Nutrition & Diet for CHILDREN Simplified

Meenakshi N Mehta
Nitin J Mehta





Foreword
C Gopalan

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4 CHAPTER

Maternal nutrition, Fetal growth and Health

BD Bhatia, I Pathak

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In all developing countries including India, majority of low birth weight (LBW) babies are as a result of intrauterine growth retardation. Numerous studies from our country have shown birth of greater number of small term infants in India than in developed countries. Further, in developing countries the nutritional status of women in reproductive age group is far from satisfactory and they have to undertake heavy physical work. The fertility rates are high and their diets are deficient in calories from childhood to adulthood resulting into poor body size of the mother. Pregnancy in such chronically undernourished mothers with perpetual semi starvation throughout gestation often results in delivery of LBW baby, especially the growth retarded one. More than 50 per cent of fetal growth retardation in our country is due to preventable causes like maternal anemia, undernutrition and small maternal size.

Fetal weight is partly due to genetic constitution of the fetus (38% variation) and partly due to maternal and uterine environmental influences (62% variation). Out of numerous biosocial, physical, endocrinal and nutritional determinants of birth weight, maternal influences are the most important one and have been documented in the literature for over four decades. Most authorities would unhesitatingly agree that one of the most important factors contributing to the healthy development of human conceptus is the good nutritional status of the mother. However maternal height, weight, weight gain during pregnancy, skull circumference, mid arm circumference, skinfold thickness, energy, protein, iron and other nutrients have all been shown to have relationship with birth weight.

Maternal Weight and Birth Weight

A large number of workers have demonstrated that maternal weight (MW) contributes significantly to birth weight (BW). Leitch et al predicted newborns

weight to be 5.7 percent of mother's pregnancy weight. Pachauri and Marwah observed 8.4 g increase in BW for every Kg increase in maternal weight. Bhatia and Tyagi found a coefficient of 12.34 g for BW in their multivariate analysis. A relationship between low MW and delivery of LBW infants has been demonstrated by number of workers. We reported 40 percent incidence of term LBW babies if MW was less than 38.36 kg (25th percentile value) in rural women.

Maternal Weight Gain and the Birth Weight

Both physiological and epidemiological evidence suggest that energy is the most common nutrient limiting fetal growth. Since estimation of energy intake is inaccurate and weakly correlated with energy balance, measurement of maternal weight, maternal weight gain and changes in fat pad thickness as estimates of energy balance has been suggested. The weight gain during pregnancy varies between 10–12 kg in well nourished European women. However, majority of Indian women are short as well as light and the weight gain in these women is also much less (5.0–7.5 kg). The stored fat is also much less in these women resulting in poor fetal as well as postnatal growth. Some of underprivileged pregnant women do not gain weight but even lose weight during pregnancy which has been strongly correlated with fetal growth retardation. Sixty seven percent of fetal weight gain occurs during third trimester and is almost exclusively influenced by maternal factors. Definite positive correlation has been established between weight gain during pregnancy and the BW of off-spring. An additive action of prepregnancy weight and the weight gain during pregnancy has been suggested.

Maternal Mid Arm Circumference and Birth Weight

Although mid arm circumference (MAC) is a good and sensitive indicator of muscle mass, there is paucity of data on its relationship with BW of offspring. MAC has been suggested to be used to assess maternal nutritional status during pregnancy. The incidence of term LBW babies at the two extremes of MAC (<21 and > 24 cm) was found to be 40.28 and 11.48 percent respectively.

Maternal Diet and Birth Weight

Prolonged starvation due to war time famines resulted in reduction of mean BW of off springs and an increase in the incidence of LBW babies and a fall in incidence of high BW deliveries. Observations of various workers also demonstrated poor dietary intake in mothers delivering LBW babies. Severe malnutrition may interfere with fetal growth early in pregnancy leading to impairment of linear growth, weight gain and brain development whereas malnutrition late in pregnancy affects the body weight mainly. Both maternal body size and dietary intakes exert their independent influence on BW of offspring. Dietary intakes during formative years determine the ultimate body size of mother which along with diet in current pregnancy determines the ultimate fetal size. Studies have shown that persistence of lower dietary intakes throughout gestation result in

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fetal growth retardation. Such progressive nutritional depletion may be partly reversible than previously suspected because calorie supplementation to severely undernourished mothers during any trimester of pregnancy improves the BW of offspring while supplementation of protein alone had little effect on fetal growth unless calories were added. A Guatemalan study observed that when there is chronic under nutrition, birth weight can be raised by sufficient calorie supplementation throughout the pregnancy.

Maternal Hemoglobin[Hb] and Birth weight

Pregnancy in anemic mothers result in greater number of both preterm and term LBW babies. A high incidence of LBW infants has been reported in anemic mother's inspite of adequate weight gain. The BW of newborns has been directly correlated with maternal Hb levels. In our studies we observed significant correlation between Hb and BW even after controlling maternal anthropometeric parameters, serum albumin status and the gestation.

Maternal Serum Proteins and Birth Weight

A positive correlation between maternal serum proteins and BW has been reported. However, a number of workers have failed to establish any relationship between maternal protein status and BW. We also reported that the significant correlation between serum albumin and BW was lost once the relationship was controlled for MW, MH, Hb and Gestation. In mothers with similar Hb levels, the BW did not change with rise in serum albumin levels where as in mothers with similar serum albumin level, the BW increased significantly with rise in hemoglobin levels. Serum albumin levels had limiting influence on BW only in average built mothers.

BIRTH WEIGHT AND FUTURE CONCERNS

Barker documented linear relationship between lower birth weight and risk of later life cardiovascular disease, type 2 diabetes and metabolic syndrome. Studies suggest that faster weight gain during the first 4 months of life is associated with greater risk of being overweight at 7 years. Further, faster growth in infancy increases later life risk of obesity and cardiovascular disease. Preterms on formula milk developed obesity, dyslipidemia, hypertension, and insulin resistance as compared to those fed human milk. Indian data (Delhi cohort) also showed adult life – metabolic syndrome and insulin resistance in relation to BMI gain in infancy. These studies suggest to prevent rapid weight gain in early infancy to control later life obesity and cardiovascular risks. Further, Hales and Barker proposed that impaired fetal nutrition supply in maternal under nutrition leads to metabolic adjustment in fetus so as to spare brain growth; however, this was not supported by animal studies, Rat mothers fed wheat or Bengal gram diets isonitrogenous to 10% casein diet (as it happens in rural agricultural families, mainly consuming the grown crop), body weights remained unaffected while brain weight was

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affected. In latent iron deficiency (pregnancy-lactation) body and brain weights both were affected. Fetal brain iron was reduced, with irreversible alterations in neurotransmitters. Studies undertaken in the Department of Pediatrics, Banaras Hindu University, Varanasi showed that the intrauterine growth retarded offspring's of undernourished mothers showed hypotonia, hypoexcitability, limp posture, poor recoil of limbs, incomplete Moro's and crossed extensor responses. Their EEG had shortening of sleep cycle (REM and NREM). There was some inter and intra hemispheric asymmetry and abnormal paroxysmal discharges; suggesting dysmaturity of brain. In humans, maternal under-nutrition during "Brain growth period", affected child's cognitive development, learning abilities, higher mental functions and showed persistence of soft neurological signs. The severity of maternal-fetal under nutrition can also be seen in NFHS-3 data (16% underweight; 18% stunted and 24% wasted in first month). Intrauterine growth retarded babies of undernourished mothers had lowest means for weight, crown-heel length, skull circumference and delayed development during first 9 months of life. The irreversible damage to brain has also been demonstrated by Cranial MRI studies.

CRITERIA FOR MATERNAL UNDER-NUTRITION

Many workers have suggested different arbitrary cutoff limits of maternal weight, height, WHRI, hemoglobin and serum total proteins, albumin and free alpha aminonitrogen levels to classify the mother as under-nourished. These cut off limits of various parameters do not correspond to same percentile. ICMR has suggested mothers weighing 45 kg with a height of 145 cm as the reference Indian women when their own mean figures for weight and height are 45 kg and 154 cm in females aged 21 years and 41.4 kg and 151.6 cm in females aged 17 years. The 45 kg weight limit corresponded to 50th percentile whereas 145 cm height limit corresponded to 10th percentile in of most studies. Thus it would be more appropriate to take 50th percentile values of both weight and height of National figure to call a mother as reference woman. In most Indian studies mothers with height <145 cm and weight <45 kg with wide variations in Hb and albumin have been designated as undernourished. To avoid such variation it is suggested that similar percentile values for all the parameters should be used as cut off limit to designate a women as undernourished, e.g. if we take 10th percentile limit for weight, then 10th percentile of height, Hb, albumin should taken as cutoff limit. Our studies suggest that both anthropometric and biochemical parameters should be considered together to evaluate maternal nutrition status. In a multivariate analysis MW, MH, Hb and gestation were found to be significant determinants of BW even when other variables were simultaneously controlled. Thus, we can take MW amongst the maternal anthropometric parameters and Hb amongst the biochemical parameters to evaluate the nutritional status of pregnant women. We have even given nomograms for estimation of BW using MW, MH, Hb and gestation as determinative variables.

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Nutrition & Diet for CHILDREN Simplified

Salient Features

- A useful and informative text
- Provides comprehensive information on the subject of nutrition
- Focuses on the nutritional management of newborns, infants, and children in health disease conditions
- Overviews the scope and functioning of the various National Nutritional Programs
- Includes innumerable charts, diagrams, illustrations, and tables to understand and follow the topic easily
- Recipes for different age groups of children from different parts of India and surrounding countries in practical term from locally available foods
- Serves as a practical guide book for mother as well as all the postgraduate students and practitioners of child health, pediatrics, and nutrition, and the health workers dealing with children.



Meenakshi N Mehta MD DCH FIAP FICN was formerly Professor and Head in the Department of Pediatrics at Lokmanya Tilak Municipal College and General Hospital, Sion, Mumbai, Maharashtra, India (1975-1995), then at Mahatma Gandhi Memorial Hospital (1996-2011), as Consultant Pediatrician and Head of the Department. She was also the first Dean of the Rajiv Gandhi Medical College and Chhatrapati Shivaji Maharaj Hospital (1992-1993) of Thane Municipal Corporation, Thane, Maharashtra, India.

In 1972, she was awarded the WHO Fellowship for the Senior Teachers in Child Health at UK, Africa, and India, for social Pediatrics; Senior Heinz Fellowship at UK (1979); WHO Short-term Consultant on Diarrheal Diseases, New Delhi (1988). She won the Nestle Nutrition fellowship to represent Indian Academy of Pediatrics (IAP) India at Bali, Indonesia, for the international workshop and symposium on PEM (1989).

She started the subspecialty of pediatric gastroenterology and nutrition at the Sion Hospital. She has over 200 publications in national and international journals and books in her credit. She has been the section editor and author on nutrition for all the 5 editors IAP Textbook of Pediatrics and the IAP Color Atlas of Pediatrics. She has held many academic positions, Honorary General Secretary, Nutrition Society of India, Chairman Nutrition subspeciality of the Indian Academy of Pediatrics, Convenor Bombay Chapter of NSI, and Fellow of the International College of Nutrition.



Nitin J Mehta MSc PhD FICN Dip (Lib Sc and Hosp Admn) did his Masters Degree in Animal Physiology and Doctorate in Clinical Biochemistry from University of Bombay. He was the Chief of Clinical Biochemistry at King Edward Memorial Hospital till he retired in 1995 and then took up similar appointment at a private hospital—Sir HN Hospital, both in Mumbai, Maharashtra, India.

During the course of his service, he had more than 50 research papers published in various topics in clinical biochemistry and particularly in nutrition. He was a postgraduate teacher in medical technology course in University of Bombay. He has been a Fellow of International College of Nutrition [FICN].

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