# CHAPTER - IV

# SUMMARY

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Mammals are unique in the sense that the embryo is nurtured in the womb for varying periods of time before birth. The fetus formed from the mammalian embryo, after organogenesis goes through different phases of development before it is finally expelled by the mother through an intricate process that protects its viability. Even after birth, the infant in most mammalian species continues to derive nourishment and protection from the mother till it can fend for itself.

The growing embryo and the fetus are well protected in the intra-uterine environment against nutritional inadequacies because of the preferential transport to them of many nutrients through the placenta. In addition, the placenta acts as a barrier against the excessive entry of nutrients, specially those whose excess present hazards and prevents the entry of other substances altogether so that fetus is protected even from the internal environment. The fetus is also protected physically, as it is surrounded by the amniotic fluid.

Fetal growth results from an interplay of maternal, fetal and placental factors. Factors affecting human fetal

growth include parity, height and weight of the mother, gestational age, sex, genetic, nutritional and toxic factors, environmental conditions, maternal health and structure and function of the placenta.

The inadequate availability of nutrients during gestation probably constitutes the single most important environmental factor influencing the outcome of the reproductive process in that it accounts for the majority of cases of fetal growth retardation in the poor areas of the world and for a substantial proportion of pregnancy loss and neonatal mortality. Poor gestation performance of poorly nourished mother has also been found by a number of investigators. The critical nutrients whose deficits affect development vary at different stages. In the earlier stages when the quantitative requirements for micronutrients such as substrates for oxidation, protein and calcium are small in relation to the requirements of maternal metabolism, maternal deficiencies may not have serious consequences but may affect overall growth and development in later stages. On the other hand, a deficiency of micronutrients such as iodine, pantothenate, folate, etc. which are critical for cell division and organogenesis may have more adverse effects in this stage.

The diets of the poor in this country are often inadequate in food energy protein, calcium, vitamin A and riboflavin. Clinical symptoms are associated with the deficiencies of these in an appreciable proportion and are aggravated during pregnancy. Iron deficiency anemia is also common even when the diets are adequate in iron because of poor availability. Maternal anemia accounts for an appreciable proportion of maternal mortality (15%) and is higher in Gujarat (20%). It has been shown by a number of investigators that infants born of anemic mothers are likely to develop hypochromic, microcytic anemia during the first year.

About 10% of infants among the urban poor in this country are born with a weight of less than 2 kg. This proportion may be higher in rural areas. Consequences of fetal growth retardation and malnutrition include delayed maturation of tissues critical for the survival and development of the newborn such as the lung, the intestine and the nervous system. They are also associated with poor stores in the liver of critical nutrients such as vitamin A and iron. Profiles of skeletal development in infancy derived from previous studies suggest that at least some infants are born with retarded skeletal development and fail to catch up in early infancy, presumably because of maternal deficiencies with regard to

calcium, vitamin D and other nutrients. Many studies on beneficial effects of supplementation on pregnant women at different stages have been reported.

Premature as well as full term infants subjected to intra-uterine growth, retardation are at a greater risk of neonatal mortality which is associated with features such as respiratory distress, hypoglycemia, hypothermia, decreased immunocompetence with increased risk of neonatal tetany (associated with cutting the umbilical cord under unhygenic conditions).

The present studies were undertaken on fetal and neonatal development in relation to maternal nutritional status with special reference to iron, magnesium and effects of food supplementation on pregnancy weight gains, the status of the progeny at birth and its further development. The following aspects were studied :

1) Fetal tissue stores of iron in relation to maternal iron status, gestational age and fetal growth.

2) Neonatal iron status in relation to maternal iron status, gestational age and birth weight.

3) Fetal and neonatal magnesium status in relation to maternal nutritional status, gestational age and growth status.

4) Effects of supplementation on pregnancy weight gain and outcome.

5) Pattern of organ growth during human fetal development in relation to gestational age, maternal nutritional status and fetal growth status.

6) Somatic measurements of the human fetus and neonate in relation to gestational age, growth status and plane of maternal nutrition.

Fetuses were derived from medical termination of pregnancy. For neonatal status in relation to maternal nutritional status, parturient women and their neonates were investigated in the local hospitals. Maternal blood was collected within 8 hours after abortion and within 48 hours after delivery. For monitoring of pregnancy weight gain and postnatal development of infants women living in slum area served as subjects.

1) Studies on liver, spleen and kidney stores of iron suggested that the stores of these nutrients in fetuses were found to increase with the progress of gestation. Their accretion was less in the low income group than in high income group mainly because of the smaller size of the fetus. It also

appears that fetal size rather than maternal iron status is a critical determinant of liver, spleen and kidney iron stores, and that, even with anemia in the mother, iron is preferentially transferred to the fetus. However, premature infants and full term infants with low birth weights are at greater risk of earlier onset of anemia because of a smaller size of their liver stores.

2) Low levels of maternal blood hemoglobin and serum iron were found to have a significant influence on blood hemoglobin levels in the newborn. This suggest that hemoglobin synthesis rather than storage of iron is affected. These differential effects on storage and circulating iron may represent a biological adaptation as a satisfactory concentration of iron in liver at birth sustains the infant in the postnatal period when the diet (milk) is poor in iron and the demand for iron is very high because of rapid increase in blood volume after birth.

Thus, the results of the studies on fetal and neonatal iron status taken together suggest that even if liver iron concentration is not affected, maternal anemia may be a critical determinant for the size, iron status and vitality of the newborn. Should the deficit in blood hemoglobin and serum iron levels be combined with a deficit in blood volume,

the consequences would be even more serious. These observations emphasize the importance of treating and preventing anemia of pregnancy and emphasize the relevance of public health measures taken in this country in the form of iron-folate supplementation to pregnant women, particularly in the low income group, and the need for more extensive and effective implementation of this programme.

3) Body magnesium is distributed in bone and soft tissues equally. A progressive increase in total body magnesium content with fetal development, a large proportion of which is present in muscle has been reported. As skeletal muscle is one of the tissues more vulnerable to nutritional status, the question arises as to whether the magnesium content of fetal tissues is affected by a low plane of maternal nutrition. This is particularly relevant for the muscular rigour of the newborn infant, which is likely to be affected by muscle composition which is critical for its postnatal development. Studies were undertaken on magnesium concentration of soft tissues in the fetus such as the liver, kidney, spleen, heart and skeletal muscle. The results showed that tissue magnesium concentration decreased with the progress of gestation in the case of the spleen. However, total content increased because of a greater increase in organ size. It also

appears that fetal size rather than maternal status is a critical determinant of fetal magnesium status. Muscle magnesium levels were found to be affected by fetal size apart from the overall decrease in total magnesium stores because of smaller fetal size. Cord serum magnesium levels were not found to be influenced by either maternal magnesium status, gestational age or fetal size.

4) Studies on the supplementation of pregnant women with a fermented product 'dhokla' at different stages of pregnancy suggest that supplementation helped to alleviate the nausea and loss of appetite in early pregnancy and improve gains in the first trimester. It had a favourable outcome on the neonatal status of premature infants as well as full term infants as reflected in weight for gestational age. In addition, the proportion of low weight gains in pregnancy and birth weights tend to be less in the supplemented groups suggesting that both may have been prevented in atleast a few women. Thus supplementation of this kind ensures minimal levels of food intakes in poor pregnant women and helps in the overall well-being of the mother and the infant. However, the weights of the supplemented infants at 3 months and 6 months were not better than the control group presumably because of small sample size and the small numbers who must be presumed to have benefitted from the supplementation.

It is increasingly recognised that antenatal care as well as the care of the infant in the immediate post-partum period play a crucial role in the promotion of lactation performance as well as mother-infant relations. Information on perinatal practices indicated the persistence of traditional antenatal and post-partum practices such as lack of antenatal medical care, avoidance of some foods during pregnancy, with-holding of breast milk for 2-3 days after delivery and for longer periods in a few cases, dietary restrictions for the mother in the post-partum period and unhygenic conditions with regard to severing and bandaging of umbilical cord in home delivered cases. Information on resumption of menstruation after delivery indicates a considerable delay in such resumption in poor women.

5) Studies on organ growth at different stages of gestation suggested that the proportion of body weight contributed by liver, kidney and heart was substantially the same from 12 weeks of gestation to term. The contributions of lung and brain weight to the body weight declined with the progress of gestation suggesting their ontogenetic priority. The differences in organ and fetus weights between the two socio-economic groups studied are manifested after mid-pregnancy due to rapid growth rate during this period so that the differences in growth

pattern associated with those in nutrient supplies are accentuated. The weights of these organs in growth-retarded fetuses, as judged by their low weight for gestational age, were less but their percentage contribution to total body weight did not differ from growth-normal fetuses. In this connection, their smaller size may also be associated with their retarded biochemical maturation.

6) Somatic measurements were made in the fetus and in the neonate at different stages of development in relation to maternal nutritional status and growth status. The results suggested that some indices of growth such as weight, weight/crown heel length and arm circumference are more readily affected than others, namely, head circumference, crown heel length, crown rump length, leg length which are well preserved in the face of fetal growth retardation as judged by low weights for gestational age.

Thus the present studies point out that growth-retarded fetuses are born with lower stores of nutrients such as iron and magnesium and have smaller organs which are critical for survival and development. In addition, prematures in the poorly nourished group are in double jeopardy since they are born before they have the

opportunity for catch up growth. The beneficial effects of supplementation on the neonatal status of premature infants and male infants as well as on the feeling of well-being in case of a few women suggest the importance of such programmes for the poorer sections of the population.