Weight, Gestational Age and Apgar score

Parameter	Gestational age weeks			5min Apgar score		
	<37 week	>37 week	Total %	≤3	4-6	≥7
	n (%)	n (%)	n (%)	n (%)	n (%)	n (%)
Birth weight <2500g	20 (41.66%)	28 (58.33%)	48 (39.67%)	8 (16.67%)	36 (75.0%)	4 (8.33%)
Birth weight >2500g	17 (23.29%)	56 (76.71%)	73 (60.33%)	03 (4.11%)	14 (19.18%)	56 (76.71%)
Total	37 (30.58%)	84 (69.42%)	121 (100%)	11 09.09%	50 41.32%	60 49.59%

- **Relationship between Birth Weight and Apgar score:** Apgar score is a simple and repeatable test which swiftly assesses the health of newborn immediately after birth.[13,14] For more than two decades, Apgar scores have been used to predict developmental outcome in neonates. However, most studies have used full-term babies. The predictive value of Apgar scores for LBW infants has remained unclear. Apgar score 0-3 is considered critically low, score value 4-6 is considered moderately low and more than 7 is the best score index.

In the present study, we correlate Apgar scores of 121 term and preterm infants with combination of birth weight and gestational age to foresee developmental outcome shown in **Table 2**. Out of 48 LBW infants, 08 (16.67%) had poor to very low (<3) Apgar score and 4 (8.33%) of them had good score, i.e. >7, whereas 36 (75.0%) LBW infants have shown moderately low (in the range 4-6) Apgar score. On the other side, out of 73 infants with ABW, 56 (76.51%) infants showed a good Apgar score (>7) whereas, 03 (4.11%) infants exhibited very poor (<3) Apgar score. Thus Apgar score was better among ABW infants as compared to LBW infants. The five-minute Apgar score is positively correlated with birth weight. Apgar score was lower in underweight neonates and in small for gestational age (SGA) infants compared with their appropriately grown counterparts. Observed results were correlating with the findings of Stark CF[15].

A significant correlation existed between Apgar scores and birth weight, which may provide a useful prognostic index for the relationship between health and birth weight of newborn. Apgar score and gestational age have also shown positive correlation which is in consistence with Lee HC[16], but fail to provide a developmental prognosis.

- **Relationship between Birth Weight and Maternal nutritional status:** Serum protein, Serum Albumin and blood Hemoglobin levels are considered as indirect indicators of maternal nutritional status. As shown in **Table 3** In the present study, we found a significant positive correlation of maternal serum Total protein and serum albumin levels with the birth weight of infants. Mean total protein levels ($p<0.05$) and serum Albumin levels ($p<0.01$) were significantly low in mothers who delivered LBW infants as compared with mothers who delivered ABW babies. The result suggests undernourished mothers have resulted in LBW infants. Similar correlation of maternal serum albumin level with birth weight of the baby was observed by groups in South India.[9,17,18] Though our findings contradict the finding of S.Swain et. al.[19] who did not observe any significant relation of maternal serum albumin with birth weight but, this may occur for various causes as pointed out by B. Singer[18].

Table 3: Relationship Between Birth Weight and Maternal Nutritional Status

Parameter	Low birth weight Mean±SD	Acceptable birth weight Mean±SD	
Weight (g)	2325±300	3920±180	P<0.002
Maternal Hemoglobin g/dl	10.7±1.2	11.1±0.8	NS
Total Protein g/dl	5.12 ±0.42	6.44± 0.67	P<0.05
Serum Albumin g/dl	3.02±0.36	3.98±0.73	P<0.01

- **Developmental outcome observed in first 30 days of neonatal life:** Results from **Table 4**, Indicates number of babies fall sick in the first 30 days of life was almost 6.2 times in the low Apgar score, 3.04 times in moderate Apgar score babies as compared to babies having good Apgar score. Developmental outcome increases as the Apgar score rose from low to good. Cord Albumin level indicated frequency of sick babies was nearly three times higher in hypoalbuminic as compared to the normal albumin level group. Albumin is synthesized by the liver, which provides normal colloidal oncotic pressure and reduce oedema, inflammation. It also facilitates the transport of various metabolites, including drugs. It is an important scavenger of free-radical. Hypoalbuminemia is associated with poor feeding, increased incidence of diarrhea, shock, metabolic acidosis and hyper-lactic acidemia.[20] In the present study, we found somewhat similar results of considerable delay in developmental landmark among hypoalbuminic infants. The root cause once again points to the nutritional status of the mother during pregnancy.

Table 4 Relationship between Cord Serum Albumin, Apgar Score and Developmental landmark in neonates

Variable	Birth weight		No of babies fall sick in first 30 days of life	Percentage	Developmental Status
Apgar score	**LBW**	**ABW**			
<3 low score	08	03	09/11	81.81	Poor
4-6 moderate score	36	14	20/50	40.0	Poor to moderate
>7 good score	04	56	08/60	13.13	Good
Cord Albumin g/dl	No of babies				
<3.0g/dl	35		23/35	65.71	Poor
>3.0g/dl	86		19/86	23.99	Good

Conclusion

Even though there is contradicting arguments regarding maternal nutrition and developmental landmark in an infant's life, our study support that the nutritional status of the mother during pregnancy have an influence on the health of an infant and role in achieving developmental milestones. LBW and problems related to developmental growth of an infant can be prevented by good nutritional status of the mother during pregnancy. Promotion of optimal nutrition will not only ensure optimal fetal development, but also reduces the risk of chronic diseases in adulthood. So there is a need to evaluate further, maternal nutritional status during the entire pregnancy correlating with economic status, genetic makeup, mental status of the mother and its influence on health outcome of an infant.

References

1. Page EW; Human fetal nutrition and growth. Am. J. Obstet. Gynecol; 1969;104(3):378-87.
2. Shelley HJ. Carbohydrate metabolism in the fetus and the newly born; Proc. Nutr. Soc., Engl. Scot; 1969;28:42-49.
3. Stephenson T, Symonds ME, Maternal nutrition as a determinant of birth weight. Arch. Dis. Child. Fetal. Neonatal Ed. (2002) 86;4-6.
4. Lumey LH. Compensatory placental growth after restricted nutrition in early pregnancy; Placenta; 1998;19;105-112.
5. Kramer MS; Effects of energy and protein intakes on pregnancy outcome: an overview of the research evidenced from a controlled clinical trial. Am. J. Clin. Nutr; 1993;58(5):627-635.
6. Eltahir ME, Gerd S, The effect of maternal anthropometric characteristics and social factors of gestational age and birth weight in Sudanese newborn infants. BMc Pub Health; 2008;8;244.
7. Grimmer I, Buhrer C, Dudenhausen JW, Stroux A, Preconceptional factors associated with very low birth weight delivery in East and West Berlin: a case control study; BMC Pub Health, 2002;2;10-18.
8. Stein CE, Fall CH, Kumaran K, Osmond C, Cox V, Barker DJ; Fetal growth and coronary heart disease in south India. Lancet; 1996;348(9037):1269-1273.
9. K.E.elizabeth, Viji Krishnan, T. Vijayakumar, Umbilical cord blood nutrients in low birth weight babies in relation to birth weight and gestational age, Indian J Med Res,2008;128,128-133.
10. J. F. Pedersen, Ultrasound evidence of sexual difference in fetal size in first trimester; British Medical Journal, 1980;281,(6250),1253.
11. M. Jane, A. Kusin, and C. De, With Birth weight distribution in a healthy urban population in Surabaya–Indonesia; Tropical and Geographical Medicine, 1989;41(2);146–150.
12. Allen J Wilcox, On the importance and the unimportance of birthweight; Int. J. Epidemiol.2001;30(6):1233-1241.
13. Papile LA. The Apgar score in the 21st century. N Engl J Med; 2001;344(7):519–20.
14. Dallas TX: American Heart Association. Textbook of neonatal resuscitation. 4th ed. Elk Grove Village (IL): American Academy of Pediatrics; 2000.
15. CF.Stark, RS. Gibbs, and WL. Freedman, Comparison of umbilical artery pH and 5-minute Apgar score in the low-birth-weight and very-low-birth-weight infant; American Journal of Obstetrics and Gynecology; 1990;163(3);818–823.
16. Henry Chong Lee, Pramela Ramachandran, Ashima Madan; Morbidity Risk at Birth for Asian Indian Small for Gestational Age Infants. Am J Public Health. 2010;100(5):820–822.

17. Iyengar L, Effect of dietary supplements in late pregnancy on the expectant mother and her newborn; Ind J Med Res; 1967;55;85-89.
18. B Singer, J.Wolfsdorf; Another look at cord blood proteins; S. Afr. Med J;1974;48;2306-08.
19. Swain S, Singh S, Bhatia BD, Pandey S, Krishna M; Maternal hemoglobin and Albumin & fetal growth; Indian pediatrics 1994;31(7);777-82.
20. Sgro M, Campbell D, shah V. Incidence and causes of neonatal hyperbilirubinemia in Canada. Canadian Medical Assoication Journa;.2006;175(6);561.