III B.Sc Nutrition, FSM & Dietetics

NUTRITION THROUGH LIFE CYCLE

CNU52

UNIT IV

ICMR Nutrient allowances, Dietary guidelines. Nutrition for adults. Basis for requirement **-** Common nutrition related problem of pregnancy, food plan for pregnant women. Lactation**-** physiology, hormonal control and reflex action, efficiency of milk production, composition of breast milk and problems encountered during breast feeding. Current scenario in the field of Nutrition in pregnancy and Lactation.

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NUTRITIONAL AND FOOD REQUIREMENTS OF ADULTS

NUTRITIONAL REQUIREMENTS

Man needs a wide range of nutrients which perform various functions in the body. During adulthood nutrients are required for energy, for replacement of wornout tissues and maintenance of body functions. Though there is no growth during adulthood, protein is required for the replacement of wornout tissues. The nutritional requirement of other age groups is sometimes extrapolated from adults' requirements. Table 2.1 gives RDA for an adult suggested by ICMR in 2010.

Table 2.1 ICMR Recommended Dietary Allowances for an adult man and woman—2010

	Man			Woman		
Nutrient	**Sedentary**	**Moderate**	**Heavy**	**Sedentary**	**Moderate**	**Heavy**
Energy kcal	2320	2730	3490	1900	2230	2850
Protein g	60	60	60	55	55	55
Visible fat g	25	30	40	20	25	30
Calcium mg	600	600	600	600	600	600
Iron mg	17	17	17	21	21	21
Vitamin A						
Retinol µg or	600	600	600	600	600	600
β-carotene µg	4800	4800	4800	4800	4800	4800
Thiamine mg	1.2	1.4	1.7	1.0	1.1	1.4
Riboflavin mg	1.4	1.6	2.1	1.1	1.3	1.7
Niacin Equivalent mg	16	18	21	12	14	16
Pyridoxin mg	2	2	2	2	2	2
Vitamin C mg	40	40	40	40	40	40
Dietary folate µg	200	200	200	200	200	200
Vitamin B_{12} µg	1	1	1	1	1	1
Magnesium mg	340	340	340	310	310	310
Zinc mg	12	12	12	10	10	10

Energy

Energy requirements of an adult man and woman are based on Reference man and Reference woman. Energy requirements for other individuals of different body weights and age are extrapolated.

Reference Indian Adult Man and Woman

Reference man is between 18–29 years of age and weighs 60 kg with a height of 1.73 m with a BMI of 20.3 and is free from disease and physically fit for active work; on each working day, he is engaged in 8 hours of occupation which usually involves moderate activity, while when not at work he spends 8 hours in bed, 4–6 hours in sitting and moving about, 2 hours in walking and in active recreation or in household duties.

Reference woman is between 18–29 years of age, non-pregnant non-lactating (NPNL) and weighs 55 kg with a height of 1.61 m and a BMI of 21.2, is free from disease and physically fit for active work; on each working day she is engaged in 8 hours of occupation which usually involves moderate activity, while when not at work she spends 8 hours in bed, 4–6 hours in sitting and moving about, 2 hours in walking and in active recreation or household duties.

An important factor which determines energy needs is the nature and duration of physical activity, whether moderate or heavy. For those whose occupation entails heavy work, allowances have to be higher than for those who are either sedentary or engaged in moderate work. The allowances are made under the assumption that the energy expenditure for non-occupational activities remains unchanged.

Table 2.2 ICMR Classification of activities based on occupation

	Male	*Female*
Sedentary	Teacher, tailor, barber, executive, shoemaker, priest, retired personnel, landlord, peon, postman, computer professional	Teacher, tailor, executive, housewife, computer professional
Moderate	Fisherman, basket maker, potter, goldsmith, agricultural labour, carpenter, mason, rickshaw-puller, electrician, fitter, turner, welder, industrial labour, coolie, weaver, driver, servant	Maid, coolie, basket maker, agricultural labour, beedi maker, brick maker
Heavy	Stone cutter, blacksmith, mineworker, wood cutter, gangman	Stone cutter

Protein

The average daily protein requirement of an Indian adult, in terms of a high quality protein like milk, egg at the physiological level is estimated to be 0.5 g/kg of body weight. One gram per kilogram of body weight is the RDA for men as well as women is suggested considering protein of mixed vegetable origin with NPU 65 relative to egg. The estimates of nitrogen losses and the amount of nitrogen needed to maintain balance have a coefficient of variation in the same individual from day to day. The figure of 1.0 g/kg body weight includes a 30 per cent addition to cover this variability.

Protein/Calorie Ratio of Diets

It is useful to consider together the protein and energy requirement on habitual Indian diets. The protein requirement can be expressed as the ratio of protein calories to total dietary calories (PE %).

This concept is useful because in many population groups enough diet is not consumed to meet energy needs resulting in energy deficits. It will be seen that a PE per cent between 6 and 12 would meet the protein requirement of any group provided its energy needs are met.

Fat

Recommended total fat calories is between 15–30 per cent E (energy). In the diets of adults in India, about 20 per cent energy is derived from fats. At all levels of calorie intake, invisible fat furnishes about 9 per cent energy and visible fat 10 per cent. This would come to 10–20 g of fat per day depending upon the level of calories consumed.

In habitual diets of our country, which are cereal-legume based, about half the invisible fat (6 per cent energy) is composed of linoleic acid. The Expert FAO/WHO consultation committee has placed it at 3 per cent energy. It has also been deduced to be 5g per day. This requirement can be met even by the invisible fat component of existing Indian diets.

A higher level visible fat intake of 20–40 g/d is recommended in accordance with physical activity to provide energy density and palatability to the diet. A minimal intake of 12 g visible fat can meet linoleic acid requirement.

Saturated fatty acids, cis-monosaturated fatty acids, proteins and cholesterol can increase essential fatty acid requirement. It would appear prudent to choose the visible or cooking fat from unsaturated vegetable oils. Blend of two or more vegetable oils ensures the recommended intake of fatty acids.

Minerals

After examining the evidence for calcium nutrition status of the Indian population, the Expert Committee suggested an upward revision of calcium RDA from 400 mg to 600 mg.

The requirement of calcium prescribed by ICMR is same for both men and women. To meet this requirement an adult needs to take at least 300 ml of buffalo's milk on cereal legume diet. It is suggested that a Ca : P in the diet should remain 1 : 1. Hence the RDA of phosphorus is 600 mg. During infancy the Ca : P ratio suggested is 1 : 1.5. Bone mass increases during childhood and adolescence and peaks between the ages of 20 and 30 years. Peak bone mass is influenced by calcium intake. Other factors like age, sex, genetic factors, hormonal status and exercise also influence. After 30, the rate of withdrawal exceeds the rate of deposit; therefore establishing healthy bone mass in childhood and early adulthood is crucial.

Iron requirement for woman is 4 mg higher than man. Iron loss through menstruation in women of reproductive age groups are 0.6 mg/day on an average, when spread over the whole month. Those who are taking vegetarian diets should ensure adequate amounts of vitamin C for enhancing iron absorption.

The requirement of zinc is 2.7 mg/d. To get this amount, the RDA suggested is 12 mg/d, correcting individual variation. In an Indian population the rate of absorption is 20–25 per cent.

Vitamins

The requirement of vitamin A is same for both men and women. The conversion ratio of retinol to β-carotene is 1 : 8. The requirement of B vitamins is based on calorie requirement (0.5 mg of thiamine, 0.6 mg of riboflavin and 6.6 mg of niacin per 1000 calories). Hence, requirements of B vitamins are higher for moderate and heavy workers. The previous recommendation of 2 mg/d of pyridoxine of adults is retained.

An intake of 20 mg of vitamin C may be sufficient to maintain the ascorbic acid levels in the adults. Taking into account that 50 per cent of vitamin C is lost in cooking, 40 mg is suggested for all adults. Where there is minimal exposure to sunlight, a specific recommendation of a daily supplement of 400 I.U (10 µg) of vitamin D is made. The requirement of vitamin E suggested is 0.8 mg/g of essential fatty acids. This roughly works out to 8–10 mg tocopherol/d depending on the edible oil used. FAO/WHO suggested 55 µg of vitamin K for adults.

7

Nutritional and Food Requirements of Expectant Mother

Adequate nutrition before and during pregnancy has greater potential for a long-term health impact than it does at any other time. Maternal health is a complex, influenced by various genetic, social and economic factors, infections and environmental conditions, many of which may affect the foetal growth. Physiological adaptations result in improved utilisation of nutrients either through increased absorption, decreased excretion or alternations in metabolism.

A woman who has been well nourished before conception begins her pregnancy with reserves of several nutrients so that the needs of the growing foetus can be met without affecting her health. Infants who are well nourished in the womb, have an enhanced chance of entering life in good physical and mental health. The effects of undernutrition during reproduction will vary depending upon the nutrients involved, the length of time it is lacking and the stage of gestation at which it occurs.

A woman whose diet is adequate before pregnancy is usually able to bear a full term viable infant, without extensive modifications of her diet. Mother's diet should produce adequate nutrients so that maternal stores do not get depleted and produce sufficient milk to nourish her child after birth. The nutritional demands are highly increased in an adolescent mother.

NUTRITIONAL REQUIREMENTS

Increase in nutritional requirements depend on the nature of metabolic changes of pregnancy and the nutrition reserves of the mother. The RDA of the expectant mother suggested by ICMR is given in Table 7.1.

Table 7.1 ICMR Recommended Dietary Allowances of an expectant mother–2010

Nutrient	Normal adult woman	Pregnant woman (For second and third trimester)
Energy kcals		
Sedentary work	1900	+350
Moderate work	2230	+350
Heavy work	2850	+350
Protein g	55	82.2
Visible fat g		
Sedentary work	20	
Moderate work	25	30
Heavy work	30	
Calcium mg	600	1200
Iron mg	21	35
Vitamin A μg		
Retinol or	600	800
β-carotene	4800	6400
Thiamine mg		
Sedentary work	1.0	
Moderate work	1.1	+0.2
Heavy work	1.4	
Riboflavin mg		
Sedentary work	1.1	
Moderate work	1.3	+0.3
Heavy work	1.7	
Niacin equivalent μg		
Sedentary work	12	
Moderate work	14	+2
Heavy work	16	
Pyridoxine mg	2.0	2.5
Ascorbic acid mg	40	60
Dietary folate μg	200	500
Vitamin B_{12} μg	1.0	1.2
Magnesium mg	310	310
Zinc mg	10	12

Energy

Energy needs during pregnancy increase because of the

- growth and physical activity of the foetus,
- growth of the placenta and maternal tissue,
- normal increase in maternal body size, and deposition of fat,
- additional work involved in carrying the weight of the foetus and extra maternal tissues and
- slow but steady rise in basal metabolic rate during pregnancy.

BMR increases by about 5 per cent during the first and second trimester and by about 12 per cent during the third trimester. The total weight gain during 9 months of pregnancy may range from 10–14 kg with an average of 12 kg.

For a reference Indian woman, whose body weight is 55 kg, the total energy cost of pregnancy is around 80,000 kcals and the energy expenditure during normal pregnancy would be 27,000 kcals. In addition, calories are required for the deposition of fat which would be used during lactation. The caloric requirements of a pregnant woman is mostly increased in the latter half of pregnancy. Expert committee recommended an additional intake of 350 kcal/day during the second and third trimester and additional intake of 150 kcal/day during first trimester of pregnancy.

Hence ICMR recommended energy requirement of pregnant woman as follows:

Sedentary worker	:	1900 + 350 = 2250 kcal
Moderate worker	:	2230 + 350 = 2580 kcal
Heavy worker	:	2850 + 350 = 3200 kcal

Energy requirement during pregnancy comprises body weight gain consisting of protein, fat and water. It is very evident that normal pregnancy calls for a considerable weight gain over and above that represented by the size of the foetus. The fat that accumulates throughout pregnancy (specially for the first 30 weeks) acts as an energy reserve. About 36,000 kcals are deposited as fat, which is utilised during lactation. When the supply of calories are inadequate the fat may be used up to provide the high energy needs of the rapidly growing foetus and to spare the proteins for tissue growth. This results in an increase in the ketones in the urine during the 1st trimester of pregnancy. The foetus does not accumulate any fat except in the cell walls and system. All fat is synthesised from glucose except for the essential fatty acid (linoleic acid) which is transferred from the mother to the child.

Protein

The normal protein requirement of an adult woman is 55 g/day. ICMR (2010) prescribed for a pregnant woman 82.2 g/day. Additional protein is essential for:

- rapid growth of the foetus.
- the enlargement of the uterus, mammary glands and placenta.
- increase in maternal circulating blood volume and subsequent demand of increased plasma protein to maintain colloidal osmotic pressure and circulation of tissue fluids.
- formation of amniotic fluid and storage reserves for labour, delivery and lactation.
- the transfer of amino acids from the mother to foetus (up to 20 weeks all amino acids must be provided to the foetus as it cannot oxidise amino acids as a source of energy).

Protein requirement during pregnancy has been computed on the basis of N accretion. Based on the body weight gain of 12 kg in a normal healthy well nourished pregnant woman, the daily N deposited during the three trimesters is estimated to be 0.1, 0.5 and 0.9 g respectively. After increasing by 50 per cent to convert the factorial value into physiological value for N accretion, and 25 per cent for individual variation, the safe level of intake in terms of a high quality protein during the three trimesters will be 1.0, 7.0 and 23.0 g respectively. After adjusting for the dietary protein quality of protein energy rate 12–13 per cent, the safe intake during the latter half of pregnancy recommended by the Nutrition Expert Committee is 27.2 g/day with balanced diet.

If protein requirements are not met during pregnancy:

- there is increased risk of pregnancy.
- the foetus may grow at the expense of mother.

- maximum growth of the baby cannot be obtained.
- number of cells in tissues particularly in brain may be less.

Protein and calorie deficiency during gestation may result in poor utilisation of food by the off-spring after birth and a failure to ever compensate for early food deprivation. When amino acids are transferred, some big protein molecules also cross the placental barrier which give immunity to the infants. In the total weight gain during pregnancy there is 1 kg of protein half of which is foetal tissue.

Milk, meat, egg and cheese are complete proteins and of high biological value. A pregnant woman requires 600 ml of milk per day. Additional protein may be obtained from legumes and whole grains, nuts and oil seeds. Pulse: Cereal intake ratio should be 1 : 5. Protein supplements are not required.

Visible Fat and Essential Fatty Acids

The minimum level of total fat should be 20%E. To meet this, diets of pregnant women should contain 30 g of visible fat. A pregnant woman should consume at least 200 mg/d DHA for optimal health and fetal development. During the third trimester, 50–60 mg/day of maternal DHA stores are transferred to the foetus via placenta. DHA plays a critical role in both vision and cognitive function. Essential fatty acids relax muscles and blood vessels of the uterus and makes delivery easier. Essential fatty acid deficiency adversely affects pregnancy outcome.

Corn, cotton seed, safflower and soyabean oils are good sources of linoleic acid. α-linolenic acid is present not only in fish oils but also found in green leaf vegetables, flax seeds, rape seed, soyabean and walnuts.

Calcium

Calcium requirement suggested by ICMR for an adult woman is 600 mg/day. Requirement increases during pregnancy to 1200 mg/day.

Although the infant bones are poorly calcified at the time of birth an appreciable amount of calcium is involved in foetal development. A full term foetal body is made up of 30 g of calcium.

Increased intake of calcium by the mother is highly essential, not only for the calcification of foetal bones and teeth but also for protection of calcium resources of the mother to meet the high demands during lactation.

The pregnant woman routinely exhibits extensive adjustments in calcium metabolism, largely as a result of the influence of hormonal factors. Human chorionic somato mammotropin from the placenta progressively increases the rate of bone turnover. Estrogen also largely derived from the placenta, inhibits bone resorption, provoking a compensatory release of parathyroid hormone, which maintains the serum calcium level while enhancing intestinal absorption. The net effect of these changes is the promotion of progressive calcium retention to meet progressively increasing foetal skeletal demands for mineralisation.

Two-thirds of foetal calcium is transferred from the mother to the foetus after 30th week of pregnancy at the rate of 300 mg per day. Radio isotopic studies revealed that nearly 80 per cent calcium of the foetal skeleton and mother were obtained from the mother's diet, and the rest was obtained from maternal reserves. Pregnant woman usually absorb not less than 40 per cent of the calcium available in their diet. Calcium retention by pregnant woman is of 2 to 5 times the amount needed by the foetus in the 6th and 7th months of pregnancy indicating that maternal reserves are being built up at this stage. The amount of dietary calcium needed is reduced when vitamin D is available. Use of vitamin D and calcium reduces muscular cramps of pregnancy.

To prevent 'osteomalacia' mother's diet should contain less of phytic acid, adequate amounts of vitamin D and sufficient amount of calcium. Mothers should avoid repeated pregnancies.

Dairy products are a primary source of calcium. Green leafy vegetables like agathi and gingelly seeds also contribute to calcium.

Iron

Normal iron requirement of an adult woman is 21 mg/day. ICMR requirements during pregnancy is 35 mg/day.

The increase in iron by 8 mg/day can be attributed to the following:

- Infants are generally born with high Hb levels of 18–22 g/100 ml of blood Iron stores in the liver of the infant lasts from 3 to 6 months. Iron is also required for growth of foetus and placenta. To achieve these levels mother must transfer 240 mg of iron to the foetus during gestation.
- It is also required for the formation of haemoglobin as there is 40–50 per cent increased maternal blood volume. For this 400 mg of iron is required.
- Loss of maternal iron through skin and sweat is about 170 mg of iron.

Table 7.2 Iron requirement during pregnancy with a weight gain of 12 kg

	Gross loss	Iron requirement during entire pregnancy mg
Foetus	240 mg	230
Expansion of maternal red cell mass	400 mg	400
Obligatory loss	14 μg/kg	234
Total		**864**

The total iron requirement for the entire period of pregnancy is 864 mg.

The actual increase in requirement of iron is only in second and third trimester. But a single large dose of iron at the beginning of pregnancy is an effective way to build up iron stores and to protect against depletion of reserves. To avoid iron deficiency a woman should enter pregnancy with a store of atleast 300 mg of iron. Iron requirement in first trimester is similar to the normal requirement of 0.70 mg. During second and third trimester, the daily requirement is 3.3 mg and 5 mg respectively.

Liver, dried beans, dried fruits, green leafy vegetables, eggs, enriched cereals and iron fortified salt provide additional sources of iron.

Sodium

Normal adult woman's requirement of sodium should be maintained to prevent any defective disorders and deficiency.

1. During pregnancy there is an increase in the extra cellular fluid which calls for an 80 per cent increase in the body sodium. Restriction in the diet can cause a severe hormonal and biochemical changes.
2. When blood sodium level drops, kidney produces the hormone renin, as a result of which the sodium that is needed for use by the body is retained.
3. When the system is over taxed it can result in sodium deficiency causing an increased risk of eclampsia, prematurity and low birth weight of infants.

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3. When the system is over taxed it can result in sodium deficiency causing an increased risk of eclampsia, prematurity and low birth weight of infants.

Uses of diuretics should be discouraged during pregnancy as they can cause loss of sodium. Sodium is restricted when there is oedema or hypertension.

Iodine

ICMR recommends additional requirement of 25 μg during pregnancy to the adult requirement of 100–200 μg. Iodine deficiency in mother can lead to abortion, still births, congenital anomalies, increased perinatal mortality, cretinism and psychomotor defects. Mothers who are residing in goitre endemic areas should ensure that they get enough iodine through iodised salt and other means.

Zinc

Zinc deficiency during the antenatal period leads to adverse effects on the newborn including foetal mortality, foetal malformations including CNS teratogenecity and reduced intra uterine growth rate. Low zinc during pregnancy doubles the risk of low birth weight and trebles the risk of preterm delivery.

Vitamin A

Normal requirements of β-carotene for an adult woman is 4800 μg and during pregnancy it is increased to 6400 μg. Same level is suggested during pregnancy. Vitamin A requirements during pregnancy have been calculated on the basis of the vitamin content of livers of the newborn. Additional intake of vitamin A required for this purpose is about 25 μg/day throughout pregnancy. Since this constitutes a small fraction of the recommended allowance for normal women, no additional dietary allowance during pregnancy is suggested.

The importance of vitamin A deficiency during pregnancy on maternal and child health has been recognised by the studies conducted by NIN as shown in Fig. 7.1. Night blindness is associated with malnutrition, severe anaemia and preterm deliveries in the mother and birth asphyxia in the new-born. Serum retinol < 20 μg/dl was found to be associated with preterm deliveries and higher risk of systolic hypertension.

Liver, egg yolk, butter, dark green and yellow vegetables and fruits are good source of vitamin A.

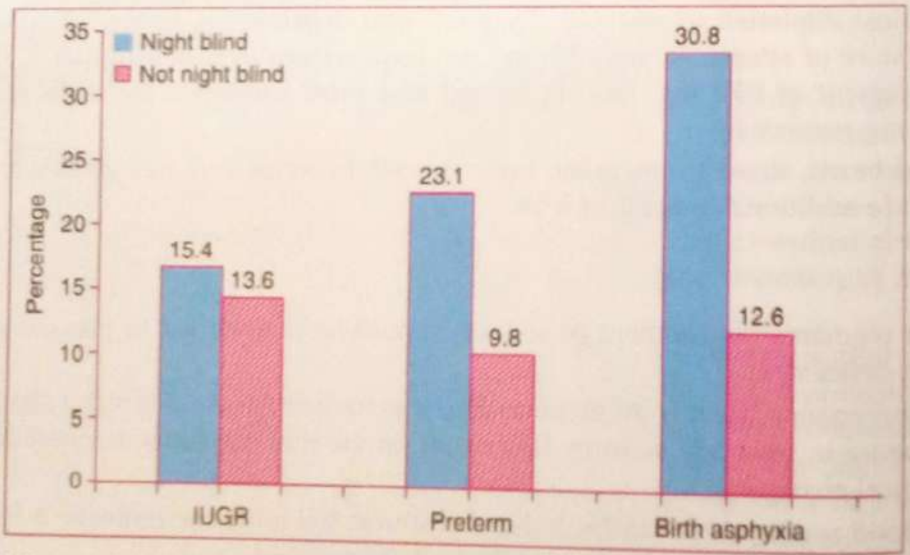


Fig. 7.1 Neonatal complications of infants of mothers with and without night blindness

A daily supplementation of 6000 I.U. for about 12 weeks appears to improve serum vitamin A levels and correct vitamin A deficiency in these pregnant women. Improving vitamin A status of pregnant women reduces maternal mortality.

Excess vitamin A should not be taken during pregnancy.

Vitamin D

Vitamin D is highly essential as it enhances the maternal calcium absorption. Its active form calcidiol and calcitriol cross the placenta with ease and play an important role in calcium metabolism of the foetus. Maternal deficiency of vitamin D results in neonatal hypocalcaemia and hypoplasia. Excessive vitamin D can also result in complications such as atherosclerosis, hypercalcaemia, calcium deposits in various vital organs and mental retardation in the infants.

Vitamin E

In animals vitamin E has an important role to play in the reproductive process and reduces the number of spontaneous abortions and still births. In women it has not been evidently proved that vitamin E deficiency can cause pregnancy failure although it may prove beneficial to those who have had repeated spontaneous abortion or failure to conceive. Very little vitamin E crosses the placenta, so infant has low tissue concentrations that persist up to at least 6 years. Requirement of vitamin E increases with increased intake of PUFA.

Vitamin K

Vitamin K is essential for synthesis of prothrombin that is necessary for normal coagulation of blood. It is highly essential for preventing neonatal haemorrhage. An oral dosage of menadione (synthetic form of vitamin K) during the last weeks of pregnancy or an injection during labour is essential to stimulate prothrombin synthesis. But care should be taken to see that the dosage is given at average level to prevent adverse effects.

Water Soluble Vitamins

Because little of water soluble vitamins are stored, the pregnant woman must rely on her daily intakes that is high enough to meet the added requirements of pregnancy. Generally maternal blood levels for water soluble vitamins tend to fall and foetal blood levels tend to exceed those of mother by 50 to 100 per cent during pregnancy.

Thiamine

The ICMR recommendations of thiamine RDA for an adult woman is

- 1.0 mg for sedentary worker
- 1.1 mg for moderate worker
- 1.4 mg for heavy worker

For a pregnant woman the requirement is increased by 0.2 mg/day.

The relationship between thiamine and caloric intake remains the same as normal adult during pregnancy i.e., for 1000 calories 0.5 mg of thiamine is required. The normal urinary excretion of thiamine drops indicating that more is being retained and used by tissues. In some cases thiamine helps to relieve the nausea of pregnancy.

Riboflavin

The ICMR recommendations of riboflavin RDA for an adult woman is

1.1 mg for sedentary worker

1.3 mg for moderate worker

1.7 mg for heavy worker

In a pregnant woman the RDA is increased by 0.3 mg/day. For 1000 calorie intake, 0.6 mg of riboflavin is required.

Requirements are increased due to increase in maternal body size and growth of foetus and accessory tissues. Riboflavin is present in higher amounts in the foetal blood than in maternal blood. Animal studies have shown that the lack of riboflavin interfere with cartilage formation resulting in skeletal malformations such as shortening of long bones and fusion of ribs.

Niacin Equivalent

The ICMR recommendations of niacin RDA for an adult woman is 12 mg for sedentary worker, 14 mg for moderate worker and 16 mg, for heavy worker. In a pregnant woman the RDA is increased by 2 mg, corresponding to the increase in calories. The conversion of amino acid into niacin is more efficient during pregnancy.

Vitamin B_6

Normal requirement of pyridoxine in an adult woman is 2.0 mg. ICMR suggested for pregnancy 2.5 mg/day. In hypertrophy, when the cells are growing in size, B_6 and amino acids are required. During 'toxaemia of pregnancy' (high B.P., oedema, proteinuria) the B_6 levels are lower. Women who used oral contraceptives prior to conception often enter pregnancy with low tissue levels of vitamin B_6. There is no satisfactory theory to explain that these low levels affect the outcome of pregnancy but they do reduce the amount of pyridoxine in breast milk during lactation. Vitamin B_6 is said to be used to control nausea of pregnancy.

Dietary Folate

Normal adult woman requirement of folate is 200 µg/day. ICMR recommendations during pregnancy are 400 µg/day. The recommended intake of folacin is based on its role in promoting

Fig. 7.2 Congenital anomaly—Spina bifida

In spina bifida, defective development of vertebrae allows a portion of the spinal cord and meninges to protrude through the defect, causing outpouching. Neurologic dysfunction is caused by this anomaly. Folic acid deficiency at the time of conception can cause spina bifida.

the synthesis of essential components of DNA and RNA which increase rapidly during growth thereby increasing the requirements. Also folic acid is essential for the development of RBCs which must increase as the mothers blood volume increases.

Malformations have been noted in the offspring of women using folate antagonist drugs such as methotrexate and valproic acid. There is some evidence in humans to suggest that deficiency of folic acid may be associated with spontaneous abortion and obstetric complications such as preterm labour and low birth weight.

The greatest significance of folic acid and its potential influence on pregnancy outcome is its role in preventing neural tube defects, such as spina bifida. In this condition there is a congenital defect in which the vertebral neural arches fail to close, so exposing the contents of the spinal canal posteriorly. Folic acid deficiency can lead to anencephaly—absence of brain. Folic acid deficiency has also been implicated in pregnancy induced hypertension.

Studies have shown that folic acid acts through an unusual mechanism—*terathanasia*—the selective promotion of spontaneous abortion of defective fetuses.

All women of child bearing years should take folic acid supplementation. It is crucial to note that, because the neural tube closes by 28 days of gestation (before most women realise that they are pregnant) supplementation with folic acid should ideally occur prior to conception. Studies have shown that red cell folate levels exceeding 400 ng/ml are best for preventing neural tube defects. This can be achieved only with folic acid supplementation.

Women of child bearing age should be encouraged to include generous amounts of folic acid. Foods such as dark green leafy vegetables, legumes, orange juice, soya, wheat germ, almonds and peanuts contain folic acid. In addition women planning pregnancy should begin periconceptional supplementation with folic acid at levels of 400 to 800 μg per day. It is difficult to provide 300 μg of additional amount of folic acid during pregnancy through food and can be met through supplements of medicinal folate.

Vitamin B_{12}

Normal adult woman's requirement of vitamin B_{12} is 1 μg and this requirement remains the same even during pregnancy. The foetus has priority over the mother in B_{12}, and foetal blood had twice the amount of B_{12} than does maternal blood, even when maternal levels are depleted. Low maternal levels are associated with prematurity. The capacity of a woman to absorb B_{12} is increased during pregnancy and a large amount is transferred to the foetus. Vegan mothers have more chances of getting B_{12} deficiency as vitamin B_{12} is present in foods of animal origin. Serum levels drop during pregnancy and return to normal without supplementation after delivery. On the basis of the B_{12} content of foetuses, it has been estimated that foetal demands may be of the order of 0.3 μg per day.

Vitamin C

ICMR recommendations of vitamin C during pregnancy is 40 mg higher than normal woman requirement. The foetal requirement is too small and sufficient safety margin is given for an adult women and extra allowance may not be necessary during pregnancy. In pregnancy vitamin C can fully cross the placental barrier. The vitamin C content of foetal blood is thrice as much as maternal blood. There is some evidence to show that the placenta can synthesize vitamin C. This may account for higher levels in foetal tissue. Low maternal intake of vitamin C is associated with premature rupture of foetal membranes and increased neonatal death rates.

A few studies have suggested an association between low plasma levels of vitamin C and preeclampsia.

> ***Share of Nutrients***
>
> - Nutrients given to foetus at the expense of mother—folic acid, vitamin C, vitamin B_{12}, iron and calcium
> - Nutrients for which mother and fetus compete—vitamin B_1, B_2, B_6 and D
> - Nutrients for which mother has priority over fetus—vitamin A and Iodine
> - Nutrients stored in fetus—vitamin A and iron
> - Nutrients not stored in fetus—vitamin C, D and calcium

Largely because of assisted reproduction, the rate of multifetal pregnancy is rising rapidly. Women with multifetal pregnancy have an increased need for weight gain, energy, essential fatty acids, iron, calcium and other nutrients compared with women with single fetus pregnancy. Total weight gain in twin pregnancy is 16–20 kg.

Relationship between Maternal and Foetal Nutrition

Nutritional deficiencies during the growth period in the womb and after birth tend to cause low weight and small size rather than deficiency abnormalities at earlier times.

Due to undernourishment of the mother the baby is at an increased risk of being premature with low birth weight and developmental irregularities. Intrauterine nutrition is highly important for the growth of the central nervous system and kidneys of the foetus which mature during the latter part of pregnancy. Therefore nutrition deficits before birth can never be wholly reversed after birth.

Schematic diagram, Fig. 7.3 shows the relationship between maternal and foetal nutrition.

Inadequate food intake and poor nutrient utilisation
↓
Maternal malnutrition
↓
Reduced blood volume expansion
↓
Inadequate increase in cardiac output
↓
Decreased blood and nutrient supply to the foetus
↓
Reduced placental size
↓
Reduced nutrient transfer
↓
Foetal growth retardation

Fig. 7.3 Relationship between maternal and foetal nutrition

Intrauterine growth retardation can occur due to deficiency of energy, dietary folate vitamin A, zinc, vitamin B_{12}, riboflavin and iodine.

Table 7.3 **Impact of nutritional deficiency on the outcome of pregnancy**

Nutrient	*Impact of deficiency on the Mother*	*Impact of deficiency on the Infant*
Energy and Protein	• Abortion • Complications during delivery • Ketosis • May not gain enough weight to have normal lactation. • PIH	• Premature infant • Low birth weight Infant • Less brain cells
Linoleic Acid	—	• Retarded foetal growth
Calcium	• Muscular cramps • Repeated pregnancy with poor diet can result in osteomalacia • During lactation breast milk may be deficient in calcium	• Calcification of bones and teeth is decreased • Underweight due to the decreased foetal bone growth
Iron	• Hypochromic microcytic anaemia. Complications during delivery	• Born with less stores of iron and susceptible for anaemia
Iodine	• Goitre • Increased risk of miscarriage and still birth	• Chance of getting goitre • Cretinism
Zinc	• Foetal mortality • Foetal malformations including central nervous system and terato-genecity	• Reduced intra uterine growth rate • Low birth weight • Preterm baby
Vitamin A	• Mortality • PIH	• Decreased levels in foetus so more susceptible for vitamin A deficiency
Vitamin D	• Decreased calcium absorption	• Calcium metabolism of foetus is affected
Vitamin K	• Decreased prothrombin synthesis • Increased loss of blood during delivery	• Increased risk of neonatal haemorrhage
Thiamin, Riboflavin and Niacin	• Deficiency symptoms	
Folic acid	• Megaloblastic anaemia • Abruptio placentae • PIH	• Foetal malformation Neural tube defects, spina bifida, congenital abnormalities like hare lip, cleft palate, hydrocephalus • Low birth weight
Vitamin B_{12}	• Pernicious anaemia	• Premature baby
Vitamin C	• Premature rupture of foetal membranes	• Increased neonatal death rate.

GENERAL DIETARY PROBLEMS

Nausea and Vomiting

Nausea in pregnancy may be due to nervous disturbances, placental protein intoxication or due to derangement in carbohydrate metabolism.

Morning sickness of early pregnancy can be improved by small and frequent meals. Fairly dry and consisting chiefly of easily digested energy foods such as carbohydrates are more readily tolerated. Liquids may best be taken between meals instead of with food. If the condition develops to hyperemesis gravidarum, a severe prolonged persistent vomiting, peripheral parenteral nutrition and careful oral feeding is essential. Skim milk is better tolerated than whole milk. Fruits and vegetables can be given. Fatty rich foods, fried foods, excessive seasoning, coffee in large amounts and strongly flavoured vegetables may be restricted or eliminated if the nausea persists. She should avoid becoming too hungry.

Leg Cramps: The common occurrence of cramps during pregnancy, manifested nocturnally by sudden contractions of the muscle, is thought to be related to a decline in serum calcium levels related to a calcium phosphorus imbalance. Prevention or relief of these leg cramps has been reported with reduction of milk (a high phosphorus, high calcium beverage) intake and supplementation with nonphosphate calcium salts. Magnesium is another mineral with the potential for relieving leg cramps.

Heart Burn

Increased progesterone production causes decreased tone and mobility of the smooth muscles of the gastrointestinal tract. This leads to regurgitation. In most cases, this is an effect of pressure of the enlarged uterus on the stomach which in combination with the relaxation of the oesophageal sphincter, results in occasional regurgitation of the stomach contents into the esophagus. Heart burn is a common complaint during the latter part of pregnancy. This can usually be relieved by small and frequent meals limiting the amount of food consumed at one time and drinking fluids between meals. Sitting upright after meals for at least 3 hours before lying down may also help.

Beliefs, Avoidances, Cravings and Aversions

Food avoidances reflect mother's conscious choice not to consume certain foods during pregnancy e.g., heat producing foods like papaya and gingelly seeds.

Cravings and aversions are powerful urges toward or away from foods which pregnant women experience. The most commonly craved foods are sweets and dairy products. The most common aversions reported are alcohol, coffee, other caffeinated drinks, meats and strongly spiced foods.

Consumption of non-food items like laundry starch, ice cubes or clay is called pica. It occurs more often during pregnancy than at any other time. The etiology of pica is poorly understood and one theory suggests that the ingestion of non-food substances relieves nausea and vomiting. It has also been hypothesised that a deficiency for essential nutrient, such as calcium or iron, results in the eating of non-food substances that contain these nutrients. Much of this behaviour appears to be based on superstitions, customs and traditions that one often passes from mother to daughter.

Weight Gain during Pregnancy

All pregnancies should be started with BMI of 20–26 because maternal and foetal consequences occur at both extremes. Optimal weight gain is about 11 to 13 kg. About 900 to 1800 g is an average gain during the first trimester. Thereafter 450 g/week during the remainder of the pregnancy is usual. Sharp sudden increase in weight after the 20th week of pregnancy, which may indicate excessive, abnormal water retention should be watched. Weight reduction should never be undertaken during pregnancy. Excessive weight gain places an extra strain on the organs and increases the incidence to toxaemia. It is not correct for the mother to think that low gain in weight results in smaller baby which is easy to deliver.

Tables 7.4 and 7.5 give the components of weight gain during pregnancy and recommended weight gain based on body mass index.

Table 7.4 Components of weight gain during pregnancy (28–40 weeks)

Component	Weight g
Foetus	3000
Placenta and amniotic acid	1500
Maternal tissues and blood	7000
Total	11500

Table 7.5 Recommended weight gain for pregnant women based on body mass index

Weight category based on BMI	Total weight gain (kg)
Under weight (BMI < 19.8)	12.5–18
Normal weight (19.8–26)	11.5–16
Overweight BMI > 26–29	7–11.5
Obese > 29	6.0

Research shows that continuing a regular exercise regimen throughout pregnancy is helpful in improved fitness, prevention of gestational diabetes, facilitation of labour and reduced stress.

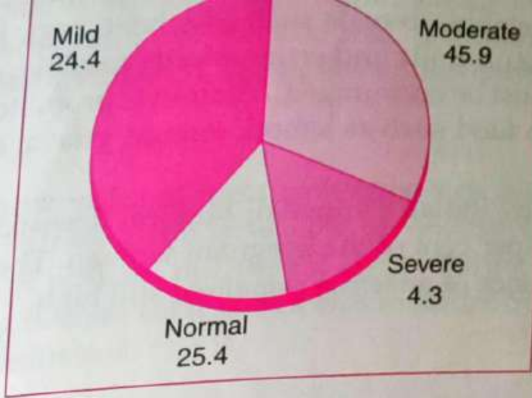
COMPLICATIONS

About 1,25,000 women die in India every year from causes related to pregnancy and child birth. The main causes are anaemia, haemorrhage and toxemia which are often preventable (2006).

Anaemia

According to WHO/UNICEF/UNO, a pregnant woman is anaemic if the haemoglobin level is below 11.0 g/dl or haematocrit per cent is below 33 per cent.

The prevalence of anaemia in Indian pregnant women is shown in Fig. 7.4.



Haemoglobin (g/dl)	Normal (>=11)	Mild (9–11)	Moderate (7–9)	Severe (< 7)

Fig. 7.4 Prevalence of anaemia among pregnant women in India (Percentage) Around 75 per cent are anaemic with different degrees

Factors implicated in the etiopathogenesis of anaemia during pregnancy and low birth weight are maternal age, weight, height, parity, literacy, income, infections, pregnancy related complications, nutritional stress, cultural beliefs, taboos and inappropriate food practice. Too little space between births or too many infections and too little intake of nutrients involved in erythropoiesis during pregnancy leads to anaemia.

Physiological changes in the blood occur progressively during normal pregnancy. Haemoglobin mass increases, red blood cell volume increases, plasma volume rises and haemoglobin concentration drops from 13.4 to 11.6 g per 100 ml. Severe anaemia in pregnant women increases maternal morbidity and mortality and involves a higher risk of the foetus.

A significant fall in birth weight due to increase in prematurity rate and intrauterine growth retardation has been reported to occur when maternal haemoglobin level falls below 8 g/dl.

Anaemic pregnant women are prone to urinary infections. The effect of anaemia and urinary tract infection in pregnancy could also be the cause of low birth weight infant.

Iron deficiency anaemia in the mother may also produce alterations in brain function and impaired schooling later. Low birth weight infants have a high mortality rate and those that survive have greater rates of morbidity and poorer neurological development.

The predominantly cereal diet in the tropics should be able to provide 40 mg iron per day.

Through the PHC or ICDS distribution channel 60 mg elemental iron and 500 µg of folic acid per day are distributed in the last trimester of pregnancy to prevent anaemia.

The demand for folate during pregnancy is increased because of increased cellular proliferation.

Megaloblastic anaemia results in intensified nausea, vomiting and anorexia.

Anaemia due to B_{12} deficiency in pregnancy is uncommon. A single injection of 40 mcg of B_{12} is enough to produce a maximum response in 10 days in B_{12} deficient mothers.

All pregnant women, irrespective of haemoglobin levels, must be provided with the recommended dose of iron and folic acid (folifer) supplements.

Women with haemoglobin levels below 7 g/dl are considered to be severely anaemic. Recommended therapeutic dose for women in the reproductive age group is one tablet of iron thrice daily for a minimum of 100 days. This will provide equivalent to 180 mg elemental iron and 1500 µg of folic acid per day.

Pregnant mothers should take iron and folic acid rich foods. Regular consumption of iron rich foods such as green leafy vegetables, cereals such as wheat, ragi, jowar and bajra, pulses and jaggery. In addition, wherever culturally and economically feasible, consumption of animal flesh foods such as meat and liver must be encouraged. Vitamin C promotes absorption of iron. Regular consumption of vitamin C rich food such as lemon, orange, guava, amla, mango along with iron rich food must be promoted.

Recent surveys carried out by Indian Council of Medical Research indicates that of the beneficiaries covered are about 2-25 per cent of the pregnant woman. They had received >90 tablets of IFA. Consequently the prevalence of anaemia remained still high.

Constipation

The pressure of the enlarging uterus on the lower portion of the intestine, in addition to the hormonal muscle relaxant effect of placental hormones on the gastrointestinal tract may result in constipation. Physical inactivity may also make elimination difficult. Increased fluid intake and use of natural laxative foods such as whole grains, dried fruits and other fruits, vegetables that are rich fibre, juices usually induce regularity. Laxatives should be avoided. Regular habits of exercise and sleep are essential for proper elimination.

Oedema

Mild, physiologic oedema is usually present in the extremities in the third trimester. The swelling of the lower extremities may be caused by the pressure of the enlarging uterus on the veins returning fluid from the legs. This normal oedema requires no sodium restriction or other dietary changes.

Pregnancy Induced Hypertension

Studies conducted at National Institute of Nutrition indicate that pregnancy induced hypertension (eclampsia) is associated with higher incidence of vitamin A and protein deficiencies resulting in poor pregnancy outcome.

It is common among women subsisting on inadequate diets with little or no prenatal care. The symptoms of PIH include hypertension, abnormal and excessive oedema, albuminuria, convulsions or coma. Optimal nutrition is a fundamental aspect of therapy. Emphasis is given to adequate dietary protein. Correction of plasma protein deficits stimulates normal operation of the capillary fluid shift mechanism and circulation of fluid tissue with subsequent correction of the hypovolaemia (abnormal reduction in volume of circulatory plasma). In addition, adequate salt and sources of vitamins and minerals are needed for correction and maintenance of metabolic balance.

In severe preeclampsia, oral feeding is suspended in favour of intravenous infusion with 10 per cent dextrose drip during which the patient remains in sedation. Then oral feeding with 10 per cent dextrose, barley and fruit juice is allowed. Bed rest is advocated.

Pregnancy induced hypertension is seen in 10–20 per cent of all pregnant women in India. It is associated with increased maternal morbidity and mortality, related to intrauterine growth retardation, premature delivery and perinatal asphyxia. Pregnant women with preeclampsia are at increased risk for abruptio placenta, intracerebral haemorrhage and hepatic and renal failure.

Preeclampsia is associated with oxidative stress, imbalance between prooxidants and antioxidants leads to potential cell or tissue damage. Vascular endothelial damage is known to play a key role in the patho physiological mechanism of preeclampsia. Free radical mediated lipid peroxidation may be involved in the endothelial damage.

Excess free radical disturbances are associated with increased utilisation of antioxidants resulting in decrease in the concentration of ascorbic acid, α-tocopherol and β-carotene. Antioxidant supplementation in primigravida may be helpful in preventing preeclampsia.

Hypertension

This can cause considerable maternal and foetal consequences. Nutritional therapy will centre on (1) prevention of weight extremes, underweight or obesity (2) correction of any dietary deficiencies and maintenance of optimal nutritional status during pregnancy and (3) management of any related preexisting disease such as diabetes mellitus. Sodium intake may be moderate but should not be unduly restricted.

Gestational Diabetes Mellitus

During pregnancy glycosuria is not uncommon, because of the increased circulating blood volume and its load of metabolites. Insulin antagonism is due to the combined effect of human placental lactogen, oestrogen, progesterone, free cortisol and degradation of the insulin by the placenta. Most of these women revert to normal glucose tolerance after delivery.

Several studies have shown that elevated glycosylated haemoglobin levels early in pregnancy correlate with increased incidence of malformations. Hence the management and counsellings of women with diabetes in the reproductive age group should begin prior to conception, with efforts aimed at achieving Hb_{AIC} concentration around 6.5 per cent. Glycosylated haemoglobin measurements are used to aid in the timing of conception. Among diabetic women with poor control, perinatal mortality ranges from 3–5 per cent and major congenital defects from 6–12 per cent.

Strategies to reduce the occurrence of neonatal macrosomia and maternal prepregnancy obesity may help lower the rate of recurrence of gestational diabetes mellitus.

Pregnancy is optimal when the mother is biologically mature. A biologically mature female is a young woman who is atleast 5 years post menarchial and this has greater impact on pregnancy than her chronological age.

WHO and UNICEF have repeatedly emphasised that **too early** pregnancies (teenager), **too late** (35 and over), **too close** (less than two years) and **too many** (four and over) are not safe or conducive to the health of either the mother or her infant.

International women's day is on 8th of March

Some suggested recipes during pregnancy

Recipes	Reason
Dairy products like milk, curd, khoya, yogurt and cheese, paneer. Banana, green leafy vegetables, whole grain cereals	To meet the requirements of protein, calcium and vitamin D and to prevent muscle cramps Natural laxatives and prevent constipation
Fruit salad	Appetising and provide many nutrients and also fibre.
Omlette, boiled egg, scrambled egg, liver curry	Good quality protein and iron
Rice flakes upma, puffed rice ball	Good source of iron and easy to digest
Green gram, dal, pakoda, bread pudding, carrot halwa	Nutrient dense foods to be given to meet increased requirements.
Pickles, rasam, sour foods	These foods may give relief from nausea.

8

NUTRITIONAL AND FOOD REQUIREMENTS OF LACTATING WOMEN

The nutritional link between the mother and the child continues even after birth. The newborn baby depends for some period solely on breast milk for his existence.

ROLE OF HORMONES IN MILK PRODUCTION

Sucking by infant initiates hormonal changes that lead to milk production and let down reflex, which releases milk as shown in Fig. 8.1.

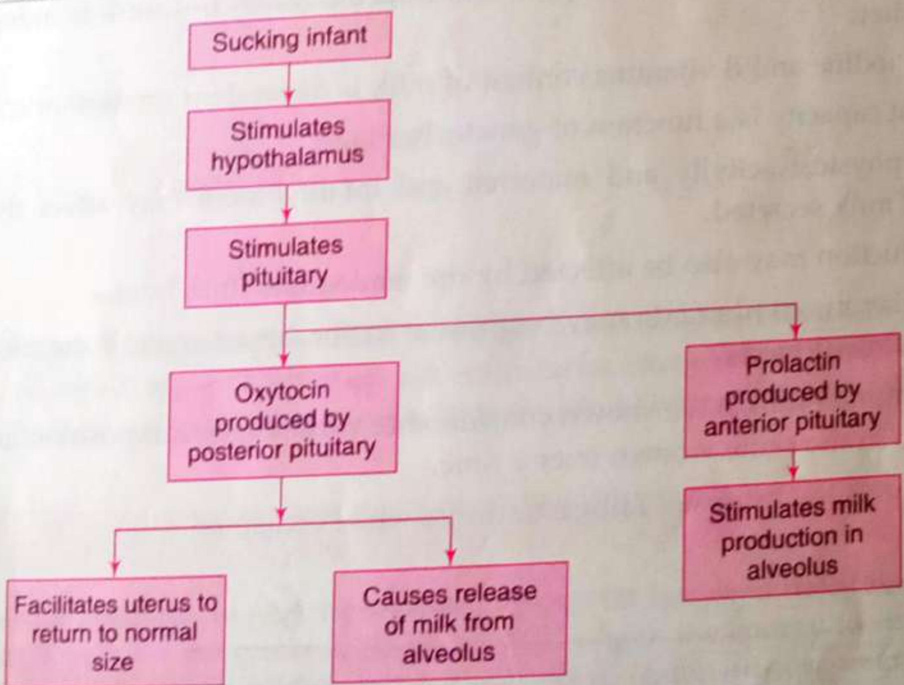


Fig. 8.1 Process of stimulation of milk production

The process of lactation is controlled by various hormones. The source of these hormones and their function is summarised in Table 8.1.

Table 8.1 **Hormonal control of lactation**

Hormone	Source	Activity
Estrogen	Ovary and placenta	Stimulates breast development during pregnancy
Progesterone	Ovary and placenta	Stimulates breast development during pregnancy
Prolactin	Anterior pituitary gland	Stimulates milk production
Oxytocin	Posterior pituitary gland	"Let down" reflex: Smooth muscles surrounding the alveoli of the nipples contract to allow the release of milk. In pain, emotions or embarrassment the let-down reflex may sometimes be inhibited. Doubting about the ability to produce enough milk can interfere with the "let down" reflex. Oxytocin counter-acts this.

Factors Affecting the Volume and Composition of Breast Milk

- Fat and energy concentration in milk are significantly related to maternal fat stores.
- Milk of primiparae has a higher fat concentration than that of multiparae.
- There is no significant effect of supplementary feeding on the production of milk.
- The frequency of milk removal is an important determinant of the volume of milk secreted. Sucking stimulates the release of hormones that stimulate milk production. Frequent feeding removes the locally active inhibitor.
- Undernourished mother produces less quantity but same quality of milk.
- Lactose, protein, calcium, iron, copper and flourine content of milk is independent of the mother's diet.
- Selenium, iodine and B vitamins content of milk is dependent on mother's diet.
- Lactational capacity is a function of genetic heritage.
- Maternal physical activity and maternal and infant illness may affect the amount and content of milk secreted.
- Milk production may also be affected by the inadequate fluid intake.
- Unusual flavour compounds may be present in the breast milk, if the mother consumes strong flavoured foods.

Analysis of human milk have shown considerable variation in composition, not only among women but also in the same women over a time.

Figure 8.2 shows the causes of failure to thrive while breast fed.

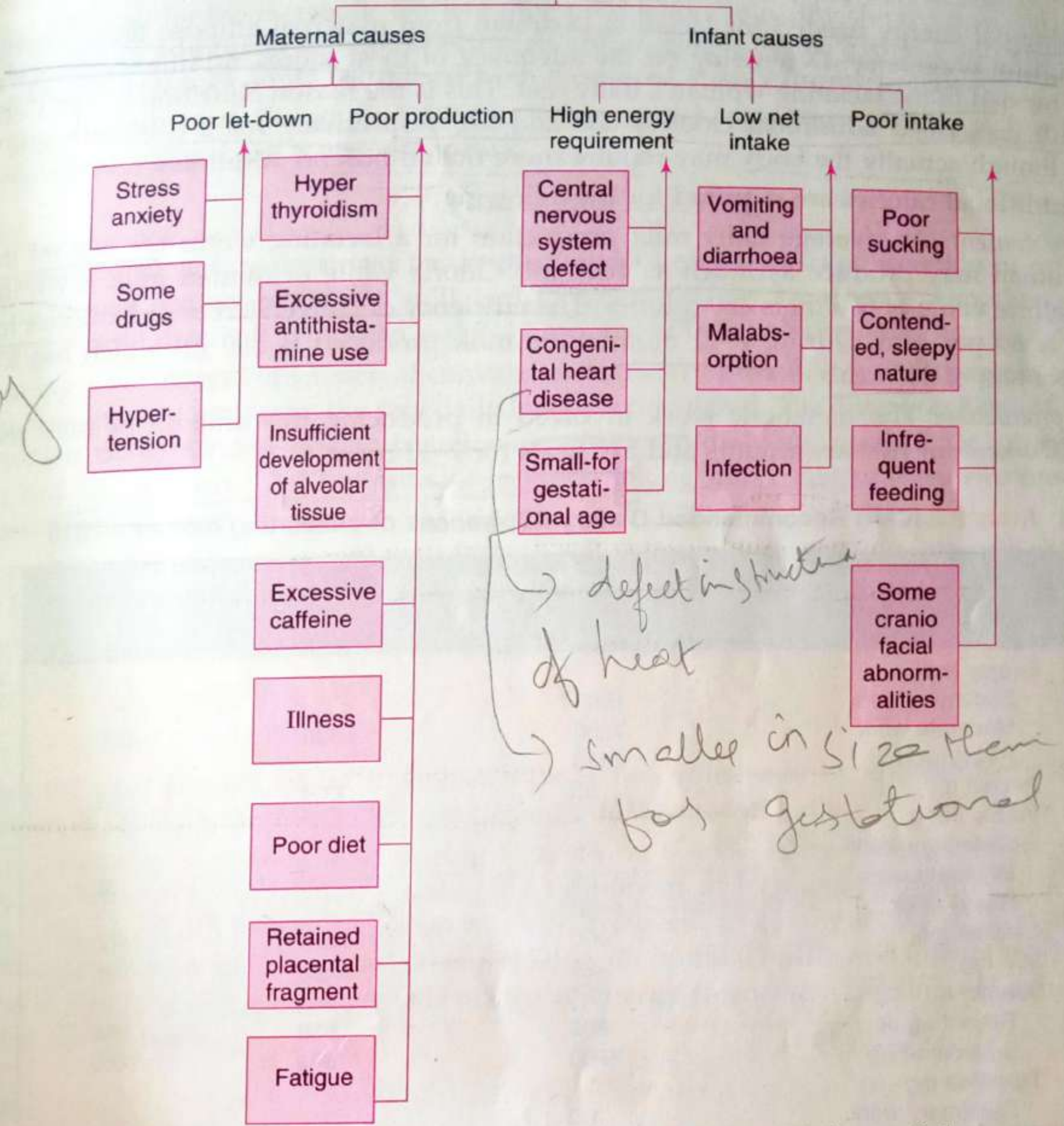


Fig. 8.2 Diagnostic flow chart for failure to thrive while breast fed

Source: (Modified) Mahan Kathleen K and Sylvia Escott-Stump (edited), 2000, Krause's Food, Nutrition and Diet therapy, W.B. Saunders Company, Philadelphia

NUTRITIONAL REQUIREMENTS

Lactating mother's nutritional requirements should meet **(1)** her own daily needs **(2)** provide enough nutrients in milk for the growing infant and **(3)** furnish the energy for the mechanics of milk production. Diet of lactating mother and her nutritional status during pregnancy affect to a certain extent quality and quantity of breast milk. RDA of a lactating mother is given in Table 8.2.

Nutritional needs exceed during lactation compared to pregnancy. In six months a normally developing infant doubles the birth weight equivalent of which is accumulated in 9 months of pregnancy.

Hence the lactating mother during 0–6 months require 680 kcals for the energy content of milk and 570 kcals for the metabolic work of milk production. In reality she requires 680 + 570 = 1250 kcals. But an additional amount of 600 kcals are suggested by the Expert Committee, 2010, as the rest of the calories are to be utilised from the stored energy during pregnancy.

Additional energy may be required if the lactating mother is teenager, feeding more than one child, underweight, or if she is also pregnant.

Protein

During lactation, protein requirement has been computed on the basis of secretion of protein in milk. The protein content of human milk is 1.15 g/100 ml. On an average a mother secretes 680 ml and 580 ml during 0–6 months and 7–12 months of lactation period.

Assuming a 70 per cent efficiency of conversion of dietary protein into milk protein and a 25 per cent of individual variation, the safe daily intake is calculated. The Nutrition Expert Committee (2010) has recommended, during lactation an additional daily intake of 22.9 g for the first 6 months and 15.2 g during 7–12 months of lactation taking into consideration a balanced diet with dietary protein is of PE ratio 12–13 per cent.

If energy or protein is lacking, there will be a reduction in milk volume rather than in milk quality. At very low protein intakes the proportion of casein may be reduced. The availability of more protein or more energy will not enhance the amount of protein in the milk nor increase the volume of milk.

Fat

Although the total amount of fat in breast milk is not influenced by the mother's diet, the composition of the milk fat reflects the composition of the mother's diet.

The requirements of linoleic acid during lactation is 6 en%. After taking into account the contribution from invisible fat, the visible fat requirement of lactating women is 10% E. This supplies a high level of EFA needed. This would correspond to a daily intake of 30 g of visible fat. Lactating mother should consume 200 mg/d DHA for optimal health and infant development. The level of fat in the diet would provide adequate energy to enable a nursing woman to meet her higher energy needs.

Calcium

Breast feeding is associated with transfer of approximately 200 mg/day of calcium from mother to the infant. Studies have demonstrated that the increased calcium demand leads to mobilisation of this important mineral from the mother's skeleton, leading to transient reduction in Bone Mineral Density (BMD) of lumbar spine and femoral neck regions (4–7 per cent) during 3–6 months of lactation.

Inspite of low intake and prolonged drain of calcium through breast milk, LS-BMD (Lumbar Spine-Bone Mineral Density) continued to rise in better nourished mothers. It is possible that conservation of calcium occurred through either increased absorption or reduced excretion or both. But these compensatory mechanisms could offset the breast milk calcium loss only in mothers with better nutritional status.

Inspite of low calcium intake, the negative effect of lactation may be spontaneously compensated provided the mothers have better body weights and BMIs.

The increased amount of calcium that is required during gestation for mineralisation of the foetal skeleton is now diverted into the mother's milk production. Both during pregnancy and lactation 1200 mg has been prescribed by ICMR. The retention of dietary calcium in lactating women is about 30 per cent, hence an extra amount of 600 mg is prescribed. About one litre of milk or milk products should be given to lactating mother to meet 1200 mg of calcium.

Iron

The iron requirement during lactation is 25 mg/day. The baby is born with a relatively larger reserve of iron since milk is not a good source of iron. A good allowance of iron in the mother's diet during lactation does not convey additional iron to the infant. Iron requirement during lactation is the sum of the requirement of the mother and that required to make up the iron lost in breast milk. Since there is amenorrhoea during lactation the basal requirement will be same as in adult woman 14 μg/kg.

Milk levels of selemium and iodine may be low if maternal intake is very low.

Vitamin A

The quantity of retinol present in 680 ml of human milk is 50 μg, so the ICMR recommends an additional allowance of 350 μg of retinol. This can be achieved by including liver, fish liver oils, egg yolk, milk and green leafy vegetables in the diet.

B Vitamins

As calorie and protein requirements are increased during lactation, B vitamin requirements are also increased. Additional B vitamins are required for the amounts that are present in human milk.

Thiamine: The thiamine in breast milk secreted by Indian poor women is below 15 μg per 100 ml. The maximum concentration of thiamine in milk can be achieved by supplementing 20 μg /100 ml. At this concentration with an output of 700 ml of milk 0.14 mg of thiamine would be lost by the mother. Thiamine content of mother's milk depends on mother's diet. Dietary allowances for thiamine for lactating mothers is 0.5 mg/1000 kcal and their daily requirement is computed on the basis of their energy allowance. The additional allowance recommended by ICMR (2010) on the basis of additional calorie allowance is 0.3 mg for 0–6 months lactation and 0.2 mg for 7–12 months.

Riboflavin: The riboflavin content of breast milk of low income Indian mothers is less than 30 μg per 100 ml. With supplements, the concentration can be raised to 30 μg per 100 ml. The amount of riboflavin lost through milk is 0.23 mg per day. Additional allowance of riboflavin corresponding to the increased energy allowance would be 0.3 mg. RDA for riboflavin during lactation is computed on the basis of 0.6 mg per 1000 kcal. If the diet meets the requirement of protein and calcium the requirement of riboflavin would be definitely met. Milk is not only a good source of calcium but also a good source of riboflavin.

Niacin: The nicotinic acid content of breast milk of Indian women ranges between 100 and 150 μg per 100 ml. The amount lost in milk is between 0.9 and 1.2 mg per day. The dietary allowances for niacin is 6.6 mg niacin equivalents per 1000 kcals.

Folic acid: The folic acid content of breast milk secreted by Indian women is 1.6 μg per 100 ml. At the higher level, the amount of folate lost by the mother would be about 25 μg a day. An additional allowance of 100 μg of folate should be provided during lactation.

Vitamin B_{12}: The amount of vitamin B_{12} secreted in milk per day is 0.25–0.3 μg. An additional intake of 0.5 μg per day would cover the needs during lactation. Vegan nursing mother should take supplements.

Vitamin C

The normal adult woman RDA for vitamin C is 40 mg. The additional needs during lactation are calculated on the basis of the vitamin C secreted in milk. Assuming a daily milk secretion of 700 ml milk with an ascorbic acid content of 3 mg/100 ml by well nourished women, the additional requirement during lactation is 20 mg. Taking into consideration of the cooking losses (50%) the Expert Committee (2010) recommends an additional intake of 40 mg per day during lactation. Hence lactating mother requires 80 mg of vitamin C per day.

Fluid

An increased intake of fluids is necessary for adequate milk production, since milk is a fluid tissue. Water and beverages such as juices, soups, butter milk, and milk all add to the fluid necessary to produce milk. A lactating mother should take 2–3 litres of fluid per day.

Nutritional Risk

The lactating woman is likely to be at nutritional risk if

- she is under 17 years of age.
- she is economically deprived.
- her usual diet is nutritionally restrictive or includes unsound nutrition practices.
- she is on a modified diet for chronic systemic disease.
- her weight is less than 85 per cent of ideal weight.
- she has multiple gestation.
- she has had poor weight gain during pregnancy.
- she has had rapid weight loss while breast feeding.
- she is pregnant while breast feeding.
- she has a history of an eating disorder.