Pediatric Nutrition in Health & Disease



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Foreword
BNS Walia

JAYPEE

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4 Maternal Nutrition in Pregnancy and Lactation

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INTRODUCTION

Maternal nutrition not only influences the health and well being of the mother but also has intermediate and long-term effects on the development and health of the infant.[1] The fact that maternal nutrition during the antenatal period directly influences the fetal outcome has well been recognized. When a precursory study into the link between nutrition and pregnancy was done in a series of women who consumed minimal amounts over the 8-week period, it was discovered that they had a higher mortality or disorder rate concerning their off spring than women who ate regularly since children born to well fed mothers had less restriction within the womb.[2] Pregnancy and lactation are times of heightened vulnerability. The threat of malnutrition begins in the womb and continues through the life cycle. A mother who was malnourished as a fetus, young child or adolescent, is more likely to enter pregnancy stunted and malnourished. Her compromised nutritional status affects the health and nutrition of her own children. Growth faltering earlier in life leaves women permanently at risk of obstetric complications and delivering low birth weight babies.

PRECONCEPTION NUTRITION

It is estimated that a woman planning for a pregnancy be prepared even before the conceptual stage, which is known as the perinatal period. It requires a mother to be in good nutritional state prior to conception and that this state be maintained throughout pregnancy, labor and the period after birth. A mother well nourished before conception, will encounter fewer premature births and produce healthier babies.

The most important factor in prepregnancy nutrition is ensuring that the mother is healthy and without any major factors, which could worsen the chances of conception, like anorexia or bulimia, both of which can hinder conception. The minimum basal metabolic index (BMI) of 20.8 is a positive factor for preconception stage. Gaining weight restores fertility and a body fat content of at least 22% is necessary for a normal ovulatory function and menstruation.[3] On the other hand the same is true for obese women with a BMI of more than 30, which is a direct result of decrementing amounts of insulin activity and sex hormones may reduce the viability of the ovum. If a woman planning to conceive needs to gain or lose weight, it is recommended to be done gradually. The ideal weight of a woman planning to conceive is thought to be optimal at BMI between 20–26. This together with good diet and nutrition before pregnancy, would also maximize the reserves of micronutrients which are required during pregnancy.[4]

Some nutrients are considered to be beneficial for the pregnancy state and it is recommended that the standard dosage of these is followed as per the RDA:

- Magnesium and zinc supplements for the binding of hormones at the receptor sites.

- Folic acid supplement or dietary requirement of foods containing it for regular growth of the follicle.
- Regular vitamin D supplement decreases the chances of deficiency in adolescence. It has an important role in reducing the incidence of rickets with pelvic malformations which can hamper normal delivery.
- Vitamin B_{12} is known to reduce chances of infertility and ill health.
- Omega 3 fatty acids help in prevention of premature delivery and low birth weight.[3] Good dietary sources are oily fish, flax seeds, walnuts and pumpkin seeds.

NUTRITION DURING PREGNANCY

The post conception stage and the weeks following it are the most vulnerable, being the period when fetal development occurs within the womb. The energy needed for the organ and system development is derived from those present in the mother's circulation and around the lining of the womb. During the early stages the placenta is not formed and hence the transport of nutrients from the mother to the embryo is not possible. Therefore it is important that the mother's diet is healthy comprising all the essential nutrients so that the embryo is not deficient in these components. Diets should be rich in folic acid and iron to prevent neural tube defects.

Nutritional Recommendations During Pregnancy

Energy

Energy requirements during pregnancy are variable due to the energy sparing adaptations which protect the mother or fetus from nutritional strains.[5] Energy supplements in pregnancy have been shown to have variable effects on birth outcome, with more obvious benefit in women who are nutritionally at risk during this stage. The National Institute of Nutrition (NIN), (ICMR) group has worked out the recommendations of various nutrients for the pregnant and lactating mothers. Based on the prepregnancy weight of 55 kg, 'the additional energy requirements' of an Indian woman as per the recommendations of NIN are:[6]

	12 kg increase	10 kg increase
1st trimester	85 kcals	70 kcals
2nd trimester	+ 280 kcals	+ 230 kcals
3rd trimester	+ 470 kcals	+ 390 kcals

Therefore an average recommendation of 350 kcals/d through the second and third trimesters, as additional requirement during pregnancy (for an Indian woman of 55 kg body weight and pregnancy weight gain between 10–12 kg) may be made.

Proteins

Protein intakes to meet the average requirements of women during pregnancy, have been worked out by NIN by rounding off high quality protein for 10 kg gestational weight gain. These are 1, 7 and 23 g/d in 1st, 2nd and 3rd trimesters respectively.[6] A balanced energy/protein supplement (protein < 25% of energy) tends to influence pregnancy outcome favorably, while a very high protein supply may also be harmful.[7] It is therefore recommended that protein supplements are not required to meet this additional requirement during pregnancy. To achieve high quality protein content in an Indian diet, the foods can be varied, selecting foods with high protein content. For instance, pulses or legumes which have an individual protein efficiency ratio (PE) of 28% can be added as a cup of lentils or whole gram at meal time, or even between meals. Similarly a greater use of milk or milk based products (with a PE ratio of 15%), or non-vegetarian foods like eggs (PE ratio of 30%) or flesh food can further increase protein intake. All these food groups also add high quality protein to diet.[6]

Gestational Weight Gain

Fetal growth is reflected by gestational weight gain. A low weight gain is a risk indicator of intra-uterine growth retardation and perinatal mortality. On the other hand a higher gain is a risk indicator for maternal diabetes, macrosomia, delivery problems, birth trauma and asphyxia. It is now well known that intrauterine growth retardation and macrosomia may program obesity and metabolic syndrome later in life. The recommended total weight gain ranges for pregnancy are highlighted in Table 4.1.[8]

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TABLE 4.1: Weight gain recommended for pregnancy

Prepregnancy weight category	Recommended total gain (kg)
BMI < 19.8	12.5–18.0
19.8–26	11.5–16.0
> 26.0–29.0	7.0–11.5

Source: Institute of Medicine. Nutrition during pregnancy, 1990.

Essential Fatty Acids

Some data exists in support of supplementation of essential fatty acids (EFA) like fish oil during pregnancy showing improved birth weight,[9] but random controlled trials have failed to elicit any such co-relation.[10]

MICRONUTRIENTS IN PREGNANCY

Vitamins

Fat Soluble Vitamins

Requirement of vitamin D increases twice the normal during pregnancy, therefore besides consuming rich dietary source of vitamin D, exposure to sunlight increased the vitamin production in the skin. An average well nourished woman would be having adequate reserves of the vitamin to sustain through the pregnancy period. Therefore the extra supplement of vitamin A may not be required. Good dietary sources include milk and milk products, green leafy vegetables, fruits like mangoes, papaya, vegetables like carrot, jaggery (source of β carotene, a precursor of vitamin A). Vitamin E requirement also increases during the last 8–10 weeks of pregnancy. The role of this vitamin is to prevent oxidation of the total fat reserves which are stored for providing for the growing fetus. Good sources of vitamin E are oily fish, flax seeds and green leafy vegetables.

Iron

As well known, iron requirements increase dramatically during pregnancy. The absorption of iron is directly proportionate to the level of iron stores in the body. When dietary iron stores are inadequate for the increased demands of iron, the maternal stores are depleted. By the first trimester, the iron stores are low or absent in women. However, during pregnancy, the iron status of the fetus is maintained near normal, even if depletion of iron stores and subsequently anemia occurs in the mother. Iron deficiency during pregnancy can produce anemia, fatigue and irritability in the mother and may impair growth of the fetus. Iron supplements should be taken with food to enhance iron absorption (meat, fish and fruits and vegetables rich in vitamin C).

Zinc

Low zinc intake during pregnancy increases the risk of delivering a low birth weight baby and may increase risk of birth defects.[11] Zinc requirements are about 50% higher during pregnancy.

Magnesium

Deficiency of magnesium can cause fatigue and muscle cramps and increase risk of premature birth and maternal hypertension. An intake of 400 mg/d is recommended. In a cross sectional study, birth weight has been shown to be positively co-related to magnesium intakes in early pregnancy.[12]

Calcium

During pregnancy about 30–40 g of calcium are transferred to the fetus during pregnancy, most of it during the third trimester.[8] The absorption of maternal calcium increases rapidly during pregnancy. An intake of about 1000–1200 mg of calcium throughout pregnancy reduces bone loss, since during late pregnancy, the calcium must be withdrawn from maternal bone and transferred to the fetus. Keeping in view the importance of most micronutrients, the deficiency of any of these can have adverse effects during pregnancy, both for the mother and the baby as shown in Table 4.2.[13]

Dietary and Environmental Hazards During Pregnancy

Alcohol

Consumption of alcohol during pregnancy is potentially hazardous due to the devastating effects on the outcome, termed as fetal alcohol syndrome (FAS).[14] It is characterized by abnormal facial

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TABLE 4.2: Effects of micronutrient deficiencies during pregnancy

Nutrient	Effect on mother	Effect on fetus/ placenta
Vitamin D	Reduced bone density, may increase risk of osteoporosis	Impaired skeletal and tooth development, hypoglycemia, rickets
Vitamin A	Anemia	Low birth weight, premature birth
Vitamin E		Birth defects, spontaneous abortion
Folate	Anemia	Low birth weight, birth defects, miscarriage
Thiamine		Infant beriberi (severe B_{12} deficiency producing heart failure)
Iodine	Hypothyroidism	Severely impaired mental and motor development
Calcium	Increased risk of hypertension and eclampsia, decreased bone density may increase risk of osteoporosis	Impaired skeletal and tooth development, rickets
Magnesium	Increased risk of hypertension and eclampsia	Premature birth
Zinc		Birth defects, premature birth and low birth weight
Iron	Anemia	Low birth weight, premature birth, increased infant mortality

Source: Keen CL, et al. (eds), Maternal nutrition and pregnancy outcome. Ann NY Acad Sci:1993;678.

structure and impairment in growth and intellectual development. The mechanism involves the crossing over of alcohol and its metabolites through the placenta. The fetus does not have the enzymes to breakdown these toxic products including alcohol, which remain in the fetal circulation over prolonged period, thus exposing the fetus to high concentrations of alcohol for a long duration.

Caffeine

In pregnancy, the metabolism of caffeine is known to slow down, taking 2–3 times longer to metabolize. Intake of > 300 mg caffeine per day (equivalent to > 3 cups of caffeine/d) can be devastating due to its causing impaired growth and development and increasing risk of miscarriage.[15] Caffeine tends to constrict the blood vessels in the placenta which can result in reducing the supply of oxygen and nutrients to fetus.[16] It is recommended that pregnant women should best avoid coffee, black tea, chocolates and colas.

Food Additives

Additives like non sweeteners, i.e. saccharine, cyclamate and aspartame should be avoided by pregnant women due to the fact that these pass through the placenta and could be carcinogenic, especially when exposure begins *in utero* and continues through adult life.

Heavy Metals

Exposure of toxic metals like mercury, lead, cadmium and nickel can be harmful for the pregnant women, including the industrialized and agricultural chemicals due to their risk of being transported to fetus through the placenta. Even low levels of lead passing through the placenta increase the risk of premature birth, irreversibly impairing intellectual and motor development throughout childhood and lowering IQ.[13]

Hypervitaminosis A

Excess intake of vitamin A above the recommended levels during pregnancy (> 25000IU) has been linked to birth defects, including malformations of the skull, heart and the central nervous system.[17] It is interesting to note that deficiency of choline and vitamin E enhance the toxicity of high doses of vitamin A during pregnancy.

Tobacco

Children of mothers with history of smoking may have long-term impairments in physical growth and intellectual performance. The adverse effects are dose

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dependent and directly proportionate to the number of cigarettes smoked during pregnancy. The adverse effect is due to the reduced blood flow through the placenta and restricted oxygen and nutrient flow to the fetus. Smoking can deplete maternal stores of zinc, vitamin C, vitamin B_6, folate and vitamin B_{12}.[17]

Special Considerations During Pregnancy

Heartburn, Nausea, Constipation: A woman may encounter certain problems like heartburn, nausea and constipation during the entire period or specific periods of pregnancy. This is due to the changes in the hormonal levels during this period. The progesterone levels are raised which cause the muscle tone to relax and slow down the digestive process especially the peristalsis.[17] As a result there is a reflux of the gastric juices, at the lower esophagus, causing irritation and discomfort which is termed as heartburn. This can be minimized by eating smaller meals and avoiding taking meals immediately prior to physical activity or exercise. However, the relaxing of the muscle tone is otherwise beneficial as it helps to slow the transit time allowing increased nutrient absorption along with the gastro intestinal tract (GIT). The problem of reflux can also be alleviated by avoiding lying down immediately after meals (3–4 hours) and even when doing so to keep the head ended elevated. Another common problem of nausea can be tackled by having small frequent meals and not with meals which can be of help too.[17] Nausea may also be controlled by supplemental vitamin B_6 (25–75 mg/d) and magnesium (200–500 mg/d).[18]

Many women experience severe constipation and hemorrhoids during pregnancy which is due to increased water absorption from the stools which transits slowly along the GIT. Therefore liberal fluids and high fiber diet is recommended to ease the problem. Lots of fresh fruit and green vegetables and whole grain cereals can help the stool motility. Extra-vitamin C and regular moderate exercise can be helpful.

Hypoglycemia

Pregnant women are prone to develop hypoglycemia due to increased utilization of glucose by the fetus from the mother. This is particularly so at the early hours in the morning or if the woman has skipped a meal or is on a long fast. Skipping meals tend to produce more ketone bodies which can adversely affect the fetal development. Frequent small consumption of snacks and meals is recommended for these women to avoid hypoglycemic attacks.

Gestational Diabetes

About 5% of pregnant women may develop reduced ability to secrete insulin and control blood sugars resulting in gestational diabetes.[19] Hyperglycemia during pregnancy has an adverse effect on the fetus and the mother producing complications later on. Therefore dietary modifications with moderate exercise can help maintain normoglycemia and thus prevent complications. Supplemental zinc and chromium are known to enhance the action of insulin.[20]

Hypertension and Toxemia of Pregnancy

Extreme increase in the blood pressure during pregnancy can cause toxemia characterized by protein loss in the urine and fluid retention. This can prove fatal for both mother and the fetus.[21] These complications can be prevented by suitable dietary modifications. Too much restriction of salt can also increase the risk; therefore undue salt restriction should be avoided. Low calcium or zinc is known to increase the risk of toxemia. Calcium supplementation (2 g/d) during pregnancy can be beneficial. Supplemental B_6 (25–50 mg/d) may also be helpful in prevention and treatment of this disorder.[22]

Lactation Period

Nutritional Needs During Lactation

Breast milk is Mother Nature's unique gift bestowed upon the child through the mother. Milk production in the first 6 months of lactation averages about 750 ml/d, but women can vary in their output which can far exceed this volume being up to 2000 ml/d.

The composition of breast milk is unique due to the fact that it contains over 200 recognized components like:

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- All nutrients (energy, protein, essential fatty acids, vitamins and minerals) needed by the new born for optimum growth and development.
- Enzymes to help the newborn digest and absorb nutrients.
- Immune factors to protect the infant from infection.
- Hormones and growth factors that influence infant growth.

All of the above components, though remain same in all mothers, the concentration of each of these are dependent upon her diet. Therefore during the period of lactation it is very important that the diet of the mother for the first 6 months is optimum which can in turn optimize the breast milk formation. Breastfeeding mothers need significantly more energy, proteins and micronutrients during lactation to support milk formation. For an exclusively breastfeeding mother, who would produce an additional amount of milk for the first 6 months, would require 600 kcals, and for partially breast feeding during 7–12 months, it would be 517 kcals or approximately 520 kcals.[6] The NIN (2010) recommendations have been computed by adopting the factorial requirement during lactation. This has been computed on the basis of secretion of 9.4 g/d of protein in milk during 0–6 months and 6.6 g during 6–24 months. Therefore the additional mean and safe protein intake at different months of lactation have been rounded off to 19 g/d for safe allowance for a lactating woman during 1–6 months and 13 g from 6–12 months. As for pregnancy, has protein requirements can be met from a balanced diet with a PE ratio between 12–13%.[6]

The requirements of most vitamins and minerals go up by 50%–100% compared to the pregnancy period. The quality of the breast milk can be influenced by the quality of the food consumed while breast feeding. The type of fat consumed during breast feeding influences the fat content of the breast milk. Vegetarians produce more milk with greater amounts of fatty acids present in plant foods. This is important since essential fatty acids (omega 3 fatty acids and EPA and DHA) are essential for the development of the nervous system of the new born.[23]

Vitamins like vitamin D are essential in the maternal diet since deficiency of this can lead to low levels in the infant too. Infants fed breast milk low in vitamin D may develop skeletal abnormalities and rickets.[24] There are other major minerals like calcium and magnesium which continue to be secreted in the milk despite low concentrations of the same in the maternal diet, draining from maternal reserves. Therefore if maternal stores of calcium are continuously low, these can be totally depleted leading to osteoporosis later in their lifespan.[21] Calcium supplements along with vitamin D during lactation and during the weaning period are important to maintain calcium balance and maternal skeletal health.[25]

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