
UNIT 13 PREGNANT AND LACTATING MOTHERS

Structure

- 13.1 Introduction
- 13.2 Pregnancy and Lactation – Critical Stages in the Lifecycle
- 13.3 Physiological Changes during Pregnancy
 - 13.3.1 Expansion in Plasma Volume and Red Cell Mass
 - 13.3.2 Hormonal Profile in Pregnancy
 - 13.3.3 Organ Functions
 - 13.3.4 Placental Transfer of Nutrients
 - 13.3.5 Maternal Weight Gain
- 13.4 Nutritional Needs during Pregnancy
- 13.5 Maternal Nutrition and Foetal Outcome
 - 13.5.1 Pre Pregnancy Weight and Foetal Outcome
 - 13.5.2 Pre Pregnancy Height and Foetal Outcome
 - 13.5.3 Body Mass Index (BMI)
 - 13.5.4 Weight Gain during Pregnancy and Foetal Outcome
 - 13.5.5 Maternal Dietary Intake and Foetal Outcome
 - 13.5.6 Non Nutritional Factors: Antenatal Care, Age, Heavy Physical Work and Intra Uterine Infections
- 13.6 Nutritional Assessment and Guidance in Prenatal Care
- 13.7 Common Concerns during Pregnancy
 - 13.7.1 High Risk Pregnancies
 - 13.7.2 Management of High Risk Pregnancies
- 13.8 Lactation
 - 13.8.1 Physiology of Lactation
 - 13.8.2 Human Milk Composition and Infant Growth and Development
 - 13.8.3 Malnutrition – Effects on Milk and Effects on Mothers
- 13.9 Maternal Nutrition during Lactation
 - 13.9.1 Nutrient Requirements during Lactation
 - 13.9.2 Dietary Management
 - 13.9.3 Other Concerns during Breastfeeding
- 13.10 Let Us Sum Up
- 13.11 Glossary
- 13.12 Answers to Check Your Progress Exercises

13.1 INTRODUCTION

In the previous unit, we learnt about the basic principles of meal planning and the various considerations and guidelines that must be kept in mind while planning the diets for adults. In continuation with our discussion on adults, let us move on to study about the nutrient requirements during the periods of pregnancy and lactation,

Pregnancy and lactation are unique periods in the life cycle. They occupy a critical place in the life cycle and have health and social importance for individuals, families and society. This intergenerational significance has led all societies to recognize these as special periods and to make provisions for their care. This unit discusses the various issues pertaining to these two important physiological stages such as meeting the nutritional requirements during these periods. It focuses on nutrition in preparation for, and support of, pregnancy and lactation. As you read on, it will become evident

to you that there are heavy demands on the mother during pregnancy and lactation. What modifications should be made to meet the increased needs? Which foods must be included in the diet of pregnant/lactating women? Let us proceed with our discussion and find out all these aspects.

Objectives

After studying this unit, you should be able to:

- describe the various physiological changes during pregnancy,
- describe foetal growth and development and understand the importance of nutrition,
- identify determinants of poor pregnancy outcome,
- explain what is IUGR and LBW and their consequences,
- discuss the various aspects about lactation and importance of human milk,
- elaborate the nutritional requirements during pregnancy and lactation,
- state dietary considerations to be followed to ensure successful pregnancy and lactation, and
- counsel mothers as per their individual requirements.

13.2 PREGNANCY AND LACTATION – CRITICAL STAGES IN THE LIFECYCLE

You must be aware that the situation of women is far from optimal and it is necessary to give attention to their nutrition and health. The National Family Health Survey (NFHS-2, 1998-99) indicates that the mean BMI for women is 20.3. More than 1/3rd women have a BMI below 18.5 indicating high prevalence of chronic energy deficiency. Asia has the highest prevalence of anaemia in the world with about half of all anaemic women living in the Indian subcontinent, where 88% of them develop iron deficiency anaemia during pregnancy.

Undernutrition in children is strongly associated with undernutrition in mothers. It often starts *in utero* and may extend throughout the life cycle. It occurs during pregnancy, childhood and adolescence and has cumulative effects. Undernutrition, especially in the mother, is associated with poor pregnancy outcome including a higher incidence of low birth weight, maternal mortality, foetal and infant death and disability. Malnourished women or adolescent girls give birth to stunted and thin babies. Thus, undernutrition is handed down from one generation to another. Such children may not show catch-up growth in the later years and are more likely not to perform well in school. As adults, they may be less productive and are more likely to suffer from chronic degenerative diseases. Chronic undernutrition accounts for a large proportion of child deaths, poor pregnancy outcomes, poor quality of life and lost productivity among earning adults and spanning generations,

At no other period is the well-being and future of an individual completely dependent on the health and nutritional status of another as is during pregnancy and early periods of lactation. The mother's nutritional status is a crucial factor affecting pregnancy outcome. Her diet must be carefully planned to supply the nutrients needed to maintain her health, support the physiological changes in her body and provide for the rapid growth and development of her unborn baby while protecting her from deficiency or excess of nutrients.

The goal is not just survival, we must try and ensure that every woman who is pregnant has the opportunity for a safe and successful pregnancy and the ability to deliver and care for an infant whose physical and mental potential are not impaired. Once a child is born, she must be adequately nourished to continue to depend on their

mothers for nourishment. Lactation has high nutrient costs; hence the mother's diet must be nutritionally adequate. Let us then understand these two physiological conditions in greater details. We begin with pregnancy.

13.3 PHYSIOLOGICAL CHANGES DURING PREGNANCY

A whole new life begins at conception. Organ systems develop rapidly and nutrition plays many supportive roles. Pregnancy from conception to birth usually lasts 40 weeks (10 lunar months/menstrual cycles) in humans. During this period, the unborn child grows from a single cell to an infant that is ready for life outside the womb. Many physical changes also take place in the mother to support her developing offspring, regulate her own (maternal) metabolism and prepare her for labour, birth and lactation.

Changes in the mother are anatomical, physiological and complex, affecting almost every function of the body. They are an integral part of the maternal – foetal system, which creates the most favourable environment possible for the developing child. Many of these changes are apparent in the very early weeks.

Let us briefly look at the important physiological effects, which will help you to understand the basis of nutritional requirements.

13.3.1 Expansion in Plasma Volume and Red Cell Mass

In this sub-section we shall review the expansion in blood volume and in the red cell mass accompanying pregnancy.

Plasma: In a non-pregnant woman, average plasma volume is 2600 ml. Plasma volume begins to increase by end of the first trimester and reaches a peak by 34 weeks, when it is about 50% greater than it was at conception. The physiologic dilution accompanying the expansion in blood volume is known as *haemodilution*. Haemodilution is responsible for the decline we see in several blood parameters during pregnancy especially in the second and third trimesters.

Individual variations are seen in plasma volume – multigravidas and in mothers with multiple births, usually have a greater increase. Increase in plasma volume is correlated with obstetric performance. Women with an increase smaller than the average have higher risk of still births, abortions or low birth weight babies. This has been seen in women with hypertension, renal disease, low weight gain during pregnancy, undernutrition, smoking, pre-eclampsia, diuretic treatment and smoking.

Red Cells: Production of red cells is stimulated and their numbers gradually rise. However, as compared to the expansion in plasma volume, their increase is not as large; there is an increase in red cell mass by 20%. As the plasma volume increases much more than the red cell mass, there is usually a drop in the haemoglobin levels around 34th week of gestation.

Proteins: Total serum protein gradually decreases, along with a sharp decline in albumin. There is reduction in serum albumin along with the expanded plasma volume. Serum levels of vitamin C, folic acid, vitamin B₆ and vitamin B₁₂ follow the decline of serum albumin levels.

Other Nutrients: Fat-soluble vitamin concentrations, especially carotene and vitamin E are increased by nearly 50%. Vitamin A levels, however, remain unchanged. Progressive increase is seen in serum triglycerides, cholesterol and free fatty acids. These are brought about by increased concentrations of oestrogens, progesterone and placental hormones.

Interpretation of blood/serum nutrient values in pregnancy is therefore complex compared to the non-pregnant state, as they depend on a number of factors including the stage of gestation. It is necessary to conduct biochemical tests at suitable intervals such as in the first, second and third trimesters, to follow these changes and determine if there is a deviation that calls for an intervention. The most common measurement of nutritional importance done routinely in India is haemoglobin in the second and third trimesters. Measurement of blood pressure and fundal height are other two measurements done routinely to determine high risk pregnancies and development of the foetus.

13.3.2 Hormonal Profile in Pregnancy

Hormonal changes characteristic of pregnancy include the following:

Human chorionic gonadotropin (HCG) begins to increase immediately on implantation of the ovum and reaches a peak at around 8 weeks of gestation. It then declines to a stable value until birth. In the first 8-10 weeks, HCG maintains the corpus *luteum*, which is the main source of oestrogens and progesterone in the early weeks of pregnancy. These hormones play an essential role in the development of the placenta.

Human placental lactogen, with a structure similar to the growth hormone, increases throughout pregnancy. Its rate of production parallels the rate of placental growth and is a good indicator of placental function. At the peak rate of secretion, the amount produced is 1-2 g per day, much higher than any other hormone. Placental lactogen stimulates lipolysis and is important in maintaining a flow of substrates to the foetus. Placental lactogen along with prolactin also promotes the development of mammary glands. After delivery, placental lactogen disappears from the maternal circulation.

Oestrogens and progesterone are secreted by the placenta from 8-10 weeks of gestation. Progesterone increases throughout pregnancy. It stimulates maternal respiration ensuring an adequate supply of oxygen to the foetus. In addition, it relaxes smooth muscle in the uterus to accommodate the growing foetus and allow for child birth. Progesterone, while stimulating lobular development in the breast, inhibits milk secretion during pregnancy.

Placental secretion of oestrogens increase with progression of pregnancy. Oestrogens perform many functions. They stimulate uterine growth, increase blood flow to the uterus and promote breast development. Oestrogens also induce prolactin secretion by the maternal pituitary. Prolactin secretion helps in mammary gland development. After delivery, oestrogen induced mammatrophs (prolactin secreting cells) in the pituitary secrete large amounts of prolactin to initiate and maintain milk production.

Another hormone that is increased in maternal plasma during pregnancy is **cortisol**. Cortisol enhances production of glucose from amino acids (gluconeogenesis) and also antagonizes the action of insulin. This way it increases the availability of glucose to the foetus which relies solely on glucose for its energy needs. In the marginally glucose intolerant women, these changes as a result of pregnancy may predispose them to frank impaired glucose intolerance.

13.3.3 Organ Functions

Dramatic changes occur in renal functions to eliminate the nitrogenous and other waste products of maternal and foetal metabolism. Effective renal plasma flow, (volume of plasma filtered by the renal tubules), increases by 75%. This is one of the earliest physiological adjustments in pregnancy. The glomerular filtration rate increases by 50% in early pregnancy. These changes in renal functions while helping to clear waste products on one hand, are also associated with increased excretion of glucose and amino acids but unrelated to the plasma levels of these constituents.

In addition, the heart and the lungs respond suitably to the increased blood flow to the placenta and to the increased demand for oxygen to the foetus. The intestinal absorption of all nutrients is enhanced to take care of the increased requirements. The amount absorbed depends on the amount ingested, maternal stores and progressively increasing requirements of the foetus.

13.3.4 Placental Transfer of Nutrients

The placenta is a transitory structure developing during pregnancy and lies implanted on the uterine wall. It is connected with the foetus through the umbilical cord. The foetus derives all its nutrition from the mother across the placental barrier. If the consumption, absorption and utilization of the nutrients by the mother and the transport of nutrients across the placental barrier are inadequate, then foetal malnutrition develops. Dietary inadequacies are a inajor cause of foetal undernutrition in developing countries. Maternal diseases such as diabetes and hypertension compromise the delivery of nutrients across the placenta to the foetus. The transfer of nutrients also depends on their concentrations in maternal plasma and blood flow to the placenta. The mechanisms for transfer of nutrients across the placental barrier are either simple or facilitated diffusion or active transport, as in the case of transfer across the intestinal brush border. Fat-soluble vitamins and electrolytes are transferred by simple diffusion; glucose is transferred by facilitated diffusion; while amino acids, water-soluble vitamins and minerals like calcium and iron are transferred by active transport. The role of placenta in promoting foetal nutrition is shown in the Table 13.1.

Table 13.1: Role of the placenta in foetal nutrition

Nourishes the foetus	• facilitates transfer of oxygen and nutrients from mother to foetus.
Removes wastes	• picks up foetal waste products such as CO₂, urea, bilirubin.
Foetal lung	• performs the respiratory, absorptive and excretory functions that the foetus lungs, digestive system and kidneys will provide after birth.
Protective barrier	• protects the foetus from harmful agents, which are of high molecular weight including proteins except maternal immuoglobulin G conferring immunity to the foetus. • transports nutrients and in some cases can store them.
Endocrine gland	• produces several hormones that maintain pregnancy and prepare the mother's breasts for lactation.

13.3.5 Maternal Weight Gain

The often quoted figures for weight gain during pregnancy are from the study of Hytten and Leitch reported from UK in 1971. In this study, average weight gain by primigravidae eating without any restriction was 12.5 kg. This weight gain represents two major components. 1) The products of conception, the foetus, amniotic fluid and the placenta 2) maternal tissues gained, expansion of blood and extracellular fluid, enlargement of uterus and mammary glands and maternal stores (adipose tissue).

In India, several studies have examined the weight gain during pregnancy by women from upper and lower socio-economic groups. While in tlze upper economic group, tlze average weight gain is 11 kg, the lower economic group women gain only 6-7 kg during pregnancy. Lower weight gain is associated with increased risk of intra uterine growth retardation and perinatal mortality. It is useful to define certain terms here. When a baby is born full term, 39-40 weeks of gestation but has a weight less

than 2.5 kg, the baby is referred as a *low birth weight (LBW)* baby or as a *small for date* baby. These babies have suffered intra uterine growth retardation, i.e. retardation in *growth in utero*. If a baby is born prior to full term and weighs less than 2.5 kg, it is not to be classified as low birth weight or small for date. Such babies are *pre maturely born*. However, in many developing countries, obtaining correct information on gestational duration is difficult and therefore quite often the babies born before full term and weighing less than 2.5 kg are classified as LBW. The developmental trajectory of a pre term baby is quite different from that of a low birth weight baby and therefore it is important to distinguish between these two.

The rate of weight gain is as important as the total weight gain. The rate of weight gain as pregnancy progresses for three categories of women, under weight, normal and over weight prior to pregnancy is shown in the graph in Figure 13.1.

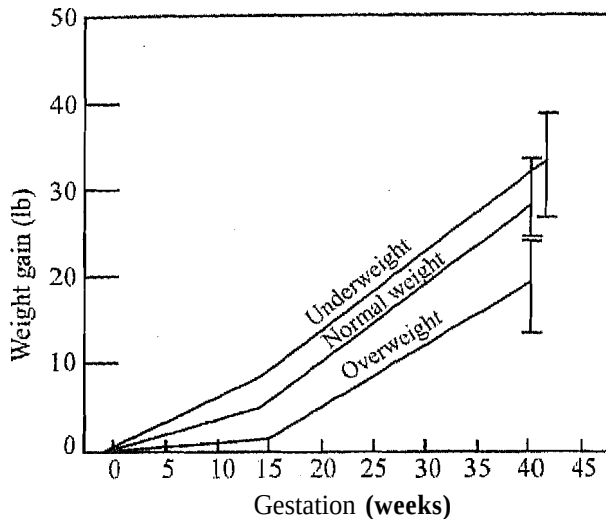


Figure 13.1: Recommended pattern of weight gain

Source: Smolin and Grosvenor (1997).

As you may have noticed in Figure 13.1, little gain occurs during the first trimester (approx. 1 kg). In the second and third trimesters, when the foetus grows from less than 500g to about 3 kg, the weight gain should be approximately 3 kg (1 kg/month) in the 2nd trimester and 6 kg i.e. 2 kg/month in the last trimester. This translates to approximately 0.5 kg per week. Although the total recommended weight gain is different for underweight and overweight women, it should be at a slow **and** steady rate (See Figure 13.1).

The recommended weight gain on the basis of pre pregnancy weight for height in the case of undernourished women is almost unattainable in India. For example, for women with pre pregnancy BMI of less than 19.8, the total recommended weight gain is 12.5 to 18 kg, an impossible target for the Indian women, one-third or more of whom have a pre pregnancy BMI of less than 18. This brings out explicitly the need to address undernutrition in the early years and during adolescence so that realistic targets can be set for weight gain in pregnancy. For women with normal BMI of 19.8 to 26, the recommended weight gain is 11.5 to 16, while for the obese with BMI of greater than 26, the recommended gain is 7-11.5. In the Indian setting, a total weight gain of 10-12 kg appears reasonable.

So far we have read about the physiological changes which develop during pregnancy. These physiological changes contribute towards the increased **nutrient** demands on the nutritional status of the expectant mother. Through our subsequent discussions, you will be able to learn about the nutrient requirements during pregnancy.

Check Your Progress Exercise 1

- 1) Fill in the Blanks.
- a) The duration of pregnancy from conception to birth is usually weeks to menstrual cycles.
 - b) Expansion of blood volume results in
 - c) and promote the development of mammary glands.
 - d) enhances the production of glucose from amino acids.
 - e) Total weight gain suggested for Indian pregnant women is to kg.

2) What are the consequences of malnutrition during pregnancy?

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3) Enumerate the physiological changes associated with pregnancy.

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4) Describe the association between mother's weight and pregnancy outcome.

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5) Match the following:

A		B	
a)	Calcitonin	i)	Elevates blood glucose
b)	Cortisone	ii)	Promotes sodium retention and potassium excretion
c)	Thyroxine	iii)	Promotes calcium resorption
d)	Aldosterone	iv)	Inhibits calcium resorption
e)	Parathyroid hormone	v)	Regulates basal metabolism

13.4 NUTRITIONAL NEEDS DURING PREGNANCY

It must be evident by now that several physiological changes occur in the body of an expectant mother and that malnutrition can adversely affect the health of the mother, as well as, that of the infant. In this section, we shall study about the nutrient requirements during pregnancy.

For most women, nutrient needs during pregnancy are higher than at any other time of life cycle. Let us get to know about the energy and other nutrient requirements during pregnancy. We shall begin with the calorie requirements and proceed to the need for various macro- and micro-nutrients.

Energy: Two factors determine energy requirements: increase in mother's basal metabolism to support the work required for foetal growth and accessory tissues and changes in the mother's usual physical activity. The estimated total (cumulative) additional cost of energy is 55,000 Kcal. *It works out to be an additional 300 Kcal per day in the last two trimesters.* Refer to Table 13.2 for Recommended Nutrient Intakes for pregnancy. *Note: During the first trimester the additional energy required is small, hence the RDA is not increased*

Table 13.2: Recommended dietary intakes during pregnancy

Nutrient	Pregnant Woman
Energy (Kcal/day)	+300
Protein (g/day)	+25
Fat (g/day)	30
Calcium (mg/day)	1000
Iron (mg/day)	38
Vitamin A (RE) (mcg/day)	600
β-carotene	2400
Thiamin (mg/day)	4.2
Riboflavin (mg/day)	4.2
Nicotinic acid (mg/day)	+2
Pyridoxine (mg/day)	25
Ascorbic acid (mg/day)	40
Folic acid (mcg/day)	400
Vitamin B ₁₂ (mcg/day)	1

FAO/WHO/UNU 2004 recommendation for the extra energy cost of pregnancy is 85 Kcal/day, 285 Kcal/day and 475 Kcal/day during the first, second and third trimesters, respectively. There are many societies with a high proportion of non-obese women who do not seek prenatal advice before the second or third month of pregnancy. Under these circumstances, FAO/WHO (2004) recommends that in such societies pregnant women increase their food intake by 360 Kcal/day in the second trimester and by 475 Kcal/day in the third.

The composition of the diet during pregnancy should be the same as for a non-pregnant woman; hence the contribution to calories from carbohydrate, protein and fat does not change. However, carbohydrate intake should not be <100 g per day, otherwise ketosis may occur due to excessive breakdown of fats to meet increased calorie requirements. Prolonged ketosis may be harmful to the foetus, even though some ketone production occurs normally after an overnight fast. High acetonuria may

be a marker for maternal undernutrition and the associated increased risk of foetal or neonatal death. The foetus can metabolize ketones but its preferred source of energy is glucose. Also, you know adequate carbohydrates are needed to spare protein for growth.

Pregnant adolescent girls, underweight women and women who are exceptionally active (heavy physical activity) may require more energy. The details of these specific cases and increased needs are discussed later in this unit. However, here it is important to remember that requirements vary with pre-pregnancy weight, and body composition, amount and composition of weight gain, stage of pregnancy and activity level. Therefore, it would not be appropriate to make a single recommendation for all pregnant women. Energy status may be estimated by evaluating the rate of weight gain. If the rate of weight gain is appropriate for the stage of pregnancy, you can assume that energy intake is adequate. Fasting is not recommended, for it may be a special risk for women with a tendency towards early delivery. Chemical changes associated with fasting may precipitate labour pains.

Some mothers may ask you whether they can 'diet' or undertake fasting. Studies on animals show that when the mother's diet was restricted, foetal body weight was significantly reduced. Data on humans is rather limited. However, among mothers experiencing food shortages, infant birth weights get reduced. This has been documented in the studies from World War II. Optimal foetal growth occurs only when the mother is able to accumulate a critical amount of extra body stores during pregnancy.

Next, we shall discuss about one of the most critical nutrients required for tissue synthesis i.e. protein.

Protein: Altogether, 925 g of protein are deposited in a normal foetus and maternal accessory tissues and considering the dietary protein quality (NPU=65), an increase of 15 g per day is recommended. This increase could be either through vegetarian sources such as pulses (soyabean), milk and milk products (cheese) or through more of meat/fish and eggs in the diet. This is based on the needs of the non-pregnant woman plus the extra amounts needed for growth. The physically active pregnant women and adolescent girls would however require more as compared to sedentary pregnant woman. The protein excess/supplements are not recommended as these were associated with an increased incidence of prematurity and enhanced incidence of neonatal death.

The rate at which new tissue is synthesized is not constant throughout gestation. Maternal and foetal growth accelerates in the second month and the rate progressively increases until just before term. Therefore, the need for protein follows this growth rate. It is important to ensure protein quality, as well as, quantity. Moreover, since protein utilization depends on calorie intake, it is important to ensure that calorie needs are fully met. When there is inadequate intake of energy, protein will be catabolized to meet energy need. Under such circumstances, it has been shown that extra 100 Kcal will have the same effect on nitrogen retention as an additional 0.28 g of nitrogen itself.

Protein deficiency: The effects of protein deficiency during pregnancy are difficult to separate from the effects of caloric deficit, since in almost all cases, limited protein intake is accompanied by limited energy intakes. Under such circumstances, decreased birth weight and greater incidence of pre-eclampsia have been reported.

Protein excess: It is not advisable to recommend protein supplements. Reports in the literature indicate that high-protein supplements were associated with increased incidence of prematurity and excessive neonatal deaths. Analysis of supplementation studies in human populations suggests that supplements providing more than 20% of the calories from protein are associated with retarded foetal growth.

Apart from proteins and non-nitrogenous sources of energy, several vitamins, minerals and trace elements have been found to play a critical role in the progression and outcome of pregnancy. We will now review some of these in detail.

Micronutrients: The need for many vitamins and minerals is increased during pregnancy. Since energy intake increases, the requirements for few micronutrients needed for energy utilization i.e. thiamin, niacin, riboflavin and magnesium also increase. Since protein needs are higher, the requirements for vitamin B₆ and zinc also increase. Micronutrients involved in the growth and development of bone and connective tissue and the synthesis of new cells are needed in greater amounts.

Let us review the requirements for these nutrients.

Folic acid and vitamin B₁₂: Folic acid and vitamin B₁₂ are important for production of new cells. DNA must replicate and transmit its genetic information to RNA intermediates. As mentioned previously, folic acid has a role in prevention of neural tube defects. However, we need to bear in mind that effects of high intakes of folic acid are not well known, but it can complicate the diagnosis of B₁₂ deficiency. Therefore, care should be taken to keep total folate consumption under 1 mg/day except under the supervision of a physician. For normal, healthy individuals, the amount of folate present in a multivitamin form containing B₁₂ should be sufficient.

Vitamins A, C, E and K: All four vitamins have specific functions and a common role for all of them is to preserve the structural and functional properties of cells. Excessive consumption of vitamin A is known to be teratogenic. Hence, it is not advisable to use supplements. Vitamin A requirements should be met through diet. *Also if women of child – bearing age intend using products containing high amounts of vitamin A, they should be advised to consult their physicians before doing so.*

Vitamin C deficiency has not been shown to affect the course or outcome of pregnancy in humans, although low plasma levels have been associated with the premature rupture of the membranes and pre-eclampsia. Mega doses may adversely influence foetal metabolism. *Metabolic dependency on high doses may develop in the infant such that scurvy may arise in the neonatal period.*

Vitamin E needs are believed to increase during pregnancy but deficiency in humans rarely occurs. *Vitamin E in the infant was correlated directly with maternal concentration.*

Maternal dietary deficiency of vitamin K is almost unheard of but transport across the placenta is low. Newborns often have low body levels of vitamin K.

Although the need for vitamins A, C, E and K increase during pregnancy, symptoms of deficiency of C, E and K are seldom seen. You should advise mothers to include adequate amounts of these foods in the diet.

With the exception of iron and folic acid, routine dietary supplementation with other vitamin and mineral preparations is not necessary. You should encourage pregnant women to disregard vitamin and mineral preparations as corrective measures for inadequate dietary habits and consider food as the optimal vehicle for delivery of nutrients. For women who need supplementation e.g. those in high-risk category, a vitamin-mineral supplement is recommended from the beginning of the 2nd trimester. See Table 13.3 for amounts recommended,

Table 13.3: Daily vitamin/mineral supplementation for pregnancy for those with inadequate diets or in high risk categories (more than one foetus, heavy smokers, alcohol and drug abusers)

Nutrient	Amount	Nutrient	Amount
Vitamin B ₆	2 mg	Iron	30 mg
Folate	300 mcg	Zinc	15 mg
Vitamin C	50 mg	Copper	2 mg
Vitamin D	5 mcg	Calcium	2 mg

Next, we come over to the mineral requirements of expectant mothers.

Mineral Requirements

Iron: While B₁₂ and folic acid are needed for the normal erythropoiesis, they must be accompanied by adequate amounts of other nutrients. Iron is needed for synthesis of haemoglobin in both maternal and foetal red blood cells. At term, a normal weight infant has about 246 mg of iron in blood and body stores. An additional 134 mg is stored in the placenta and about 290 mg is used to expand the volume of mother's blood.

Maintenance of erythropoiesis is one of the few instances during pregnancy when the foetus acts as a true parasite. It ensures its own production of haemoglobin by drawing iron from the mother.

We should be concerned about the mother's iron nutriture, because maternal iron deficiency may adversely affect obstetric performance. A reduction in haemoglobin concentration means that the mother must increase her cardiac output to maintain adequate oxygen supply to the placenta and the foetus. This extra work fatigues the mother and makes her more susceptible to other physiologic stress. A very low haemoglobin level places the mother at risk of cardiac arrest, and should she **haemorrhage** on delivery, the prognosis would be poor. The most significant known consequence of maternal iron deficiency is reduced foetal iron stores, followed by increased risk of anaemia during infancy. Moderate to severe anaemia is associated with increased risk of spontaneous abortion, premature delivery, low birth weight, still birth and **perinatal** death. In some cases, pica has been associated with iron deficiency. Inadequate weight gain during pregnancy has been found to be more prevalent among mothers with iron deficiency anaemia and in those with anaemias of other etiologies.

If sufficient iron is available, the mother's haemoglobin level should be at 11.5 g/100 ml by term. Most women are not able to meet the additional requirement for iron, from diet alone (since the quantity ingested is less especially in lower income settings, and the **bioavailability** /efficiency of absorption is very low). Thus, it is recommended that pregnant women receive an oral iron supplement. 60-100 mg of iron should maintain haemoglobin levels in normal pregnant women, but those who are anaemic will require larger doses.

Another important nutrient of physiological significance is calcium. How does calcium intake influence the health status of mother and the foetus? Let us read and find out,

Calcium: The foetus retains about 25-30 g of calcium, over the course of gestation, most of which is deposited in the last trimester when the foetal skeleton is growing rapidly and the teeth are forming. On an average, the foetus draws 250-300 mg Ca per day from maternal blood supply. Additional calcium is believed to be stored in the maternal skeleton as a reserve for lactation. So an intake of additional 500 mg Ca is recommended during both pregnancy and lactation. Extensive **adjustments** in calcium metabolism occur. Efficiency of calcium absorption is better and urinary losses are

lower in pregnancy compared to the non-pregnant state. Hormonal factors play a role. Human chorionic somatomammotropin (produced by placenta) enhances the rate of bone turnover throughout pregnancy. Oestrogen largely from placenta inhibits bone resorption, thus provoking a compensatory release of parathyroid hormone. PTH maintains the serum calcium level while enhancing intestinal calcium absorption and decreasing its urinary excretion. Along with calcium and phosphorus, adequate vitamin D is required.

Other micronutrients of physiological relevance include zinc, iodine and sodium.

Zinc: Zinc, as a mineral, was found to be associated with foetal growth and birth weight. Low plasma zinc was associated with more complications in the antenatal and intrapartum periods, including pregnancy-induced hypertension. Subnormal tissue zinc in pregnancy may play a role in premature rupture of membranes at term. A point of caution is the interaction between zinc and iron. Zinc absorption is inhibited by high iron intakes, thus iron supplements may compromise zinc status. Box 13.1 gives details regarding the daily intake suggested for Indian adults.

Iodine: You would be already aware that maternal iodine deficiency leads to cretinism in the off spring. Hence, the maternal diet must consist of enough iodine so as to prevent the consequences of foetal damage.

Box 13.1	Suggested Daily Intake of Trace Elements for an Indian Adult	
	Chromium	67 mcg
	Copper	2.2 mg
	Manganese	5.5 mg
	Zinc	15.5 mcg
	Iodine	150 mcg

Sodium: As you know, sodium plays a role in fluid balance. Sodium metabolism is altered during pregnancy under the stimulus of a modified hormonal milieu. Restriction of sodium is not recommended to combat oedema. In animals it has been shown that rigorous sodium restriction stresses the rennin - angiotensin - aldosterone system to the point of breakdown. Such animals show reduced weight gain, altered fluid consumption patterns and they tend to develop water intoxication along with renal and adrenal tissue degeneration. Neonatal hyponatremia has been observed in offspring of women who unduly restricted their sodium intake before delivery. Although moderation in use of salt and sodium-rich foods may be appropriate, aggressive restriction is not warranted. Not less than 2-3 g of sodium should be consumed daily.

So far we have discussed about the nutrient requirements during pregnancy. Let us now read in detail the effects of malnutrition on the health and nutritional status of the mother and the foetus/newborn.

13.5 MATERNAL NUTRITION AND FOETAL OUTCOME

Maternal malnutrition has deleterious effects on both the mother and the offspring. Inadequate energy intakes, iron deficiency and strenuous physical work all contribute to poor weight gain in the mother, increased morbidities, and in severe cases, resulting in increased maternal mortality. The effects of malnutrition in women including during pregnancy have been covered in the previous unit on women and nutrition. The focus in this section is on the foetal outcome in terms of birth weight.

A large number of studies done specially in the developing countries have shown that maternal malnutrition seriously impairs foetal outcome. The birth weight and gestational

duration are adversely affected while pregnancy complications such as still birth are increased in maternal malnutrition. Therefore, it is crucial to improve maternal nutrition status in order to improve the foetal outcome. In this section, the relationship between several parameters of maternal nutrition and foetal outcome are discussed, so that we have a good knowledge of the priority actions at the individual and at a public health level to improve the foetal outcomes.

The World Health Organization, on the basis of world wide data, has recommended that a full term baby with birth weight less than 2.5 kg may be considered a low birth weight (LBW) infant carrying relatively higher risks of sub standard growth and development and higher risk of perinatal and neonatal mortality. Low birth weight in full term infants is chiefly attributable to poor maternal nutrition and health. The postnatal growth and development of the LBW infants is poorer than normal weight infants. More recently, the concern has been raised that the LBW infants may become more prone to chronic degenerative diseases later as adults.

In the subsequent discussions, the effect of maternal anthropometric measurements on the foetal outcome shall be reviewed in detail. We shall begin with the weight of the mother prior to conception.

13.5.1 Pre Pregnancy Weight and Foetal Outcome

Several studies from around the world from developing and developed countries have demonstrated an association between pre-conception body weight of the mother and LBW. The ICMR study in urban and rural India showed that pre-conception weight of *less than 40 kg* was a strong determinant of LBW. Another study conducted by the Nutrition Foundation of India (NFI) showed that body weight *less than 45 kg* was an influencing factor. The incidence of LBW in women with pre pregnancy weight of 45 kg or more was 17% as against 30-33% in the poor communities in general. The ICMR study also demonstrated increased perinatal mortality of the infant if the mother's pre-conception weight was less than 40 kg. A favourable pre-conception weight in rural and urban Indian women would appear to be 45 kg or more within acceptable limits of body mass index (BMI). In any case, it should not be less than 40 kg, as this is associated with a high risk of delivering a LBW infant. Distressingly, according to data gathered by National Nutrition Monitoring Bureau (NNMB), 15-29% of adult women in different states have body weights less than 38 kg. This situation can only be remedied by addressing malnutrition in the girl child.

Next, we will learn about the association of maternal height with the foetal growth.

13.5.2 Pre Pregnancy Height and Foetal Outcome

Maternal height prior to conception, determined by heredity, socio-economic environment and maternal nutritional status, is a strong independent determinant of birth weight and mortality. The ICMR multicentric study in India found that incidence of LBW rose sharply when maternal height was *less than 140 cm*. Another study found a 2.5 times higher incidence of LBW in mothers with height less than 147 cm compared to mothers with height above 147 cm. Since the cut off heights vary, it would seem again that preferably the pre pregnancy height should be *above 147 cm but in any case less than 140 cm* should be considered as *high risk for LBW*. Unlike weight which can be increased at any time during the reproductive period, adult height once reached can not be changed.

The NNMB data from different states show that 12-25% of adult women have heights less than 145 cm. Therefore, all efforts must be done to prevent stunting in the girl child, This aspect will be discussed in further detail in Unit 14 on pre school children.

Another important aspect which is gaining importance is the extent of adiposity or the optimal weight for a given height i.e. the body mass index of the mother and is being briefly discussed below.

13.5.3 Body Mass Index (BMI)

Weight for height as a marker of nutritional status has the advantage that it is independent of other factors that affect foetal outcome such as maternal age and parity. BMI is useful in predicting LBW or small or large for gestational babies. Refer to Table 13.4 to understand the relationship between increasing body mass index and reducing incidence of low birth weight babies.

Table 13.4: Prediction of low birth weight on the basis of BMI

BMI	LBW %
< 16	53
16 - 17	41
17 - 18.5	36
18.5 - 25	27
25 - 30	15
> 30	20

It is well known now that the health status both before and after conception hold great significance for both the mother and the child. Remember, we read about maternal weight gain during pregnancy in the sub-section 13.3.5. Let us now learn about weight gain during pregnancy and its impact on foetal outcome.

13.5.4 Weight Gain during Pregnancy and Foetal Outcome

Weight gain and birth weight are indisputably related to each other. Several studies have shown a higher occurrence of LBW with inadequate maternal weight gain. It is suggested that a low weight gain after 20 weeks of gestation may result in pre term birth and low weight gain through out pregnancy in LBW. A weight gain of 7-11 kg appear to be a measure of adequate foetal growth although preferably it should be closer to 10 kg rather than 7 kg.

Yet another significant factor is the food intake and dietary choices of the mother, which is being discussed next.

13.5.5 Maternal Dietary Intake and Foetal Outcome

Among the various nutrients, energy intake appears to be the most crucial, for developing countries. Studies from India have reported lower mean birth weight for lower income urban and rural mothers who had an energy intake of 1200-1600 Kcals, pre pregnancy weight of 43 kg and a weight gain during pregnancy of only 5-6 kg. The mean birth weight of the infants was 2.7 kg. As against this women from upper socio-economic groups with energy intake of 2000-2500 Kcal, pre pregnancy weight of 45-55 kg, and a weight gain of 11 kg, had babies with a mean birth weight of 3.1 Kg. It is not only the energy intake during pregnancy but chronic energy deficiency from early childhood that is a major factor in the low body weights of the lower income women. Therefore, body weight changes must occur much before pregnancy.

Iron and folate are the other crucial nutrients that have an effect on birth weight. A recent review concluded that there was enough evidence to suggest that iron deficiency anaemia resulted in higher occurrence of LBW through pre filature deliveries. Folate supplementation of pregnant women was shown to improve birth weights. Additionally, dietary folate deficiency is implicated in neural tube defect, as you may already be aware by now.

Certain other factors which may influence the health status of the mother and/or the foetus are being elucidated next.

13.5.6 Non Nutritional Factors: Antenatal Care, Age, Heavy Physical Work and Intra Uterine Infections

The incidence of LBW is lowest and mean birth weight is highest in the state of Kerala, which is attributed to better quality of health care and higher female literacy rate in Kerala. An ICMR study in six states of India has shown that average age of marriage in girls was 13.8 years and the age at consummation of marriage was 15.3 years. It should be noted that the age of 14-18 is a period of active growth, the period of adolescence. From the average weights and heights of Indian rural girls, it is seen that 68% of the girls will be at high risk of poor pregnancy outcome at the age of 14 y and the risk reduces to 24% at the age of 18 years. Thus, early age at marriage is another high risk factor for poor foetal outcome.

Heavy physical labour even in advanced stages of pregnancy is another factor to contend with in the settings of developing countries like India. It is suggested that under warm environmental temperatures and in an upright posture, increased sympathetic activity could result in poor utero placental blood flow affecting the foetus adversely. The average gestational duration of full term deliveries in poor communities in India is about a week shorter than in the well off sections. This is attributed to the increased sympathetic via the heavy physical labour.

Pre natal intra uterine infections could be another factor contributing to LBW. It has been reported that infants born in poor environmental backgrounds have increased IgM (immunoglobulin M, an antibody), which is a reflection of the high exposure to intra uterine infections.

A WHO review has identified 43 factors that influenced birth weight and gestational duration. They are grouped into seven categories for convenience. These include:

- 1) Genetics and constitution (e.g. sex of the baby)
- 2) Demographic and psycho social factors (e.g. age of the mother)
- 3) Obstetric factors (e.g. Parity)
- 4) Nutritional factors
- 5) Maternal morbidity during pregnancy
- 6) Toxic exposures (e.g. cigarette smoking)
- 7) Antenatal care (Number of visits and quality of care)

The following are the salient modifiable factors which affect birth weight and gestation adversely: Iron deficiency anaemia, folic acid deficiency, inadequate pre/antenatal care. These are the factors that must be addressed as a top priority from public health point of view to improve foetal outcomes and reduce the high incidence of LBW in India.

We will now learn about the significance and various aspects of nutritional care during (prenatal/prior to) pregnancy.

13.6 NUTRITIONAL ASSESSMENT AND GUIDANCE IN PRENATAL CARE

In the preceding sections, we have seen that there are unique physiologic changes in the pregnant woman's body, which has enhanced metabolic work that obviously

accounts to the increased nutrient and energy needs. Thus, care during pregnancy is of special importance and the first step required for this is a comprehensive nutritional assessment. As in case of any other person, this will provide the foundation for planning personalized nutritional care, education and guidance throughout pregnancy so that we can help ensure that both mother and baby are healthy.

What should we focus on?

Our focus should be strongly on the preventive aspects of nutrition, identify women at-risk, recognize special needs for counseling, and plan an optimal follow-up nutrition care.

Although nutritional needs are increased, there are individual differences and problems that may affect the nutritional status of the mother. The factors that may influence the mother's status include physiologic, psychological, situational, cultural, social, economic or personal. Among these, socio-economically disadvantaged and adolescent mothers require more attention.

When providing advice and counseling to the mother, it is important to remember that nutrition is essential to health in 2 ways i.e. on a physiological level and on a personal level. We need to consider both of these in assessing the mother's needs and goals.

Ideally, we should undertake preconception nutrition assessment and education, correct any deficits and promote a planned pregnancy. The care process like any other will consist of the parameters as mentioned in Table 13.5.

Table 13.5: Essentials of a prenatal care process

Phase		Aspects to be Focused on
Assessment	Nutrition status	Anthropometric data: weight, height, mid-arm circumference, focus on pre pregnant weight and serial measurements to monitor weight gain Laboratory data: Haemoglobin, haematocrit, blood glucose Clinical signs of nutrient deficiencies
	Historical data/ relevant background information	Age Obstetrical history Medical history (including medications or supplements) Social history (living situation, availability & access to food) Personal history (substance abuse, level of physical activity) Nutrition history (allergies, food intolerances, cultural-ethnic food practices)
	Diet history	Use 24-h recall Food record Food frequency questionnaires Diet history (including activity – associated general day's intake pattern)
Analysis		Determine whether there are any nutrient deficiencies. Whether food intake is adequate and whether food habits are appropriate Check whether energy intake is sufficient vis-à-vis energy expenditure

Planning care	Identify areas for counseling and education and problem areas. Identify the reasons for deficiencies i.e. the limiting factors Based on your observations, develop a counseling plan. The focus should be on: Guiding her to identify for herself how her food practices are meeting nutritional needs for her pregnancy Reviewing the reasons for these increased needs (why it is important to get the increased nutrients needs) Help her to realize which nutrient needs are not met Guide her to identify ways in which to meet the nutritional demands If she is from low-income circumstances and there is an ICDS anganwadi in the area, counsel her to avail of the food supplement and the iron-folate prophylactic supplements Counsel her to make the requisite timely ANC visits
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Having gone through the discussion above, the significance of adequate nutritional care must be clear to you. However, keeping in mind the high morbidity and mortality rate, it is essential to understand the common complications which may arise especially among the disadvantaged sections of our society. Our next section will deal with some of these aspects. However before we proceed, you need to attempt the following exercise which will help you in getting a holistic view about the aspects discussed so far.

Check Your Progress Exercise 2

1) What modifications are made in the requirements of the following nutrients during pregnancy and why?

a) Protein

b) Folate and B₁₂

c) Iron

d) Calcium

- 2) Which non-nutritional factors can adversely affect the health of the pregnant mother and the foetus?

.....

- 3) Enlist any five aspects which must be considered in a good prenatal plan.

.....

- 4) Fill in the blanks:

- a) During the course of gestation a foetus retains to mg calcium.
 b) and combination provides proteins of good quality.
 c) A pregnant woman should have more of foods rich in and
 d) The RDI for energy during pregnancy increases by Kcal.
 e) A very low sodium intake by mother during pregnancy can result in

13.7 COMMON CONCERNS DURING PREGNANCY

Many of the physiological changes that occur during pregnancy affect the digestive tract and may cause discomfort to the mother. Most of these problems are minor, but in some cases they may be more serious. Nausea, constipation, heartburn, pica, food cravings and aversions, as well as, food sensitivities are common nutrition-related concerns. We may need to advise mothers about simple strategies to help avert them. In this section however, we shall elaborate upon certain clinical conditions which may arise during pregnancy that may increase the risk for the development of complications during pregnancy, delivery and post-partum and how to manage these. Let us begin with the study of these conditions.

13.7.1 High Risk Pregnancies

Until now we have considered the nutritional needs of pregnant women. In this sub-section, we will consider specific conditions that contribute to high-risk pregnancies. Health care professionals favour health promotion with a preventive approach. Various factors have been identified which are associated with high risk. They are summarized in the Table 13.6. Some of these, you will realize cannot be changed as in case of personal characteristics and some can be changed, some are preventable and others can be controlled.

Some problems are directly related to the pregnancy itself such as anaemia, hyperemesis gravidarum (extreme form of morning sickness) or pregnancy-induced hypertension. For some, the normal physiological stress imposes demands on a relatively poor maternal nutritional status or maternal reserves that are not sufficient to meet the new additional needs. Pre-existing diseases such as diabetes, chronic hypertension or phenylketonuria also pose risks. Hence, it is important to pay attention to such mothers. Adequate nutrition and consistent prenatal care can reduce the risk of premature delivery or low birth weight babies. High-risk pregnancies need special management including intervention to correct malnutrition. This aspect is discussed next.

Table 13.6: High-risk pregnancies: risk factors for poor pregnancy outcome and pregnancy-induced complications

Personal Characteristics (Cannot change)	Personal Habits Living Situation (Seek to change)	Chronic Preexisting Maternal Problems (Screen, Treat)	Obstetric History (Screen, Prevent)	Current/ Potential Pregnancy- Induced Problems (Screen, Prevent Treat)
- Sex - Age - Adolescent - Older woman - Family history - Diabetes - Heart disease - Hypertension - Phenylketonuria	- Smoking - Alcohol/drug-use - Poor diet - Malnutrition - Obesity - Underweight - Sedentary-lifestyle	- Hypertension - Insulin-dependent diabetes mellitus - Non-insulin dependent DM - Heart disease - Pulmonary disease - Renal disease - Maternal phenylketonuria	- Low birth weight - Stillbirth - Abortion - Foetal anomalies - High parity	- Anaemia - Iron deficiency - Folate deficiency - Pregnancy-induced hypertension - Gestational diabetes

13.7.2 Management of High Risk Pregnancies

Although the risk factors are many, we will consider some selected factors, especially the nutrition related ones. Let us have a look at these one by one.

A) Anaemia in Pregnancy

Anaemia is the most common complication and is often compounded by low socio-economic status. However, it is seen frequently in upper income women too in the absence of poverty. In majority of cases, the anaemia is of nutritional origin, the main cause being dietary iron deficiency which may date back to pre pregnancy years. Acute blood loss caused by haemorrhage is a related cause. Folate deficiency, which is less common, results in megaloblastic anaemia. Although it can exist singly, it usually occurs with iron deficiency. Anaemia caused by other factors is less common.

Iron deficiency anaemia (microcytic hypochromic anaemia) is widespread among adolescents and young women during their reproductive years. They become highly vulnerable when greater physiological demands are imposed by pregnancy. Since the iron cost of pregnancy as shown in Table 13.7 is high (1200 mg), negative iron balance tends to occur. Iron deficiency anaemia accounts for approximately 3/4th or more of the non-physiologic anaemia in pregnancy. Physiologic anaemia is a term used to indicate *anaemia due to haemodilution in normal pregnancy*.

Based on blood volume changes during pregnancy and the iron content of foetuses at different gestational ages, the iron requirements for pregnancy in an iron replete non anaemic woman has been computed as shown in Table 13.7.

Table 13.7: Iron requirement for pregnancy

Requirement	Iron (mg)
Foetus at term	280
Expansion of red cell mass	450
Placenta and umbilical cord	90
Maternal blood loss during delivery	150
Obligatory loss in the mother - day to day	230
Total iron cost of a pregnancy	1200

The increase in iron requirements during the first trimester is minimal as menstruation losses are nil and transfer to the foetus has not begun but the increase during the second and third trimester is quite large. The absorbable iron requirements are worked out to be 0.8 mg per day in the first trimester, which increases to 6.3 mg during the second and third trimesters. Assuming a 5-8% absorption of iron in Indian pregnant women, the dietary iron requirement in the first trimester is 10-16 mg per day that can be easily met through existing diets. However, in the second and third trimesters, the iron need simply can not be met through the diet as it rises to a phenomenal 80-120 mg per day. If a woman begins her pregnancy with normal iron stores of 500 mg, then the amount to be provided will reduce to 30-40 mg per day. This is the basis on which pregnant women in developed countries are recommended supplemental iron of 30 mg per day. However, among the Indian pregnant women, stores of iron are likely to be negligent. Further, most women in India are already anaemic even before the pregnancy commences. Computation of iron requirements for correction of anaemia and pregnancy needs in Indian women have been worked out and these estimates indicate that 60-100 mg elemental iron will be needed as supplements for pregnant women. On this basis the nutritional anaemia control programme in India provides 100 mg elemental iron. One tablet daily for pregnant women in the second and third trimesters to be continued for three more months postpartum.

The mother may not have adequate iron stores and dietary intakes may not fulfill the increased need for iron during the second half of pregnancy. Iron is required not only for haemoglobin synthesis but also to ensure adequate foetal stores that will last in the infant for the first 6 months of postnatal life.

Upto 2 years of pregnancy, iron rich diets are required to replace the iron lost during pregnancy and delivery. If there is a shorter interval between pregnancies, the drain on the mother's depleted iron reserves will be even greater. Hence, it is necessary to ensure adequate iron intake. In addition to dietary intake, an iron supplement is routinely prescribed. We will need to be alert that routine iron supplements may have unpleasant gastrointestinal side effects or imbalances with other trace elements of zinc. Also excess iron intake may potentially mask inadequate pregnancy-induced haemodilution. While supplementation is needed, it is important to emphasize food sources of iron in the mother's daily diet.

Certain degenerative diseases may also arise during pregnancy. The most common ones being, hypertension and gestational diabetes. These may regress after pregnancy or continue to progress throughout life.

Let us now get to know about these conditions.

B) Hypertensive Disorders of Pregnancy

Hypertension may have been existing before pregnancy. Alternatively, a mother may develop hypertension during pregnancy, a pregnancy-induced hypertension (PIH) which presents a serious complication. The cardinal symptoms are: hypertension, proteinuria and oedema, which usually occur after the 20th week of pregnancy. The onset of PIH may be signaled by unusual weight gain within a few days. Studies show that PIH incidence is higher in very young mothers (< 20 years) or older mothers (>35 years), mothers who are underweight and whose nutritional status is poor (including deficits in energy, protein, vitamins and minerals), in those who have pre-existing vascular disease e.g. essential hypertension, Type I diabetes mellitus or a familial predisposition.

Several nutrients have been studied for their role in PIH. These include protein, sodium, calcium and zinc. Incidence of PIH is greater among underweight women who fail to gain weight normally during pregnancy. Research evidence therefore indicates that an optimal and regular pattern of weight gain is vital to support the pregnancy.

Of course, prevention is best. However, if PIH develops, we need to advise the mother to have a well-balanced nutritious diet with sufficient energy and protein. Sodium intake can be 2-3 g since dietary sodium intake should be moderate but sodium restriction does not cure the syndrome. Maintenance of good nutritional status is important. Mothers should be aware and careful since severe PIH can cause convulsions and can prove to be life-threatening.

Next, let us review pregnancy and diabetes mellitus.

D) *Pregnancy and Diabetes Mellitus*

During pregnancy, a woman who has pre-existing chronic disease requires special care, especially in case of mother's suffering from diabetes. Diabetes developed during pregnancy is termed as *gestational diabetes*. Studies have clearly shown that patient education and intensive management for glycemic control can help the mother to have a healthy pregnancy, a healthy baby and reduce the risk of complications. We need to emphasize to the mother that self-monitoring plays a very important role in maintaining a 'tight' control on the blood glucose levels. For more details on control of diabetes, you may refer to Unit 12 in the Clinical and Therapeutic Nutrition Course (MFN-005).

Yet another important factor which poses increased risk during pregnancy and delivery is excess body weight, whether it is prior to or during pregnancy. Let us read about the consequences and management of overweight/obesity with regards to pregnancy.

E) *Pregnancy and Obesity*

Obesity is associated with increased risk for gestational diabetes, hypertension, pre-eclampsia, perinatal mortality and the need for induced labour or caesarian section. Lower weight gains are acceptable for overweight women because the foetus can receive a part of its energy requirements from the maternal stores. Studies have shown that obese mothers have the best pregnancy outcomes when they gain approximately 6-7 kg during pregnancy.

Each obese pregnant woman should receive individual assessment and be given nutrition counseling at the beginning and throughout the course of pregnancy. Weight management should be directed towards a slower rate of gain rather than weight loss at any time during gestation.

Besides this, a carefully supervised exercise programme should be recommended as adjuncts for cardiovascular fitness, maintaining a sense of well-being and normal blood sugar levels.

Next, we shall read about adolescent pregnancy.

F) *Adolescent Pregnancy*

The pregnant adolescent is viewed as a high-risk patient, highly susceptible to suboptimal pregnancy outcome. Even when not pregnant, a teenage girl has difficulty meeting her nutrient needs. Nourishing a growing foetus adds to her burden,

The competition between maternal and foetal needs places both mother and infant at a risk. The frequency of prenatal problems e.g. toxemia, anaemia, premature births, low birth weight and increased maternal/neonatal mortality is higher for adolescents than for adult women. Complications like iron deficiency anaemia reflect poor diet and inadequate prenatal care. Prolonged labour reflects the mother's physical immaturity.

Growth usually continues for 4 years post menarche, although at a much slower rate than during pre-puberty. Adolescent girls who become pregnant within 4 years of menarche/at a low gynaecologic age, are generally considered biologically immature, and therefore, at a high risk.

Thus, nutritional needs for an adolescent mother must be estimated, in addition to her needs for growth. The dietary intake must meet the requirements for pregnancy, as well as, her individual needs at different stages of growth. Her nutritional requirements can be estimated by summing the RDI for the specific age and the additional recommendations. (We do **not** have sufficient specific information on nutritional needs of pregnant adolescents). Energy expenditure of adolescent girls is variable; hence the best assurance of an adequate intake is *satisfactory weight gain*. This should be accomplished by individual counseling on the basis of estimates of body size, growth rate, and age and activity level.

Special attention needs to be paid to the calcium and iron needs. Nutritional assessment should include pre-pregnancy weight, the gynecological age (the chronological age minus the age at menarche), and the dietary intake history and activity patterns. Attention should be given to the pre-pregnancy nutrient intakes and nutritional status, low intakes of nutrient-dense foods during pregnancy and restricted food intakes.

Weight gain is another aspect deserving attention. 'Allowable' or recommended weight gain could be higher than for adults. The weight gain required can be calculated by adding the following:

- Expected weight increase as a result of normal growth (non-pregnant) during the 9 months of pregnancy. (The increase in weight may be much higher for a girl during the first year after menarche to almost 10 kg, 4 years after menarche).
- Increase is required to support pregnancy.
- If underweight, the increase that is needed to achieve average weight for height.

In this unit, we reviewed in detail the physiological changes, nutrient requirements and some of the common complications associated with pregnancy. In our next section, we shall study about the nutrition and health significance of lactation. Before we proceed to the next section, you must attempt the check your progress exercise to revise your understanding.

Check Your Progress Exercise 3

- 1) Enumerate the modifiable and non-modifiable etiological factors associated with pregnancy.
.....
.....
.....
- 2) Why do iron requirements increase during pregnancy?
.....
.....
- 3) Describe the terms:
 - a) Gestational diabetes
 - b) PIH.....

13.8 LACTATION

Lactation is a physiologic process which has profound relevance for both the mother and the newborn. It is the period following pregnancy when the woman nourishes a fully developed and a rapidly growing baby with breast milk.

A lactating woman secretes about 500 ml milk/day in the first month which increases to about 850 ml/day by the fifth month. On an average, a well-nourished lactating woman secretes about 850 ml/day.

We need to understand the establishment and maintenance of lactation, if we want to help mothers with proper and effective lactation management and prevent lactation failure especially in case of inexperienced mothers.

During pregnancy, changes occur in the mother's breasts to prepare for milk production and as you have seen, body fat are deposited to ensure that energy is available for lactation. The establishment and maintenance of lactation are determined by several factors including the anatomical structure of the mammary gland and adequate development of the alveoli, ducts and nipples, initiation and maintenance of milk secretion and the ejection of milk from the alveoli to the nipple. You may recall studying the anatomy of the mammary gland and the physiology of lactation in the Applied Physiology Course (MFN-001) in Unit 12. We suggest you look up the unit once again now. This information will help you in grasping the concepts explained here better. The major physiological features of lactation are being discussed next.

13.8.1 Physiology of Lactation

Lactogenesis is the onset of copious milk secretion around parturition, triggered by a fall in plasma progesterone levels. Although some colostrum is secreted after delivery (2-3 days), full lactation begins later. The first 2-3 days after delivery is a period of rapid lactation initiation, followed by the longer period of maintenance of lactation. This complex neuroendocrine process is facilitated by interplay of various hormones. *Oxytocin* and *prolactin* instigate the lactation process. Prolactin is responsible for milk production and oxytocin is involved in milk ejection from the breast.

A cyclic process of secretory activity, luminal distention and expulsion of milk into the duct system continues throughout lactation as directed by the suckling of the infant and the let-down reflex. Regular sucking stimulates the continuation of milk secretion. Milk removal from the breast is a product of coordinated interaction between suckling of the infant and let-down reflex of the mother, as depicted in the Figure 13.2. As the infant commences suckling, afferent impulses generated in the receptors in the areola travel to the brain where they stimulate the release of oxytocin from the posterior pituitary. Oxytocin travels through the blood stream to the breast where it combines with specific receptors on the myoepithelial cells, stimulating them to contract and force milk from the alveoli into the mammary ducts and sinuses.

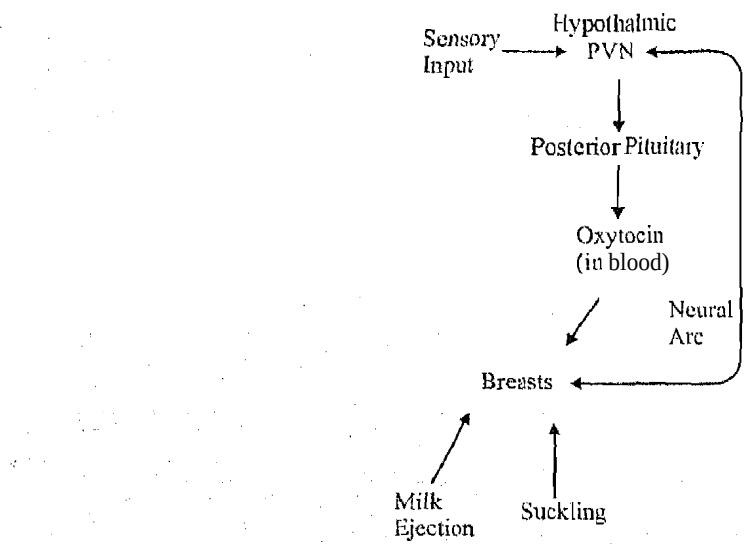


Figure 13.2; Basic features of 'let-down reflex'
Source: Worthington - Roberts and Williams (1993).

We all know that human milk contains several nutrients and that it is tailor made to meet the requirements of the growing infant. The subsequent text will dwell upon the composition of milk with special reference to its influence on the health of the infant.

13.8.2 Human Milk Composition and Infant Growth and Development

This sub-section deals with composition of human milk, compares human milk with cow's milk and why human milk is preferred and recommended for infants. We will also examine the impact of mother's diet and nutritional status on the quantity (volume) and quality (composition) of human milk.

Nature has designed milk to be species-specific. Thus, human milk is unique to the needs of the young homosapiens. The value of human milk for the health and growth of the baby is undisputed and rarely does breastfeeding need to be discouraged. The composition of the breast milk is described next.

A) Composition of Human Milk

Research clearly shows that each type of mammalian milk is unique and consists of a highly complex mixture of organic and inorganic compounds. Human milk is a solution of proteins, sugar and inorganic compounds in which a variety of fatty acids are suspended. Its nutritional composition is presented in Table 13.8.

Table 13.8: Nutrient composition of human milk

Nutrients	Amount (per 100 ml)
Energy (Kcal)	65
Protein (g)	1.1
Carbohydrates (g)	7.4
Fats (g)	3.4
Calcium (mg)	28
Iron (mg)	-
β-carotene (mcg)	137
Thiamine (mg)	2
Riboflavin (mg)	2
Niacin (mg)	
Vitamin C (mg)	3

Source: Nutritive Value of Indian Foods, NIN (1989).

Milk composition varies between mothers (inter-individual variation) from one period of lactation to the next (intra-individual variation) and even within a single 24-hour period (diurnal variation) and the time during the feed, as well as, the breast. The composition of milk is also related to the amount secreted, timing of withdrawal and individual variations, which includes maternal age, parity, health and socio-economic status. Gestational age of the infant also affects, since milk from mothers of premature infants has higher concentrations of some nutrients as compared to milk from mothers of term infants. Similarly, diet and use of oral contraceptives may also influence composition.

The concentrations of most nutrients fall between certain limits in the *milk* of healthy well-nourished mothers. The caloric value of human milk depends mainly on the fat content. Even after prolonged lactation for 2 years or more, the quality of milk produced by Indian and African women appears to be relatively well-maintained, although the quantity may be small.

Special characteristics of colostrum, beneficial to the infant are summarized herein:

- Volume of colostrum: 2-10 ml/feeding/day – related in part to the parity of the mother
- Typically yellow, due to a relatively high carotene content
- Transparent, contains more protein, less sugar and much less fat
- Lower in calories than mature milk (58 vs. 70 Kcal/100 ml)
- Concentration of sodium, potassium, and chloride greater than in mature milk
- Facilitates establishment of 'bifidobacteria' in the gastrointestinal tract of newborn
- Facilitates passage of meconium in the newborn's intestines
- Abundant content of antibodies – passive immunity for infant.

Colostrum changes to transitional milk between the 3rd and 6th day at which time the protein content is still quite high. By the 10th day, major changes have been completed. By the end of the 1st month, the protein content reaches a consistent level. As the content of protein falls, the content of lactose and fat progressively rise, as lactation becomes more firmly established.

The energy density of human milk depends on the relative proportions of protein, fat and the principal carbohydrate, lactose. Lactose content is ~7 g/dl and protein 0.9-1.0 g/dl. Lactose contributes 40-45% of the calories and protein 5-6%. Fat concentration and energy density may not affect total energy intake of breastfed infants since those who nurse on demand apparently compensate for a lower milk energy density by consuming higher volume of milk. Triglycerides constitute 98% of milk lipid with wide diversity in the fatty acid composition. Medium chain fatty acids are synthesized only in mammary alveolar cells while both saturated and unsaturated acids (≥ 16 C atoms) are derived either from diet or fat stores.

Having studied the composition of breast milk, let us next get to know about the importance of human milk.

B) *Importance of Human Milk for Infant Growth and Development*

Let us now look at the value of human milk in promoting infant growth and development. Success of lactation must be judged ultimately by its adequacy for growth and health of the breast fed infant. Lactation performance can be evaluated from the weight gain of the infant, in everyday life, although researchers have used a variety of methods.

We have listed some characteristics that make breastfeeding beneficial to the infant:

- Mature milk contains about 1/3rd the protein found in cow's milk – more than 25% of its nitrogen is non-protein nitrogen. The concentration of casein to whey protein is lower; 1.5 for breast milk and 0.2 for cow's milk. Thus human milk with its low casein content forms a flocculent suspension with a curd tension of 0. These curds are easily digested and hence better tolerated by the infant.
- Lactoferrin in human milk inhibits the growth of certain iron-dependent bacteria in the GI tract and therefore affords protection against gastrointestinal infections.
- Presence of phagocytes, lysozymes and lactoperoxidases, afford immunity against harmful microorganisms such as, *S.aureus*, *Candida sp.*, *Salmonella sp.*
- Protection from respiratory tract allergy and eczema.
- Immunoglobulins provide passive immunity and protect against infection by retarding viral and bacterial invasion of the mucosa.
- Protective effects have been substantiated for necrotizing enterocolitis, acrodermatitis enteropathica, intractable diarrhoea, pathogenic *E.coli* infection.

- Relatively low in amino acids that are detrimental at high levels. High in amino acids that infant cannot synthesize e.g. cystine and taurine.
- Lipids: lower in foremilk-hind milk has a three fold higher fat content. Higher content of linoleic and oleic acid, cholesterol, the latter being needed for myelin synthesis.
- Contains lipase which helps in digestion of milk triglycerides and partly accounts for a greater ease in fat digestion of breastfed infants.
- Higher levels of lactose and nitrogen-containing oligosaccharides which have *L.bifidus* promoting activity.
- Minerals: As compared to cow's milk, 6-times more phosphorus, 4-times more calcium – lower renal solute load – better availability.
- Lower iron content but nearly 50% of iron in human milk is absorbed.
- Levels of water-soluble vitamins likely to reflect maternal dietary or supplementary intake.
- Several hormone-like substances and growth factors in human milk.

The significance of human milk in maintaining the health of an infant was highlighted above. However, we all know that in countries like India, the prevalence of malnutrition is widespread and it can have serious consequences on the health of the mother and the quantity/quality of milk secreted. Read the subsequent text to learn more on this aspect.

13.8.3 Malnutrition – Effects on Milk and Effects on Mothers

Milk is the sole source of nourishment for many infants for upto 6 months or a year or even more. Therefore, the relationship between maternal nutritional status and lactation performance is important. Let us look into the effects of maternal undernutrition. Theoretically, we could expect both quantity and quality of milk to be affected:

- **Volume:** A large healthy baby who can vigorously suck will induce and obtain much more milk from its mother than a small, sickly or preterm infant. These differences in yield may not be indicative of a mother's capacity for lactation. However, studies on women from less developed countries including Ethiopia, Nigeria and on poor Indian women show that volume of milk produced is not adversely affected, since milk production is a function of infant demand. However, it is strongly affected by feeding other foods/fluids.
- **Energy:** In case of chronic undernutrition, an association between postpartum weight loss and lower energy transfer may occur. In dietary supplementation trials, increasing maternal energy intake did not help much in increasing energy transfer except in women whose initial fat reserves were very low. In women with adequate fat reserves, apparently a gradual weight loss up to 0.5 kg/week may not adversely affect lactation.

Protein: Some studies show that the protein content of milk may be affected by chronic protein undernutrition. In some cases, the tyrosine content of milk was significantly lower. In Indian women, it was seen that the milk of malnourished mothers had more casein and less whey. By giving a high protein diet supplement, the whey:curd ratio could be increased.

- **Fat:** Fat content of milk appears to be subject to variability as compared to other constituents. The average fat content in milk from well-nourished mothers tends to be higher than milk from less well-nourished mothers. This may have implications for the caloric intake of the infant. Supplementing the mother with adequate intake of energy, protein and fat helped to increase the fat concentration

in milk. Low levels of fat are apparently related to diet during lactation, inadequate energy intake in pregnancy and an inadequate amount of fat gain. The fatty acid composition of milk lipid is altered by the mother's diet, including the type and amount of dietary fat, total energy intake and carbohydrate intake.

When lactating women were fed a diet rich in PUFA, their milk also had a higher PUFA content. Providing mothers with fish oil supplements increased the ω -3 fatty acid in milk. When caloric intake is severely restricted, fatty acid composition resembles that of the depot fat. A substantial increase in the proportion of dietary Kcals from carbohydrate results in an increase in the milk lauric and myristic acids. The proportion of medium chain fatty acids was observed to be 30-45% on a low fat diet. However, the total fat content was not significantly altered.

What would be the effect on the micronutrient content of the milk? Let us read to find out.

- **Minerals:** There appears to be no relationship between dietary intake and concentrations in milk for copper, iron or zinc. Iron supplementation did not increase milk iron levels. In case of zinc, the milk concentrations may be influenced by maternal zinc intake within a physiologic range and the effects of low maternal intakes are most apparent with prolonged nursing. Selenium content of human milk indicates that it is related to maternal selenium status.
- **Vitamins:** Although there are inter-individual variations in vitamin concentrations, diet and drug use by individual women influences vitamin composition in human milk. Vitamin D activity of human milk is influenced by maternal vitamin D intake, as well as, maternal exposure to UV light. Concentration of vitamin A is strongly influenced by the mother's diet. Vitamin A content of breast milk has been found to be much lower in some developing countries than in Western countries.

The levels of water-soluble vitamins are more likely to reflect maternal dietary or supplement intake than most other ingested compounds. In lactating women of low socio-economic status, supplementation with folate, vitamin B₁₂ and B₆ increased the levels of each vitamin in milk. B₆ in milk may be a sensitive indicator of maternal vitamin B₆ status. There are reports of vitamin B₁₂ deficiency in infants of vegan and malnourished mothers.

So far, we have dealt with the various aspects of lactation and the importance of maternal nutrition for ensuring infant well-being. Let us now examine the impact of lactation from the mother's perspective.

Effects on Mother

Successful breastfeeding requires adequate nutrition and rest. For adequate lactation, substrates must be available in sufficient quantities from the mother's diet or body stores laid down during pregnancy. If these are insufficient, some degree of subsidy from maternal body tissue can be expected. As you well know, the simplest evidence of tissue depletion is weight loss. In a sense, pregnancy and lactation need to be considered as a continuum.

Among well-nourished women, weight loss can occur after childbirth, although this depends on their caloric intake and their physical activity. In poorer communities, dietary intakes of breastfeeding mothers are not very different from non-lactating women. However, given the lower caloric intakes, weight loss during lactation may not always be as severe as might be theoretically expected. It is possible that changes in tissue composition may mask the changes in body weight. An increase in body water, concomitant with an increase in body fat would result in great weight loss. However, the longer the duration of lactation, the greater would be the impact on the mother's nutritional status.

Studies indicate that there are major physiological alterations in calcium and bone metabolism during lactation, independent of maternal calcium intake. Bone resorption and bone formations are high, particularly in the 1st 3-6 months of lactation. Decreased urinary calcium excretion and increased absorption efficiency have been observed.

We shall next discuss about the nutrient requirements of the mother during lactation which are essential for maintaining her own health, as well as, the normal composition of her milk. Before proceeding further, you must attempt the check your progress exercise given below to recapitulate the concepts learnt so far.

Check Your Progress Exercise 4

- 1) 'Human milk is unique to the needs of the young homosapiens'. Discuss the statement with reference to composition of milk.

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- 2) Enumerate any five characteristics which make breastfeeding beneficial for the infant.

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- 3) Briefly describe the effects of maternal under nutrition on nutrient composition of milk.

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13.9 MATERNAL NUTRITION DURING LACTATION

As we have already seen, the mother's nutrient intake must support breast milk production and can influence the nutrient composition of milk. In fact, you will find that the need for energy and many nutrients is even greater during lactation than during pregnancy. The maternal nutrient need is highlighted next.

13.9.1 Nutrient Requirements During Lactation

Maternal nutrient requirements during the period of lactation include requirements for maintenance and activity and in addition, the amount of nutrients secreted in human milk. The latter would generally be determined from the yield and composition produced by healthy women with adequate lactation. Hence, you will realize that needs of women relate to the volume of milk produced. It is important to remember however that the requirement for a nutrient will be greater than the amount secreted in milk because the transfer of energy and nutrients from diet to milk is not 100% efficient. In practice, the mother subsidizes lactation from the nutrient stores she has laid down during pregnancy and if not, by the loss of body tissues. Specific requirements during

lactation for many nutrients have not been extensively investigated. The RDIs are generally based on allowances for the non-pregnant, non-lactating woman plus the amount secreted in the milk. You will need to remember that it is assumed that the mother is more than 18 years old, and she herself is no longer growing.

Let us then get to know about the nutrient needs of a lactating mother.

Energy and Protein Needs: Remember that during pregnancy, well-nourished women will have laid down approximately 2-4 kg of fat. This can be mobilized to supply a portion of the additional energy for lactation. It is estimated that this amount of storage fat will provide 200-300 Kcal/day for a period of three months. However, this amount represents only a part of the energy cost of milk production.

The volume of milk produced is assumed to be 750 mL based on various studies. With an average content of 70 Kcal/100ml, the daily output of energy would be approximately 520 Kcal. You must remember that the efficiency of milk production would be 80% or a maximum of 90%. Thus, an additional energy supply of approximately 600 Kcal/day should be adequate to support lactation. The intakes recommended by the ICMR are shown in Table 13.9.

Table 13.9: Recommended dietary intakes for the lactating women

Nutrients	RDIs	
	0-6 months of Lactation	6-12 months of Lactation
Energy (Kcal)	+550	+400
Proteins (g)	+25	+18
Calcium (mg)	1000	1000
Iron (mg)	30	30
Vitamin A(mcg)		
Retinol or	950	950
β-carotene	3800	3800
Thiamine (mg)	+0.3	+0.2
Riboflavin (mg)	+0.3	+0.2
Niacin (mg)	+4.0	+3.0
Ascorbic acid (mg)	80	80
Folic acid(mcg)	150	150
Vitamin B ₁₂ (mcg)	1.5	1.5

Source: Nutrient Requirements and Recommended Dietary Intakes for Indian, ICMR (1990).

Note in Table 13.8, the RDIs for all major nutrients are given for the first 6 months of lactation, as well as, the second 6 months of lactation, when the volume of milk produced has decreased. However, women who had a low pre pregnancy weight gain, who have decreased weight for height and who breastfeed more than one infant, will more likely need additional kilo calories during lactation. FAO/WHO 2004 recommends that *well-nourished women* with adequate gestational weight gain should increase their food intake by 505 Kcal/day for the first six months of lactation, while *undernourished women* and those with insufficient gestational weight gain should add to their personal energy demands 675 Kcal/day during the first six months of lactation. Energy requirements for milk production in the second six months are dependent on rates of milk production, which are highly variable among women and populations.

The additional protein intake suggested in Table 13.9 not only takes into account the additional protein needs but also the net protein utilization of Indian diets,

The requirement of several micronutrients also increases and is summarized herewith.

Micronutrient: Vitamin and mineral deficiencies can have profound influence on the composition of milk. Calcium is a nutrient of special concern, since there are some reports in the literature that if the mother's diet is not adequate, it will be mobilized from her bones. This is especially of concern in case of prolonged lactation. Hence, the RDI for calcium is high for lactating mothers.

The requirements for other nutrients are all increased, reflecting the need for milk production and the need to replenish maternal stores. Folate needs are increased above non-pregnant levels but are not as high as during pregnancy. Iron needs are not increased during lactation because little iron is lost in milk, and in most women, losses are decreased because menstruation is absent. However, if the mother's iron status is poor, supplements of 30 mg of elemental iron per day may be recommended for the first 2 to 3 months of lactation to replete iron stores.

Besides these, water needs during lactation should be paid attention to. An increase in fluid intake does not increase milk volume, however, additional fluid is needed to maintain a normal maternal fluid balance. When fluid intake is low, the mother's urine will become more concentrated to conserve water for milk production. To avoid dehydration and ensure adequate milk production, fluid intake should be increased by about 1L per day.

Now that we are aware of the nutrient needs, let us next study how to meet these needs of the lactating women.

13.9.2 Dietary Management

Meeting the needs of lactation requires a varied nutrient-dense diet. Generally, a well-balanced diet will meet nutrient needs of the mother. Whenever feasible, food should be the source of nutrients and self-initiated vitamin and mineral supplements should be avoided. The dietary intake of caffeine, artificial sweeteners and alcohol must be totally avoided. This is because most chemicals ingested by the lactating mother cross into the milk. Therefore, the mother should seek the advice of her physician before taking any dietary supplement, any medication or drugs such as caffeine and alcohol, which also pass into the milk and consequently affect infant. Excess caffeine may make the infant irritable and wakeful, but the research indicates that moderate amounts of caffeine (1-2 cups of coffee per day) will not harm or upset the infant. Large doses of coffee may interfere with availability of iron from milk. Ethanol appears in human milk in a similar concentration to the maternal blood, although acetaldehyde, which is the major toxic breakdown product of ethanol, does not appear in the milk. Alcohol may impair the milk ejection reflex, therefore, it is prudent to avoid alcohol intake when lactating.

Further, infants metabolize alcohol inefficiently. Smoking also reduces milk volume. Infant exposure to passive smoke negates the protective effect of breastfeeding and offers against sudden infant death syndrome.

Foods with a strong flavour may alter the flavour of milk. A few infants may be sensitive to particular foods e.g. cow's milk protein. Hence, when the mother's diet includes such foods, the infants may experience discomfort. However, this may not happen to most of the infants.

In general, the mother can eat whatever she likes. However, if she suspects that a particular food is causing the infant discomfort, she should consult the physician. If the food is eliminated for an extended time, appropriate foods should be substituted to ensure nutrient adequacy.

Few other concerns linked with breastfeeding are highlighted next.

13.9.3 Other Concerns during Breastfeeding

Let us look into some special concerns during breastfeeding that might be useful to you as a dietitian.

Medical Considerations: This is an area, which needs consideration. If a mother has a communicable disease like tuberculosis or hepatitis that could threaten the infant's health, then the mother and baby have to be separated. The mother can express her milk several times a day and feed the infant. In case of a mother with HIV infections, though the virus can be transmitted to the baby through milk, breastfeeding the baby yet protects the infant.

Women with chronic diseases such as Type I diabetes continue to need careful monitoring and counseling to ensure successful lactation. They need to adjust their energy intakes and insulin doses to meet the heightened needs of lactation. Maintaining good glucose control helps to initiate lactation and support milk production.

Many drugs are compatible with breastfeeding, but some medications are contraindicated either because they suppress lactation or can be secreted into breast milk and thus harm the infant. As a precaution, therefore, the mother should consult her physician before taking any drug.

Weight Loss: Some women may want to return quickly to their pre-pregnancy weight. It is important to remember that some women will lose more, whereas others may maintain or even gain weight. Moderate to severe caloric restriction and rapid weight loss is not recommended because it can decrease milk production. This is especially important in the early weeks of lactation before the process is firmly established. Therefore, a gradual rate of weight loss in the first 6 months and that exercise is the best way to reduce excess weight. However, intense exercise can raise the lactic acid concentration of breast milk which influences the taste of milk. A study has shown that infants appear to prefer milk produced prior to exercise.

Among well-nourished mothers, those who exercised demonstrated a higher level of fitness, a lower percentage of body fat and higher level of energy expenditure as compared to sedentary women. There was no difference between the groups in plasma hormones or milk energy, lipid, protein or lactose content. Exercising women tended to have a higher milk volume. It has been recommended that energy intakes should not fall below 1500 Kcal/day at any time during lactation.

The cost of providing adequate nutritional support to the mother depends mostly on what foods she can afford and selects. The cost of providing appropriate foods for the lactating mother is cheaper than feeding the infant with animal milk, if economical food choices are made. Human milk is a vital national resource, which could markedly improve the health and nutritional status of children.

This section briefed upon the nutritional requirements of the mother during lactation and some general dietary and medical considerations to be borne in mind for maintaining a safe and healthy lactation. With this, we end our discussions on this topic and hope that the information given here would be of great help in managing diverse practical situations.

Check Your Progress Exercise 5

1) Why does the nutrient needs increase during lactation? Which are the nutrients whose requirements increase and why?

- 2) List any four dietary considerations that should be kept in mind while planning meals for lactating women.
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- 3) Why must a lactating mother avoid the consumption of dietary supplements, spicy foods or caffeine?
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- 4) What are the conditions during which a lactating woman should discourage breastfeeding?
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13.10 LETUSSUMUP

In this unit, we studied about the most crucial periods of a woman’s life, pregnancy and lactation, especially from a nutritional point of view. We got to know that good nutritional care and a well-balanced diet can help to ensure that the mother herself and the infant will be healthy. Maternal nutrition has an impact on the health and nutritional status of the infant's growth and development.

We learnt about the role of various nutrients and the corresponding increase in their RDA in order to meet the increased needs. Generally, the requirements for energy and most of the nutrients are increased during pregnancy and lactation especially for adolescents and women with multiple pregnancies. Adequate monitoring and care has a crucial role in ensuring satisfactory health of the mother. Dietary restriction for weight loss is contra indicated especially during pregnancy, if the mother is obese.

In our next section on lactation, we got to know the role of adequate nutrition during lactation. We also discussed about the composition of human milk and potential benefits of breast feeding. Finally, we learnt about the different disease conditions and their effect on the process of breastfeeding.

13.11 GLOSSARY.

Acrodermatitis enterocolitis	: a rare inherited childhood disorder resulting in the inability to absorb adequate zinc from diet.
Basal Metabolic Index	: a relationship between weight and height that is associated with body fat and health risk.
Basal Metabolic Rate	: a measurement of energy required to keep the body functioning at rest.

Cretinism	: a condition of endemic or inherited idiocy, accompanied by physical degeneracy and deformity.
Enteral feeding	: a method of providing food through a tube placed in nose, stomach or small intestine.
Oesophageal regurgitation	: flow of the stomach's contents back up into the oesophagus.
Heartburn	: a burning sensation experienced in the lower area of the heart.
Haemoconcentration	: an increase in the proportion of red blood cells relative to the plasma, brought about by a decrease in the volume of plasma.
Human chorionic gonadotropin	a human hormone made by chorionic cells (in the foetal part of the placenta).
Homeostasis	: metabolic equilibrium actively maintained by several complex biological mechanisms that operate via autonomic nervous system to offset disrupting.
Hyperemesis gravidarum	: extreme, persistent nausea and vomiting during pregnancy and may lead to dehydration.
Ketosis	: a condition of having ketone bodies build up in body tissues and fluids.
Macrosomia	: 'Large body'; a baby that is considered larger than normal, a condition that occurs when mother's blood sugar levels have been higher.
Menarche	: onset of menstruation.
Necrotizing enterocolitis	: a serious intestinal illness that can cause tissue damage to the intestines.
Net Protein Utilization	: the ratio of amino acids converted in to proteins compared to the ration of amino acids supplied throughout the day.
Neural tube defect	: a congenital defect of the central nervous system, including spinal cord, skill and brain, resulting from failure of the neural and brain.
Parenteral feeding	: a method of providing a liquid food mixture through a special tube in the chest.
Parity	: the number of children borne by one woman.
Pre-eclampsia	: abnormal state of pregnancy characterized by hypertension and fluid retention and albuminuria.
Pregnancy induced hypertension	: a complication of pregnancy marked by high blood pressure especially in the last three months of pregnancy.
Stroke volume	: the amount of blood pushed into the aorta with each beat of the heart.
Teratogenic	: substances such as chemicals of radiation that cause abnormal development of an embryo.

13.12 ANSWERS TO CHECK YOUR PROGRESS EXERCISES

Check Your Progress Exercise 1

- 1) a) 40, 10 b) haemodilution
c) Lactogen, prolactin d) cortisol e) 10-12
- 2) Impact of malnutrition during pregnancy results in, lower placental weight, smaller placental size, reduced DNA content, reduced peripheral villous mass, reduced villous surface, and reduced estriol and pregnanediol excretion.
- 3) The important physiological changes during pregnancy are an increase in blood volume and composition, weight gain, increased stroke volume and cardiac output, increase in respiratory rate, decreased tone and motility of smooth muscles of stomach intestinal secretion and emptying time, and increased GFR and blood flow through the kidney .
- 4) Two characteristics of the mother's weight influence the infant's birth weight: her weight-for-height prior to pregnancy and her weight gain during pregnancy. The ideal weight gain must be 8-10 kg. Underweight mothers have a higher risk of having a LBW infant. The risk would be higher if the mother does not gain sufficient weight during pregnancy. Further, the rates of preterm birth and infant mortality are higher for underweight (BMI<19.8) women.
- 5) a) - iv)
b) - i)
c) - v)
d) - ii)
e) - iii)

Check Your Progress Exercise 2

- 1) a) An increase of 15 g protein per day is recommended. This is based on the needs of the non-pregnant woman plus the extra amounts needed for growth.
b) Folic acid and vitamin B₁₂ are important for production of new cells; DNA must replicate and transmit its genetic information to RNA intermediates. Folic acid has a role in prevention of neural tube defects.
c) Iron is needed for synthesis of haemoglobin in both maternal and foetal red blood cells. At term, a normal weight infant has about 246 mg of iron in blood and body stores. An additional 134 mg is stored in the placenta and about 290 mg is used to expand the volume of mother's blood.
d) The foetus retains about 25-30 g of calcium, over the course of gestation, most of which is deposited in the last trimester when the foetal skeleton is growing rapidly and the teeth are forming. On an average, the foetus draws 250-300 mg Ca per day from maternal blood supply. Additional calcium is believed to be stored in the maternal skeleton as a reserve for lactation.
- 2) The non-nutritional factors include age, urinary tract infections, obstetric factors, genetics, substance abuse, antenatal care.
- 3) Anthropometric measurements (to know progression in weight gain), clinical profile (haemoglobin, blood pressure), medical details, personal profile and dietary details.

- 4) a) 25-30 b) Cereal, pulse
 c) Any two of the following – energy/protein/iron/calcium
 d) 300 e) neo-natal hyponatremia

Check Your Progress Exercise 3

- 1) Non modifiable: age, gender, family history, underlying disease prior to conception like **phenylketonuria**. Modifiable: personal habits, obstetric history, pregnancy induced complications, malnutrition etc. Refer Table 13.8 for details.
- 2) The iron requirements increase during pregnancy due to increased demands for the following: foetus (full term) 280 mg, expansion of red cell mass 450 mg, placenta and umbilical cord 90 mg, maternal blood loss during delivery 150 mg
- 3) a) Gestational Diabetes: It refers to impaired glucose tolerance and hyperglycemia which develops for the first time during pregnancy.
 b) PIH: Pregnancy induced hypertension may develop as a serious complication during pregnancy. Hypertension, proteinuria and oedema, which usually occur after the 20th week of pregnancy. The onset of PIH may be signaled by unusual weight gain within a few days.

Check Your Progress Exercise 4

- 1) Human milk, including the colostrum is tailor made to meet the requirements of the growing infant. It consists of a highly complex mixture of organic and inorganic compounds. Human milk is a solution of proteins, sugar and inorganic compounds, in which a variety of fatty acids are suspended. Refer Table 13.9 for details.
- 2) Refer to sub-section 13.9.2 and answer on your own.
- 3) In case of chronic undernutrition, an association between postpartum weight loss and lower energy transfer may occur and the protein content of milk may be affected by chronic protein undernutrition. In some cases, the tyrosine content of milk gets significantly lowered. Fat content of milk appears to be subject to variability as compared to other constituents. The average fat content in milk from well-nourished mothers tends to be higher than milk from less well-nourished mothers. The fatty acid composition of milk lipid is altered by the mother's diet, including the type and amount of dietary fat, total energy intake and carbohydrate intake.

Check Your Progress Exercise 5

- 1) Nutrient need increases during lactation because the mother is still providing for all of the nutrient needs of the infant who is growing fast and is more active than the foetus. The newborn also has greater energy and nutrient needs for processes like temperature regulation and digestion were partially or completely managed by the mother when the foetus was still in the womb. An additional energy supply of approximately 600 Kcal/day should be adequate to support lactation. The additional protein intake takes into account the additional protein needs and the net protein utilization of Indian diets. The requirements for other nutrients are all increased, reflecting the need for milk production and the need to replenish maternal stores. Besides these, water needs during lactation should be paid attention to. However, additional fluid is needed to maintain a normal maternal fluid balance.
- 2) Look up sub-section 13.10.2 and answer on your own.
- 3) This is because most chemicals ingested by the lactating mother cross into the milk. Therefore, the mother should seek the advice of her physician before taking any dietary supplement, any medication or drugs such as caffeine and alcohol which also pass into the milk and consequently affects infant. Excess caffeine may make the infant irritable and wakeful.
- 4) The conditions include cardiac disease, tuberculosis, severe anaemia, kidney disorder or mental disorder.