Review: Insights into Pediatric Nutrition
Insights into Pediatric nutrition

CONTENTS

1. Insights into Pediatric nutrition ................................................................. 4
2. Issues of malnutrition in children .............................................................. 25
Insights into Pediatric nutrition

Dr. Y. K. Amdekar
MD, DCH
Consultant Pediatrician
Jaslok and Breach Candy Hospital, Mumbai
Insights into Pediatric nutrition

Nutrition is the process by which the organism assimilates food and uses it for growth, nutrient being a source material that nourishes the body. While adults need nutrition for maintenance of previously achieved growth and body functions, children require extra nutrition for continuing growth and maturation of body functions. Nutritional impairment during childhood has short and long term implications and more so during fast growth period such as fetal and neonatal period, infancy and adolescence. Thus pediatric nutrition in general and neonatal and infant nutrition in particular assume special importance.

Genetic endowment interacts with early life nutritional experiences that set the limit of metabolic capacity. When demand exceeds the capacity, functional limitation is exposed, resulting in disease. Any adverse effects during early life affect metabolic capacity and this is referred to as “programming” as put up by Barker hypothesis. Early life nutrition has the potential to change chromatin structure, to alter gene expression and to modulate health throughout the life course. Whether later interventions can reverse adverse epigenetic markings remains to be discovered. Hence there is relevance of fetal and early neonatal nutrition through infancy and subsequent childhood.

History of nutrition

Humans have evolved as omnivorous hunter-gatherers over the past 250,000 years. The diet of early modern humans varied significantly depending on location and climate. The diet in the tropics tended to be based more heavily on plant foods, while the diet at higher latitudes tended more towards animal products. Cannibalism was also prevalent in pre-historic humans. Agriculture developed about 10,000 years ago in multiple locations throughout the world, providing grains such as wheat, rice and maize, with staples such as bread and pasta. Farming also provided milk and dairy products, and sharply increased the availability of meats and the diversity of vegetables. The importance of food purity was recognized when bulk storage led to infestation and contamination risk. Cooking developed in response to demands for purity and became a ritualistic activity.

From antiquity to 1900

The first recorded nutritional experiment is found in the Bible’s Book of Daniel. Daniel and his friends were captured by the king of Babylon during an invasion of Israel. Selected as court servants, they were to share in the king’s fine foods and wine. But they objected, preferring vegetables (pulses) and water in accordance with their Jewish dietary restrictions. The king’s chief steward reluctantly agreed to a trial. Daniel and his friends received their diet for 10 days and were then compared to the king’s men. Appearing healthier, they were allowed to continue with their diet.

In around 475 BC, Anaxagoras stated that food is absorbed by the human body and therefore contained “homeomerics” (generative components), thereby deducing the existence of nutrients. Around 400 BC, Hippocrates said, “Let food be your medicine and medicine be your food.”

In the 1500s, scientist and artist Leonardo da Vinci compared metabolism to a burning candle. In
1747, Dr. James Lind, a physician in the British navy, performed the first scientific nutrition experiment, discovering that lime juice saved sailors who had been at sea for years from scurvy, a deadly and painful bleeding disorder. The discovery was ignored for forty years, after which British sailors became known as “limeys.” The essential vitamin C within lime juice would not be identified by scientists until the 1930s.

Around 1770, Antoine Lavoisier, the “Father of Nutrition and Chemistry” discovered the details of metabolism, demonstrating that the oxidation of food is the source of body heat. In 1790, George Fordyce recognized calcium as necessary for fowl survival. In the early 1800s, the elements carbon, nitrogen, hydrogen and oxygen were recognized as the primary components of food, and methods to measure their proportions were developed.

In 1816, François Magendie discovered that dogs fed only carbohydrates and fat lost their body protein and died in a few weeks, but dogs also fed protein survived, identifying protein as an essential dietary component. In 1840, Justus Liebig discovered the chemical makeup of carbohydrates (sugars), fats (fatty acids) and proteins (amino acids.) In the 1860s, Claude Bernard discovered that body fat can be synthesized from carbohydrate and protein, showing that the energy in blood glucose can be stored as fat or as glycogen.

In the early 1880s, Kanehiro Takaki observed that Japanese sailors (whose diets consisted almost entirely of white rice) developed beriberi (or endemic neuritis, a disease causing heart problems and paralysis) but British sailors and Japanese naval officers did not. Adding various types of vegetables and meats to the diets of Japanese sailors prevented the disease.

In 1896, Baumann observed iodine in thyroid glands. In 1897, Christiaan Eijkman worked with natives of Java, who also suffered from beriberi. Eijkman observed that chickens fed the native diet of white rice developed the symptoms of beriberi, but remained healthy when fed unprocessed brown rice with the outer bran intact. Eijkman cured the natives by feeding them brown rice, discovering that food can cure disease. Over two decades later, nutritionists learned that the outer rice bran contains vitamin B$_1$, also known as thiamine.

**From 1900 to the present**

In the early 1900s, Carl Von Voit and Max Rubner independently measured caloric energy expenditure in different species of animals, applying principles of physics in nutrition. In 1906, Wilcock and Hopkins showed that the amino acid tryptophan was necessary for the survival of rats. He fed them a special mixture of food containing all the nutrients he believed were essential for survival, but the rats died. A second group of rats to which he also fed milk containing vitamins survived. Gowland Hopkins recognized “accessory food factors” other than calories, protein and minerals, as organic materials essential to health but which the body cannot synthesize. In 1907, Stephen M. Babcock and Edwin B. Hart conducted the single-grain experiment. This experiment runs through 1911.

In 1912, Casimir Funk coined the term vitamin, a vital factor in the diet, from the words “vital” and “amine,” because these unknown substances preventing scurvy, beriberi, and pellagra, were thought then to be derived from ammonia. The vitamins were studied in the first half of the twentieth
In 1913, Elmer McCollum discovered the first vitamins, fat soluble vitamin A, and water soluble vitamin B (in 1915; now known to be a complex of several water-soluble vitamins) and named vitamin C as the then-unknown substance preventing scurvy. Lafayette Mendel and Thomas Osborne also performed pioneering work on vitamin A and B. In 1919, Sir Edward Mellanby incorrectly identified rickets as a vitamin A deficiency, because he could cure it in dogs with cod liver oil. In 1922, McCollum destroyed the vitamin A in cod liver oil but found it still cured rickets, naming it vitamin D. Also in 1922, H.M. Evans and L.S. Bishop discovered vitamin E as essential for rat pregnancy, originally calling it “food factor X” until 1925.

In 1925, Hart discovered that trace amounts of copper are necessary for iron absorption. In 1927, Adolf Otto Reinhold Windaus synthesized vitamin D, for which he won the Nobel Prize in Chemistry in 1928. In 1928, Albert Szent-Györgyi isolated ascorbic acid, and in 1932 proved that it is vitamin C by preventing scurvy. In 1935 he synthesized it, and in 1937 he won a Nobel Prize for his efforts. Szent-Györgyi concurrently elucidated much of the citric acid cycle.

In the 1930s, William Cumming Rose identified essential amino acids, necessary protein components which the body cannot synthesize. In 1935, Underwood and Marston independently discovered the necessity of cobalt. In 1936, Eugene Floyd Dubois showed that work and school performance are related to caloric intake. In 1938, Erhard Fernholz discovered the chemical structure of vitamin E. It was synthesised by Paul Karrer.

In 1940, rationing in the United Kingdom during and after World War II took place according to nutritional principles drawn up by Elsie Widdowson and others. In 1941, the first Recommended Dietary Allowances (RDAs) were established by the National Research Council. In 1992, The U.S. Department of Agriculture introduced the Food Guide Pyramid. In 2002, a Natural Justice study showed a relation between nutrition and violent behavior.

Thus history of nutrition can be summarised as era of nutritional discoveries in first half of 20th century and translation of information to health and disease in second half of 20th century.

**Back to basics in nutrition**

Nutrition consists of macronutrients (carbohydrates, proteins, fats, fiber and water) and micronutrients (vitamins and minerals). When one considers essential macronutrients, quantity is not the only concern. These three classes of macronutrients are complex groups, each of which contains a variety of components. You can eat the same quantity of protein, carbohydrate and fat, but deliver very different nutritive components to your body depending on the sources of these molecules. Therefore, it *is not just quantity, but quality that matters.*

**Relook at carbohydrates**

Carbohydrates are digestible and indigestible. Digestible include lactose, sucrose and vegetable starch. Indigestible include dietary fibers found in cereals, vegetables and fruits and complex oligosaccharides found in human milk. Indigestible carbohydrates reach the colon and undergo bacterial fermentation to form partially absorbed gases and short chain fatty acids, which are
absorbed from colon. These indigestible carbohydrates act as prebiotics (they alter composition of microflora in the colon in a beneficial way and help in maintaining intestinal integrity).

Monosaccharides are important energy source but must be consumed with adequate oligosaccharides and polysaccharides. Consumption of monosaccharides - simple sugars - alone leads to sudden increase in blood sugar followed by a sharp fall (as with soft drinks) The result could be a sudden jolt of energy quickly followed by feeling tired, shaky and run-down. This type of fluctuation in blood sugar can lead to dysregulation resulting in hypoglycemia and diabetes mellitus. Processed foods often have high amounts of monosaccharides such as fructose and glucose to promote sweet taste but are not good for health. High fructose intake as in fruits and intake of processed refined sugar leads to lipogenesis in the liver resulting in increased plasma triglycerides, insulin resistance and obesity.

Complex carbohydrates such as oligosaccharides and polysaccharides take a longer time to digest and thus help maintain long-term energy production. Starch provides extended or sustained energy (corn, potato).

Dietary fibers are also polysaccharides and are, therefore, considered complex carbohydrates; however, the sugar units in fiber are linked (bonded) together in such a way that the body can’t break the bonds and digest them. Thus, fiber transits through small intestine without digestion to colon and helps in excretion of toxins and waste products and relieves constipation thus maintaining intestinal integrity. Fibers that promote healthy digestion and waste excretion are found in vegetables, grains and legumes and are well represented in whole foods. Refined grains provide less fiber and micronutrients. Resistant starch is similar to fiber in the diet and is present in whole grains such as brown rice and whole wheat or barley.

Foods that have functions independent of their nutritive value are called “functional” foods. Low glycemic foods such as whole wheat, pasta, parboiled rice, legumes, barley etc. lessen the risk of type 2 diabetes. Fiber also reduces the risk of colonic cancer and constipation.

“Dysfunctional” foods such as sweetened beverages containing fructose lead to obesity due to metabolic effects of fructose, irrespective of its calorie content. Fiber replaces saturated, trans and polysaturated fats.

**Relook at proteins**

Proteins need to be broken down to amino acids. Amino acids are of 20 different versions. Many amino acids are synthesized in the body but those which cannot be produced need to be supplied in diet and are referred to as essential amino acids. Essential amino acids include histidine, isoleucine, leucine, lysine, methionine, phenylalanine, threonine, tryptophan, and valine. Concept of “complete” proteins refers to proteins containing all essential amino acids and has been considered to be present in animal foods. However recent theory suggests that vegetarian food also provides complete protein. Since different plant-based foods provide different essential amino acids, eating a varied diet featuring whole grains, legumes, and vegetable does provide all of these important building blocks to sustain health and promote vitality. In addition, some plant-based foods, such as soy, actually feature an essential amino acid protein profile similar to animal-based foods. In processed
foods, protein is sometimes provided as hydrolyzed proteins, which means it has been chemically cut into smaller chains from two to 200 amino acids, which are called peptides. Some specially produced foods for hospital or healthcare use are made of elemental amino acids; these products provide the free amino acids themselves and require no digestion before absorption.

**Relook at fats**

Fat is an important source of energy besides providing satiety and palatability. Fats are classified as saturated and unsaturated fats. Some fats are good while others are bad. Linoleic and linolenic acid are essential fatty acids that are precursors of long chain polyunsaturated fatty acids such as arachidonic and docosahexaenoic acid (DHA).

Trans fats are a type of unsaturated fat with trans-isomer fatty acid, typically created in an industrial process called (partial) hydrogenation. Unsaturated fats are the best followed by saturated fats. Transfats must be avoided.

Diet must contain fats in right proportion - 8% of calories from saturated, 10% polyunsaturated and 12% monounsaturated fatty acids.

The saturated fats are straight molecules that form solids at room temperature, such as butter and the fats found in meat. Monounsaturated fats, like olive oil, are liquids at room temperature but form solids in the refrigerator. Polyunsaturated fats, which are found in high amounts in oils from grains and seeds, such as flaxseed oil, are liquid at room temperature and remain liquid even when cooled. Polyunsaturated fat consists of omega 3 and omega 6 fatty acids. Ideal ratio of omega 3 to omega 6 fatty acids is not known but is estimated to be around 1:2. However sources of omega 6 fatty acids are abundant in routine diets and a typical American diet is known to have a ratio of 1:25. In order to achieve near ideal ratio, it is important to decrease amount of omega 6 fatty acids and this can be accomplished by reducing consumption of meats, dairy products and refined foods while increasing consumption of omega 3 rich foods such as salmon fish, flaxseed oil, walnuts and green leafy vegetables.

Proper balance of omega 3 and 6 is important for healthy cell membrane. Omega 6 is proinflammatory while omega 3 is anti-inflammatory. Thus consumption of omega 6 in large quantity may lead to atherosclerosis, arthritis, inflammatory bowel disease and asthma. Coconut oil used traditionally for massage in infants contains saturated fats and may be harmful in the long run.

Minimizing consumption of saturated fats is ideal but minimizing consumption of all fats is not good. Brain consists of approximately 70% fat and definitely needs fats too. Diets low in all types of fats have been associated with increased risk of hormone abnormalities, cardiovascular disease, and decreased brain and immune function. So, the real question is not to indiscriminately avoid all fats, but to know which fats to avoid.

Generally Indian diet lacks in alpha-linoleinic acid (omega 3) while linoleic acid content is usually adequate or at times even more (omega 6). It may be possible to use more than two or three types of oils or using plant sources of omega 3 such as green leafy vegetables or fish. Flaxseed and mustard have high levels of omega 3 fatty acid, followed by pulses, green vegetables and wheat and bajra.
Insights into Pediatric nutrition

Composition of different types of oils

Relook at micronutrients
Micronutrients refer to vitamins and minerals. Micronutrient deficiencies represent largely invisible but often devastating form of malnutrition that is prevalent in children. While the body needs variety of vitamins and minerals, major contribution to several functions comes from vitamin A and D and minerals like iron, zinc and iodine.
Routine foods such as rice, wheat, potato, banana etc do not contain any vitamin A while it is abundant in green leafy vegetables and yellow fruits. Vitamin D was thought to be in plenty due to available sunlight throughout the year. However it is known that melanin – a skin pigment – inhibits synthesis of vitamin D by absorbing 290-310 nanometer wavelength ultraviolet light from sunlight. Poor intake of calcium and diet rich in phytates and oxalates that retard absorption of calcium adds to vitamin D deficiency. Iron deficiency anemia is a late stage as much before iron stores get depleted. Cereals and legumes contain non-heme iron that is poorly absorbed. Zinc is an important mineral, the deficiency of which is linked with growth retardation and impaired immune function. Iodine is not available in specific food though food and water takes in iodine from soil. Presently, iodine fortified salt is the definite source of iodine.

Vegetables and fruits are low in calories and fat and high in micronutrients.

Functional components of vegetables and fruits – garlic and onion are immunomodulators and antibacterial and so also most of yellow fruits and green vegetables reduce risk of cardiovascular diseases and cancer.

There are important nutrient – nutrient interactions. Phytic acid in the diet blocks absorption of iron and zinc. Lead contamination interferes with utilization of iron into red blood cell. Vitamin C enhances absorption of iron from plant sources. Calcium interferes with iron absorption from diet. Adequacy of vitamin A is necessary for better incorporation of iron into red blood cell. Iron and zinc have mutual competition for intestinal absorption. Secretory and absorptive integrity of intestinal tract for micronutrients can be compromised by recurrent diarrhea, parasitic infections and H. pylori. After absorption, other factors may influence ultimate usage of micronutrients.

Due to interdependence of multiple micronutrients, deficiency of one micronutrient leads to another. Thus presence of multiple micronutrients needs to be assured in the diet.

Role of probiotics and prebiotics

Probiotics refer to useful living organisms that maintain intestinal integrity. There is a long history of health claims that lactic acid producing living bacteria are beneficial. Yogurt or curd is a traditional form of consumption of such bacteria. This is referred to as probiotic. Prebiotics refer to substances that promote growth of useful bacteria in the large intestine. Not all members of families of beneficial organisms are equally efficacious and so caution is necessary to select ideal product. Fermented products in routine food such as curds and buttermilk are good sources of probiotics. Food sources of prebiotics include oat meal, whole grains, legumes, onion, greens and fruits.

Role of antioxidants

A free radical is an unpaired electron with independent existence. They are formed indigenously from oxidation of carbohydrates and fats and unused oxygen. They are also exogenously obtained from environmental pollution, drugs, radiation, smoke, sunlight etc. Severely malnourished children are several times more at risk of developing antioxidant deficiency and hence are likely to suffer from free radical injury. They need to be neutralized by natural antioxidants from diet. Many vitamins such as vitamin A, C, E and trace elements like zinc, copper, selenium and manganese are
antioxidants. Imbalance between oxidants and antioxidants produce diseases like necrotizing enterocolitis and bronchopulmonary dysplasia.

Phytochemicals are compounds that are often present in edible plants – especially in colorful fruits and vegetables. They protect from variety of cardiovascular or ocular degenerative diseases.

It is not just the amount of nutrients present in food that is finally bioavailable to the host. Processed foods lose some of the nutritious elements and hence are inferior nutritionally. Whole grains contain entire kernel consisting of both outer and inner core of the grain while white processed flour such as white bread is devoid of the outer layer that contains much more nutritious elements. Sources of whole grain in diet include whole wheat, brown rice, oats. Consumption of polished rice leads to Beri-beri, heating milk (pasteurisation) results in loss of vitamin C.

Foods that have functions independent of their nutritive value are called “functional” foods. Low glycemic foods such as whole wheat, pasta, parboiled rice, legumes, barley etc lessen the risk of type 2 diabetes. Fiber also reduces the risk of colonic cancer and constipation.

“Dysfunctional” foods such as sweetened beverages containing fructose lead to obesity due to metabolic effects of fructose, irrespective of its calorie content. Fiber replaces saturated, trans and polyunsaturated fats.

**What is optimum nutrition?**

Optimum nutrition is one that promotes health. Health refers to achieving full potential in terms of physical growth (body building), activity (energy), intelligence and behavior (brain development), immune competence (protection against infections and immune mediated diseases), promotion of individual organ functions such as intestinal ecosystem and prevention of food related diseases such as obesity and its consequences.

There are standard recommended dietary allowances for different age groups. In general, infants need 100 calories per kg of body weight per day, thus 10 kg weight child needs 1000 calories per day. Thereafter 50 calories are required per kg weight per day between 10 and 20 kg of body weight and only 20 calories per kg weight per day beyond 20 kg body weight. Around 60% calories should be obtained from carbohydrates, 30% from fats and only 8-10% from proteins. Of course during fast growth periods such as infancy and adolescence, slightly higher protein – calorie ratio may be desirable. This is especially true in preterm neonates. Nutritional requirements and their specific problems in different age groups are discussed in subsequent parts of this monograph.
Traditional concepts of nutrition

Traditional Indian wisdom translates perfectly into contemporary modern science.

Ancient Indian system of medicine – Ayurveda – has spelt issues beyond nutritional quantity and quality. Three types of food groups are described - “Sativik” to be consumed in abundance (base of modern food pyramid), “Rajasik” to be consumed in moderation (apex of modern food pyramid), “Tamasik” to be avoided, as they are harmful.

**Food pyramid**

(see annexure)

| Energy giving foods – cereals, oil, potato, sugar |
| Body building foods – milk, nuts, pulses, egg |
| Protective foods – vegetables and fruits |
| Brain stimulating foods – blueberries (jamun), strawberries, spinach (they contain antioxidants) |
| Libido enhancer foods – zinc is “sexy mineral” – saturated fats just the opposite |
| Eye-sight sharpeners – lentin containing vegetables such as spinach, peas, red pepper, celery and sweet corn |
| Fat fighters – sweet potato, green leafy vegetables, fruits, whole grains, beans and legumes, other vegetables |
Meal times have also been given equal importance in ancient nutritional science and each mealtime is designed to offer specific benefit to promote health.

- Bed tea an activator
- Breakfast the energizer
- Midmorning snack the elixir
- Lunch the sustainer
- Midnoon the rejuvenator
- Teatime the supporter
- Dinner the revitaliser
- Bedtime milk the relaxer

Modern science emphasizes importance of breakfast for enhanced nutritional supply to brain at the beginning of the day for better performance, especially for school going children. It is therefore aptly called as energizer in ancient science.

**Nutritional assessment**

Growth is rather crude but a practically useful marker of health and nutritional status throughout childhood. Growth parameters are easy to employ in clinical practice. However individuals vary in their growth pattern depending upon multiple factors such as genetic, constitution, environment besides nutrition. Thus growth parameters may not always evaluate correctly the adequacy of nutrition. For example, breast fed infants have slower growth velocity as compared to formula fed infants but that is beneficial for long-term health.

Growth chart – referred to as “road to health” chart - is the best method of monitoring health and nutrition. While it may not detect individual macronutrient or isolated micronutrient deficiencies, it does indicate overall adequacy of calorie intake. Routinely weight, length or height and head circumference are measured and plotted on standard growth chart. It is the linear tracking of growth parameters that is important than interpretation of a single reading. It is expected that in health, growth curve maintains same centile track and does not deviate a great deal. Head circumference denotes brain growth and has a linear relation with length in the first year of life. Weight for length or height is a better index of growth as it compares two measurements in the same individual and obviates comparison with median or average in the population. This is known as age independent parameter. Mid-arm circumference is another age independent parameter of nutritional assessment. It is constant between one and five years of age. It can be compared with height – a method known as “quackstick” and also with head circumference. Such parameters are useful in screening nutritional status in the community. These parameters are not used in routine clinical practice.

There are other parameters that may be used to monitor growth but are not routinely employed and they include triceps skin fold, BMI (body mass index) and WHR (waist-hip ratio). Some of
these parameters assess body composition in terms of fat content that may not be correctly reflected by mere weight and height. For example, a thin looking child may be laden with disproportionately excess fat in the body that may not be apparent on weight chart. This has led to the concept of Indian phenotype being referred to as “thin fat adult”. Such individuals are vulnerable to all the risk factors that are associated with obesity. DEXA scan measures fat composition more precisely but is not required for routine use. Similarly indirect calorimetry measures resting energy expenditure but this is a research tool. Biochemical parameters such as serum albumin may reflect protein status but is also abnormal in liver or kidney diseases.

Finally diet recall and weekly diet charts are at times analyzed for better evaluation of actual nutritional intake but have their own limitations in clinical practice and are hence reserved for specific use by dieticians.

There are different scales of comparison used in clinical practice. Percentiles – it ranks the position of the child in comparison to the rest. Z score refer to units of standard deviation from the median. It is useful in cases where centiles lie outside the limits of 3rd and 97th centiles. Percent standard denotes percent of the median.

**Insights into maternal nutrition**

Life begins at conception and hence pediatric nutrition cannot be separated from fetal nutrition. Fetus derives nutrition from the mother and hence it is important to look into maternal nutrition as a starting point in reviewing pediatric nutrition.

Impact of maternal nutrition on a child’s life was known to ancient medical system. Extra nutrition to a woman during pregnancy and lactation has been emphasized in all the systems of medicine. Modern science has evolved clear concepts of importance of individual nutrients during pregnancy. Observations have been made to substantiate effects of maternal nutrition on fetal well being through natural disasters such as famine and man-made situations such as war. It was during World War II when Hitler announced strict rationing for Dutch population – Holland was then under Germany. Adults were allowed to consume 1500 calories per day. There were pregnant women in different gestation periods and they all were on semi starvation diet. It was observed that those women in the last trimester of pregnancy gave birth to babies with normal weight, as those mothers were otherwise healthy through their early life. But those mothers who were in first trimester of pregnancy suffered under nutrition for 6 months or more, gave birth to babies with low birth weight in spite of being healthy in earlier life. This confirmed the relation of maternal nutrition in pregnancy to neonatal birth weight. Further these babies were followed up till they were pregnant. After war ended, all these babies –both with normal and low birth weight – had better nutrition throughout their childhood. So there was a cohort of women who had normal birth weight and low birth weight but had equal nutritional inputs subsequently. It was observed that all of them delivered babies with normal birth weight. This proved that while maternal nutrition during pregnancy is a determinant of neonatal birth weight, general nutritional status of woman throughout her growing period from early childhood was equally important.

In India, 30% of neonates are born with birth weight less than 2.5 kg. This is largely because of
suboptimum maternal nutrition during pregnancy and also throughout her growing years. Situation in India is thus different than Dutch experiment. Women in India are perpetually undernourished through their childhood and then they give birth to small babies. If these small babies continue to grow on poor nutrition, vicious cycle continues through subsequent generations. Thus nutrition of girl child is far important to ensure normal maternal nutritional status subsequently. However even if the pregnant woman gets extra nutritional supplements of 300 calories during pregnancy, it would improve the birth weight of a neonate by 200-300 g. But to prevent transgenerational continuation of undernutrition, pediatric nutrition is equally important. Besides macronutrient supplementation, folate in particular is relevant to prevent neural tube defects in the fetus. However folate supplements must start before conception. Similar role of vitamin A and zinc has been considered in prevention of fetal defects. Adequacy of vitamin D, calcium and iron in maternal diet has a direct effect on accretion of these micronutrients in fetus.

Insights into neonatal nutrition – normal neonate

Nutrition in the normal neonate is not a big challenge. Having born with adequate nutrition during fetal life, no intervention is necessary beyond natural breast-feeding. It is important to initiate breast-feeding as early as possible after birth, definitely within first half an hour. In fact nature has allowed this neonate to be awake for first half an hour just for the purpose of initiation of breast-feeding. Thereafter neonate sleeps almost for several hours and hence if not initiated within first half an hour, one has lost an opportunity to ensure successful breast-feeding. This is possible even in babies born after cesarean section. It ensures bonding between mother and baby that in turn ensures successful breast-feeding.

Breast-feeding should be on demand and exclusive breast-feeding is continued till first 4-6 months. Early introduction of complementary feeds comes in the way of successful breast-feeding and hence should be implemented only after first 4-6 months depending upon adequacy of breast milk. Adequacy is judged by frequency of urination and golden yellow stools of an infant on exclusive breast-feeding. Mother’s perception of adequacy is based on happiness and satisfaction of the baby and also feeling of heaviness on the breasts before feeding and loosening of breasts after feeding as well as dripping of milk on other side as baby feeds. Objective parameters include normal weight gain. Infants on breast feeds have lower velocity of weight gain that is in fact beneficial to subsequent life. Infants on formula feeds grow fast and appear to be healthier but that may pave the way for obesity in later years. Thus weight gain is not the only parameter to evaluate normality as health is not denoted by mere weight or length gain. Health encompasses happiness and activity as important determinants of growing child as health is defined as physical, mental, emotional and spiritual well being.
Normal neonate on exclusive breast feeds does not need any supplements of water, vitamins or minerals. Cultural practices such as offering honey or sugar water is harmful and should be avoided.

Healthy gut flora preserves and promotes well being and absence of disease. Initial colonization from bacteria and galacto-oligosaccharides in breast milk helps establish healthy gut flora that forms a platform for subsequent formation of useful bacterial colonization. It is only by 1-2 years of age that gut flora matures to an adult level. Till then, proper development and modulation of gut flora depends upon healthy diet. Disturbed microbial flora during this sensitive stage of development is known to result in recurrent gastrointestinal infections, allergy and inflammatory diseases.

Role of whey proteins in infant nutrition

In early stage of breast milk production, ratio of whey protein to casein is 90 to 10 that gradually comes down to 60 to 40 and finally 50 to 50. However it is much better than animal milk that has a ratio of 20 to 80. Biological value of whey proteins is very high. They move quickly from stomach to intestines for better digestion and absorption. This results in passage of intact immunoglobulins and lactoferrin into intestine for better immune function thus resulting in antibacterial and antioxidant activity.

Plasma amino acid profile is different in breast milk fed babies than animal milk fed or even whey protein containing infant milk formulae. Taurine is an essential amino acid that needs to be supplemented in formula feeds. Tryptophan is an important neurotransmitter for better brain function and ensures good sleep pattern in a baby. It is not possible to match complexities and appropriateness of breast milk composition. Whey protein formulae have minimized the gap though antibodies in breast milk cannot be imitated.

Insights into neonatal nutrition – preterm neonate

Gastrointestinal development for nutrition, digestion and absorption takes place by 24th week of gestation as macronutrients can be absorbed in a premature baby though there exists rate-limiting absorption. While digestion and absorption may be reasonably mature by 24th week of gestation, motility is not mature and so it comes in the way of adequacy of feeding. Macronutrients are well absorbed except starch and fats – that matures by 32nd week of gestational age. Thus thereafter feeding a preterm baby is not a problem but prior to that it is.

With increasing survival of preterm infants, nutrition has assumed great importance. At the same time, it is highly debatable. There is no consensus on what should be the ideal postnatal growth of a preterm baby. Recommendations are designed to provide nutritional retention to achieve same
growth pattern as compared to intrauterine growth. It is not clear whether one should attempt to match postnatal growth to an expected prenatal growth. Even then the aim is to support life and achieve growth potential.

Infants born prior to 36 weeks of gestation need nutrient-enriched strategy that refers to higher protein (1.9 gm% v/s 1.4 gm%) and calorie content (22 cal/oz v/s 20 cal/oz) and in addition supplements of calcium, phosphorous, zinc, trace elements and vitamins. Extreme preterm neonate needs much more calories and proteins as well as minerals than late preterm baby born after 34 weeks of gestation. Smaller the gestational age, more are the requirements of nutrients that are difficult to meet. Knowing the composition of breast milk and higher requirements of preterm neonate, it becomes mandatory to supplement breast milk as breast milk alone cannot meet extra demands. It is known that breast milk of preterm baby’s mother is different than full term baby’s mother’s breast milk. Even then, needs are not met with especially in relation to proteins and minerals. Debate exists on requirements of proteins and minerals but it is clear that supplements are necessary.

**Evaluation of nutritional requirements**

During fetal life, growth velocity is particularly high. At 22 weeks, fetus is composed of exclusively lean body mass and protein content accounts for 9% of body weight. At term, lean body mass represents 87% of body weight and 14% of protein content. Fat mass deposition is significantly higher postnatally and so lean body mass is preferred for evaluation of postnatal growth of premature infant rather than weight.
**Recommendation of proteins**

Protein requirement is evaluated in consideration of not weight gain but gain in lean body mass. Increase in protein – energy ratio is mandatory to achieve increase in lean body mass and limit fat mass deposition. Protein requirements of 26-30 weeks postconceptional age may be as high as 3.8 to 4 Gm/kg/day and protein – energy ratio of 12-15%. Nitrogen absorption and utilization is maximum with whey protein. Whey protein casein ratio significantly influences amino acid intake.

There exists cumulative nutritional deficit in preterm infants at the time of discharge to the tune of 50% of reduction of growth and protein is the main determinant of growth velocity of preterm infants. If energy intake is insufficient, proteins are used for energy at the expense of growth. However with increasing energy intake with limited protein intake, excess energy is used for fat deposition.

**Recommendations of calcium and phosphorous**

There occurs dramatic physiological change in bone metabolism at birth due to several factors such as abrupt reduction of mineral supply, stimulation of parathyroid hormone, triggering of remodeling process inducing endosteal bone resorption and reduction in physical density of bone. Such postnatal adaptation modifies mineral requirements of preterm infants.

There is an active transfer of calcium from mother to fetus and there exists high accretion of calcium and phosphorous especially in last trimester of pregnancy. 100-120 mg/kg/day of calcium is transferred to the fetus in last trimester. This cannot be matched in any feeding regime postnatally. A mineral intake between 100 to 160 mg/kg/d of highly absorbable calcium and 60 to 75 mg/kg/d of phosphorus could be recommended.

Recently, for premature formulas, a content of 123 to 185 mg/100 kcal of calcium and 80 to 110 mg/100 kcal of phosphorus has been suggested by the Life Sciences Research Office. Bioavailability of calcium depends upon its solubility and highly soluble calcium glycerophosphate increases retention of calcium. In case of poor absorption of calcium from GI tract, resulting increased fecal excretion of calcium may lead to impaired fat absorption, hard stools and increased intestinal transit time – all risk factors of necrotizing enterocolitis.

**Problems of feeding in preterm neonates**

In spite of knowledge of high-energy requirements of preterm neonate, it is difficult to achieve the same due to many variable factors. Neonates with smaller birth weight and gestational age are often sleepy and have difficulty in feeding due to inability to latch, suck or swallow. They have often temperature instability, respiratory irregularity, delayed gastric emptying time and sluggish bilirubin excretion. They are more vulnerable to infections. They require assistance and support before achieving consistent nutritive breast-feeding. This needs creativity and flexibility. Infant may need multiple feeding methods during transition to oral feeds. It is important to attempt enteral feeds so as to stimulate gut function in respect of motor, vascular, hormonal and mucosal maturation. Early enteral trophic or priming feeds as small as 10-15 ml/kg/ day serves the purpose of further establishing gut function that is so vital.

Rapid increase in enteral feeds in stable preterm should be attempted.
However it is most often not possible to achieve direct breast-feeding. VLBW babies need intravenous fluids to begin with followed by parenteral feeding though attempts must be made to offer oral feeds. LBW babies may be able to feed on breasts directly but if not they need expressed breast milk to be given through spoon or tube feeding as per the need. Sometimes, even if the neonate is able to feed on the breast directly, weight gain may not be achieved due to loss of considerable energy sucking at the breast. In such a situation, the baby is allowed to suck directly on the breast for a short time followed by spoon-feeding of expressed milk. Similarly, the baby who is offered spoon-feeding but does not gain adequate weight in spite of enough nutritional intake may be considered for tube feeding as it saves energy loss due to swallowing. Thus, it is important to evaluate energy spent while feeding that may come in the way of adequate weight gain.

 Tube feeding requires extra care to avoid chance of aspiration. Outer end of the tube should be kept open and before each feed, one must aspirate stomach contents. If there is significant aspirate, aspirated fluid is returned back into the stomach and smaller feed is offered. Close watch is necessary on abdominal distension judging feed tolerance. In case of intolerance, smaller frequent feeds should be tried. Cup feeding has been shown to be more physiological and is recommended as transition from tube to breast feeding. Similarly non-nutritive sucking is recommended.

 Bottle feeding must be avoided as it comes in the way of successful breast-feeding due to nipple confusion. Baby must suck on the areola of the breast while breast-feeding, while the baby sucks at the nipple on bottle-feeding. This leads to nipple confusion and the baby sucks on the nipple while breast-feeding that not only hurts the mother but the baby does not get satisfactory milk flow. This surely results in lactation failure.

Options of nutritional supplementation

It is clear from foregoing discussion that preterm neonates do need supplements both in the form of calories and definitely in the form of micronutrients. 180 ml/kg/day of preterm human milk would supply 120-130 cal/kg/day and 3-3.7 gm/kg/day of protein. This may match recommended intake levels of calories and proteins but fall short of recommended intake of some minerals and most of vitamins. Calcium, Phosphorus, vitamin A fall short by 70-75% and vitamin C and D even by larger margins. However smaller birth weight babies may not be able to consume large volume or breast milk may not be that adequate and so need supplementation of calories and proteins too besides micronutrients.

SGA (small for gestation) and AGA (appropriate for gestation) preterm babies may differ in their requirements and so also different socioeconomic groups in India may have varying requirements of macro and micronutrients.

Multicomponent fortification has been largely accepted as there is enough data to show short term
increase in weight, linear and head growth but long term benefit of neurodevelopment is not clear. Preterm infants who have suffered from some stressful illness need much more calories and proteins for proper growth and it is much more difficult to achieve it. Breast milk of mothers of IUGR babies provides insufficient nutrition especially in developing world and they also need supplements.

Simyl MCT oil may be added to breast milk to fortify calorie requirements as it supplies 8 calories per ml. However, it may lead to abdominal distension and discomfort to the baby. Besides it does not supply all the deficient nutrients. Thus, ideal nutrition may not be guaranteed with such different additions. It is not clear whether extra fat supplementation would have deleterious effects on subsequent life. Same is the concern with coconut oil massage that is so culturally used in India. It contains saturated fatty acids that get absorbed through skin. Other option is to use human milk fortifier. Human Milk Fortifier provides additional proteins and sodium. Two sachets a day may provide enough vitamins but fall short of proteins, sodium and calcium. More number of sachets per day may result in hypervitaminosis. It may be worth considering increasing the amount of proteins and sodium in human milk fortifier once technology further advances. At present, the fortification does supplement the amount of proteins and calories. Besides human milk fortifier needs to be added to expressed breast milk and it may not be suitable for every mother. Suitable infant formula feed may be supplemented in addition to breast milk. There are special formulae available for such supplementation that would ideally offer desired macro and micronutrients. Finally one can choose to use individual supplements in the form of vitamins and minerals. Such multicomponent supplementation may be ideal when calorie and protein requirements are met with breast milk. Calcium, phosphorous and vitamin D can be supplemented through market preparations but large volume of around 10 ml per day is needed that may cause hyperosmolarity due to its sugar content and hence risk of necrotizing enterocolitis. Vitamin E is not necessary. 100 micrograms of Folate is supplied per day and iron must be added in dose of 2-4 mg per kg body weight per day from 6 weeks onwards and must be continued till one year of age and so also multivitamin supplements.

Cochrane database 2007 showed significant reduction of mortality and oxygen requirements at 1 month of age in vitamin A supplemented LBW neonates and also effect on mortality was observed till 6 months of age.

Early development has echoes in rest of our life. Growth in early childhood is the catch-up dilemma. Epigenetics – hidden influence on genes – is a new layer beyond DNA. It is a control system of switches that turns the genes on and off based on influences of nutrition and stress.

In summary, feeding a preterm neonate is a challenge. There exists extra uterine postnatal growth restriction that needs aggressive nutritional rehabilitation. It is known to result in establishing normal physical growth; however it is not clear whether future neurodevelopment would also improve. No simple standard protocol can be followed. The pediatrician needs to be flexible to make suitable changes not only in composition of nutritional intake but also in feeding techniques. Supplements are always necessary in preterm babies to varying extent and different options must be exercised to select the
best that suits the baby. Follow-up of these neonates is most important as nutrition enriched strategies need to be continued even well past neonatal age. Bogota study has shown the need for continued enriched nutritional strategy up to 3-5 years.

**Insights into nutrition in infancy**

Exclusive breast-feeding for first 4-6 months lays solid foundation of health in children. Unless confirmed to be deficient, complementary feeds must not be introduced. Breast milk must be continued as long as possible beyond first year though adequate care must be taken to avoid breast addiction.

Weaning is not an ideal term as it conveys withdrawing breast feeds and introduction of semisolid food. ‘Complementary feeds’ conveys more precisely what is ideal. Complementary food should be home made. Cereals and pulses such as mixture of rice and moong dal is an ideal food to start with. Ragi or Nachni is an excellent cereal that contains iron. Fruit juices and vegetable soups can be added to the diet that would supply micronutrients. Each item is started in small quantity and increased as per the tolerance. It should be offered in a mashed form with a consistency that is suitable to the infant. Quantity and thickness of a feed can be gradually increased. Each new item should be introduced one at a time so as to monitor any food intolerance. By 9 months of age infant is offered finger foods and by one year is able to eat family food without extra spices and oil. Thus by one year of age, the infant is on family food and does not need any special diet. Animal milk is introduced ideally only when breast milk is not available any longer but certainly must be delayed past one year if possible. In general animal food must be avoided in the first year of life so as to minimize risk of development of allergy. As gastrointestinal tract is immature in infancy, it allows animal protein to enter blood circulation exposing it to immune cells that may form allergic reaction to subsequent exposure. This is more relevant in a family with atopic disposition.

Supplements of vitamins and minerals are rarely necessary in normally fed infants. However, for fast growing infants vitamin D and calcium supplements may be necessary. Requirements of iron between 6 – 12 months is higher than at any other age and hence iron supplements are required especially in vegetarian diet that often lacks in adequate iron. Other vitamin and mineral supplements are not necessary routinely and one must decide on individual merits.

**Insights into nutrition in toddlers**

This is the age to inculcate ideal eating habits as toddlers are in general fussy eaters. It is important to realize that velocity of weight gain slows down to 35% of that of first year but velocity of length gain slows down to 50%. This disproportionate velocity results in every toddler looking rather thin
to the mother. Further this is the age where toddler likes to experiment with many new achievements and so generally is not interested in eating. Such a change makes every mother force feed the child. This is one thing that comes in the way of eating and more the mother forces, lesser the child eats and it ends up in a stubborn child who refuses to eat even when hungry. This leads to poor weight gain though child remains active and agile. However there is no loss of weight and activity and stamina continues to be normal. Such a situation needs to be avoided. Parents must expose the child to family food and leave it for him to decide how much to eat.

Because the child would eat according to his needs and one can always monitor the child’s health. To reiterate again, health is not measured by weight gain but activity and energy is the measure of health while growth is better measured by height. Most of such thin toddlers still maintain their weight centiles as well though looking thin and those who go down by few centiles are often due to genetic or constitutional factors and not due to nutritional deficiency. With exposure to play group, toddler is likely to suffer common viral infections repeatedly and that may come in the way of weight gain though it does not disturb health. All such factors make a toddler not gain much weight though height continues to grow and so also health.

Toddler must eat family food and routinely does not need any supplements.

Catch-up growth during first two years of age is due to increase in lean body mass that is so vital in development of organ systems especially the brain while that after 4 years is due to increase in fat mass with its metabolic consequences.

**Insights into nutrition in older children**

This is the age of increasing physical activity and so the child needs good nutrition. Just like toddler age group where eating habits decide nutrition, this group also suffers from similar problems. With exposure and often an access to wrong foods, this child strays away from healthy food. Likes and dislikes take a major brunt and nutrition may suffer. With pressures of schoolwork and physical activities, the child often considers nutrition as a last priority. It also leads to lack of physical exercise that adds to ill health. This is also an age where parents often
do not continue to monitor growth. Around 8-9 years of age, there often occurs a small increase in growth velocity and few children may start showing tendency of overweight. Such children may need more physical exercise to obviate such an outcome.

Family food is all that this child needs though specific deficiencies must be prevented or supplemented accordingly.

**Insights into nutrition in adolescents**

This is the age of growth spurt that needs certainly extra nutrition. This is the last chance to grow and hence more crucial for nutritional support if necessary. Calories and proteins must be consumed in larger amount and so also need for extra micronutrients. Several micronutrient deficiencies may occur in adolescents. Indoor sedentary schedule may predispose to vitamin D deficiency at a time when vitamin D requirements are higher due to rapid growth. Contrary to belief that vitamin D deficiency occurs between 6 months and 3 years, it may not be common in adolescents and adults. It is difficult to diagnose vitamin D deficiency clinically as there are no bony deformities that are peculiar to young children. Only symptom may be vague bony pains that may be misconstrued as many other diseases. Problems at this age are related to psychological and behavioral issues. Adolescent is neither a child nor an adult, neither physically nor emotionally. This results in conflicts with parents regarding not only nutritional but all other issues such as general cooperation and other habits. Several pressures due to higher expectations from parents as to educational performance and behavior take a toll on general nutrition. Either there is poor weight gain or at times it may result in overweight and obesity. Thus, to ensure good nutrition during final growth period, more than change in nutritional strategy what is required is handling the adolescent psychologically.

Adolescence is a critical period for nutritional intervention that has implications on successive generations as depicted below

<table>
<thead>
<tr>
<th>Maternal undernutrition</th>
<th>chronic intrauterine malnutrition</th>
<th>early childhood malnutrition</th>
<th>thrifty phenotype</th>
<th>continued food deprivation leading to chronic undernutrition (or affluence leading to obesity)</th>
<th>Transgenerational cycle of malnutrition</th>
</tr>
</thead>
<tbody>
<tr>
<td>chronic maternal malnutrition</td>
<td>leads to continued maternal undernutrition</td>
<td>in next generation.</td>
<td>Adolescent rapid growth period offers therefore the last opportunity for nutritional intervention to break this vicious cycle.</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**Issues of universal supplementation**

Vitamin A deficiency used to be a common problem in children and one of the causes of blindness. In order to prevent nutritional blindness, universal program was started by the government and as per the program every child between 6 months and 5 years of age received vitamin A supplements every 6 months. Over years it is being realized that prevalence of nutritional blindness has gone down in India and vitamin A being toxic, there has been a debate over continuation of universal
vitamin A supplementation program. Nutrition scientists are of the opinion now that universal vitamin A supplementation is no longer necessary and such supplementation should be considered only on the basis of individual needs.

Iodine deficiency was considered to occur only in the Himalayan belt but subsequent studies in India did confirm its presence in many parts of the country. Iodine is not available through food as no food items contain iodine. It is naturally available through food and water derived from soil and hence indirectly available to humans. Iodine deficiency is known to affect cognitive function and so has serious implications on national productivity and well being. Once this deficiency was proved to be all over the country, decision was taken to produce iodised salt, salt being the commodity consumed by one and all. Thus iodised salt was introduced in India but unfortunately did not gain acceptance due to consumer activist groups who brought political pressure on the government alleging favoritism to iodised salt producers. After withdrawing the ban on non-iodised salt for few years, fortunately this ban has been revoked and now available salt is iodised one and that would take care of iodine deficiency in the community.

Knowing that prevalence of iron deficiency is high in children and women, scientists from National Institute of Nutrition, Hyderabad have been able to double fortify salt with iodine and iron. Pilot project has been already launched and we hope it will be a successful experiment. Iron deficiency is also a public health issue and such a fortified salt may be useful to prevent deleterious effects of iron deficiency.

“Sprinkles”- fortified with iron and other micronutrients – is an inert tasteless powder that can be sprinkled on any food item that the family eats. It ensures adequate intake of micronutrients. Pilot project has been completed in India with success. Micronutrient deficiencies are common but often silent and hence ignored though may have serious implications in life. Hence such fortified products may be a simple solution to complex problem.

When nutrition falters

Earlier nutrition falters in life, more is the damage that may be irreversible. It would affect at worst not only physical growth but also cognitive development. However lesser damage may also be important as quality of life may be affected in terms of productivity. Immune system may suffer that may result in frequent or severe infections. Each organ may demonstrate subtle effects of nutritional deficiencies. Intestinal integrity and functional ability of digestion and absorption may be affected with further deterioration of health. Osteopenia resulting from nutritional deficiency may handicap physical activity. Eyes may take the brunt and vision may be affected. Thus every degree of nutritional faltering does affect health and some of these effects may be permanent throughout life.
Issues of malnutrition in children

Malnutrition refers to both undernutrition as well as overnutrition. Though commonly it is perceived to be undernutrition. This is because of epidemiology of malnutrition in India. However this is changing fast and overnutrition is also catching up in India. So we are already on the brink of dual burden of malnutrition.

Undernutrition starts in fetal life as 30% of neonates are born with weight less than 2.5 kg. This is compounded by lactation failure for variety of reasons and further aggravated by delayed complementary feeding. Thus undernutrition sets in Indian children very early in life and hence continues to have its repercussion on subsequent life.

Definition of malnutrition is not universally accepted, as malnutrition is a complex process that results due to lack of different nutrients and of varying degree. Common type of malnutrition in children is PEM – protein energy malnutrition. WHO has defined PEM as a range of pathological conditions arising from coincident lack in varying proportions of proteins and calories occurring frequently in infants and young children and commonly associated with infections.

Malnutrition may develop acutely or it may be due to chronic deficiency. At times, a child suffering from chronic deficiency may worsen acutely and so develops acute on chronic malnutrition. Acute malnutrition is denoted by reduced weight for age referred to as wasting while chronic malnutrition presents as lowered height for age referred to as stunting, in addition to reduced weight for age. Acute on chronic malnutrition is suggested by disproportionate reduction of weight for age as compared to lower height for age. Thus weight for height is reduced with both weight and height in lower centiles. This is referred to as wasting and stunting.

Malnutrition is classified in different ways.

<table>
<thead>
<tr>
<th>IAP classification</th>
</tr>
</thead>
<tbody>
<tr>
<td>Nutritional status</td>
</tr>
<tr>
<td>Normal</td>
</tr>
<tr>
<td>PEM grade 1</td>
</tr>
<tr>
<td>PEM grade 2</td>
</tr>
<tr>
<td>PEM grade 3</td>
</tr>
<tr>
<td>PEM grade 4</td>
</tr>
<tr>
<td>In presence of edema, K is suffixed to PEM grade to denote manifest protein deficiency.</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Welcome classification</th>
</tr>
</thead>
<tbody>
<tr>
<td>Marasmus - &lt; 60% of expected weight for age – no edema</td>
</tr>
<tr>
<td>Marasmic kwashiorkor - &lt; 60% of expected weight for age with edema</td>
</tr>
<tr>
<td>Kwashiorkor – 60-89% of expected weight for age with edema</td>
</tr>
<tr>
<td>Underweight – 60-80% of expected weight for age – no edema</td>
</tr>
</tbody>
</table>
Both these classifications do not take into account height faltering. It would be ideal to consider both weight and height in classifying malnutrition. Similarly most classifications do not evaluate overnutrition. Following classification takes care of both these factors.

<table>
<thead>
<tr>
<th>Obese</th>
<th>Overweight</th>
<th>Normal</th>
<th>Mild</th>
<th>Moderate</th>
<th>Severe</th>
</tr>
</thead>
<tbody>
<tr>
<td>Height for age %</td>
<td>90-95</td>
<td>85-90</td>
<td>&lt; 85</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Weight for height %</td>
<td>&gt;120</td>
<td>110-120</td>
<td>90-110</td>
<td>80-90</td>
<td>70-80</td>
</tr>
<tr>
<td>Body mass index</td>
<td>&gt; 30</td>
<td>&gt;25</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

PEM is a spectrum of nutritional deficiencies mainly addressing calorie and protein deficiency with varying degree of different vitamin and mineral deficiencies. On one extreme of PEM is calorie deficiency that is proportionately contributed by proteins and other major macronutrients. It presents clinically as loss of subcutaneous fat from different parts of the body. Last part of body fat is lost from cheeks and then it is referred to as marasmus. On the other extreme is kwashiorkor – often referred to as sugar baby kwashiorkor in which adequate calorie intake is contributed mainly by carbohydrates at the expense of lack of proteins. Such an infant has normal weight or may also have higher than normal weight due to edema but demonstrates clinical signs of protein deficiency such as edema along with changes in skin, hair and mental status. This kind of PEM is rare in India as many malnourished children lack mainly in calories and it is uncommon to consume enough calories at the cost of
lack of proteins. This may happen due to ignorance rather than lack of food as it is possible only if the child is fed on exclusive carbohydrates such as potato or banana. Most of culturally accepted food in India does contain at least some proteins. Milder deficiency of proteins in diet may result in PEM “K” denoting clinically manifesting protein deficiency as edema.

Thus marasmus and kwashiorkor are two extremes of PEM spectrum. It has large clinical significance as pathogenesis and management of these two conditions differ a great deal. Malnourished children reduce their activity, curtail their growth and bring down their BMR – basal metabolic rate in order to save energy for survival. Adaptation hypothesis was put forward by Dr.Gopalan in 1967 that explains pathogenesis of these two extreme conditions based on biochemical and hormonal adaptation. High levels of catabolic hormones including cortisol cause muscle and fat breakdown. Anabolic hormones such as insulin and insulin-like growth factors maintain near normal anabolism to prevent edema and fatty liver by enabling synthesis of albumin and beta-lipoproteins from the available pool of amino acids. Marasmus is an adapted malnutrition while kwashiorkor is maladapted malnutrition. Maladaptation in kwashiorkor is a risk factor for sudden death due to metabolic disturbances or life threatening infection. This has a relevance to management of PEM.

PEM children have associated micronutrient deficiencies. Amongst them deficiency of iron, zinc and vitamin A and D are more common,

Iron deficiency has been described in ancient medicine. Historically in Ayurveda (1500 BC) Charak Samhita described fatigue and pallor due to bloodlessness and treated with loha bhasma. Greek literature in 1550 – 1700 describes similar symptoms relieved by drinking iron rust in water or wine.

Poor dietary content of iron and fast growth leads to deficiency worsened by blood loss.

Iron deficiency is most common between 6 months to 3 years of age but is also seen through all age groups of children and women. Sources of iron are scarce in most of commonly consumed Indian food and more so in vegetarian diet. Even in non-vegetarian families, consumption of non-vegetarian food is often too little. Subclinical iron deficiency is difficult to diagnose and infants and children may have subtle symptoms such as growth failure, fatigue, irritability, poor cognitive function.

Iron deficiency anemia is a late stage of the disease – much few months before, there is depletion of hepatic and bone marrow iron stores.

Iron deficiency in pregnant mother leads to premature delivery, IUGR, still birth and increased neonatal mortality and to an extent even increased maternal mortality. It also induces irreversible neurotransmitter alterations in fetus with its permanent sequelae.

Cereals and legumes contain non-heme iron that is poorly absorbed (1-5%) as compared to heme iron (20-30%) as in fish and sea food. Absorption is enhanced by vitamin C in fruit juices and green vegetables. Phytates in food and calcium and zinc retard absorption.

Zinc deficiency is common in children from developing countries due to lack of intake of animal foods, high dietary phytate content, inadequate food intake and increased fecal losses during diarrhea.
Zinc has a fundamental role in cellular metabolism, with profound effects on the immune system and the intestinal mucosa. Zinc supplementation has shown significant benefits in prevention and treatment of diarrhea and pneumonia. Routine zinc supplementation given to low birth weight babies for a year has resulted in substantial reduction in mortality. Zinc deficiency may have adverse effects on physical growth and neurodevelopment.

Vitamin A is abundant in green leafy vegetables and yellow fruits like mango and papaya. Routine foods such as rice, wheat, potatoes, banana, sugar etc have no vitamin A. Diarrhea, respiratory infections, Measles and worm infestations diminish its absorption and hamper its utilization. That combined with poor intake makes this deficiency common in India.

**Classification of xerophthalmia**

<table>
<thead>
<tr>
<th>Code</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>X1A</td>
<td>Conjunctival xerosis</td>
</tr>
<tr>
<td>X1B</td>
<td>Bitot's spots</td>
</tr>
<tr>
<td>X2</td>
<td>Corneal xerosis</td>
</tr>
<tr>
<td>X3A</td>
<td>Corneal ulceration / keratomalacia up to &lt; one third of cornea</td>
</tr>
<tr>
<td>X3B</td>
<td>Corneal ulceration / keratomalacia &gt; one third of cornea</td>
</tr>
<tr>
<td>XN</td>
<td>Night blindness</td>
</tr>
<tr>
<td>XF</td>
<td>Xerophthalmia fundus</td>
</tr>
<tr>
<td>XS</td>
<td>Corneal scar</td>
</tr>
</tbody>
</table>

Besides ocular abnormalities, there results an increase in morbidity and mortality due to infections in vitamin A deficient children.

Vitamin A prophylaxis program was launched in India in 1970 – all preschool children are given 20,000 units of vitamin A every 6 months between one and five years of age. 100,000 units are advised along with Measles vaccine to 9 months old infant. This has reduced the prevalence of vitamin A deficiency to a large extent and continuation of the program is debated, more so as vitamin A is toxic, if given to normal children.

Quite to the contrary belief that vitamin D is plentiful and easily available to children in India, vitamin D deficiency is seen not only in infants and young children but also in adolescents and even adults. Healthy children from middle and upper socioeconomic groups are known to harbor vitamin D deficiency as reported in Indian studies. Melanin- skin pigment - has an inhibitory role in dermal synthesis of vitamin D by absorbing 290-310 nanometer wavelength of UV from sunlight. Besides, atmospheric pollution filters UV rays from sunlight and as such many children and adults may not get exposed to sunlight. In addition, diet rich in phytates and oxalates retards absorption of calcium and so also fluoride in water. Besides calcium poor diet is itself common in many vegetarian food habits. Fluoride is a powerful inhibitor of calcium absorption. Maternal vitamin D deficiency leads to fetal abnormality such as LBW, tetany, low bone density, poorly calcified skull bone, enamel hypoplasia, diabetes etc. Like vitamin A, vitamin D is also toxic and high doses of vitamin D are reserved only for those who have proved deficiency. Nephrocalcinosis is known to result due to vitamin D toxicity and may lead to chronic renal failure.
Vitamin B\textsubscript{12} deficiency is often a silent problem. Studies have shown low serum levels of vitamin B\textsubscript{12} and high levels of homocystine in children. Programming for cardiovascular risk in adulthood possibly starts at a very young age through the homocysteine axis.

**Managing PEM**

PEM may be an emergency depending upon type and degree of deficiency. It needs immediate aggressive resuscitation measures. Children with kwashiorkor are at risk of sudden death due to metabolic disturbances such as hypoglycemia, hypokalemia, hypothermia, dehydration and also due to life threatening infections. They may need initially IV fluids with suitable electrolytes, antibiotics and neutral temperature control. Once resuscitation is successful, nutritional rehabilitation starts. They may need as much as 150-200 calories, 3-4 g of proteins and 120-150 ml of fluids per kg per day calculated on the basis of actual body weight. It may not be possible to achieve this volume to begin with and slow increase in volume is necessary to prevent complications that may arise from aggressive nutritional rehabilitation. The Pediatrician has to be flexible in terms of increase in nutritional intake and should be guided by the tolerance of the child. It may take many weeks for complete rehabilitation. In principle, feeds are gradually increased in volume as well as in density of calories as per the need. Multivitamins and minerals must be supplemented as clinical signs of individual deficiency may not be evident but subclinical deficiencies do exist. Special attention should be on minerals like zinc and iron besides other vitamins and minerals, as these deficiencies are not only common but also have immediate implications in terms of immune competence.

Rehabilitation is a long process and needs to be followed up over months. Co morbid problems such as lactase and other enzyme deficiencies need appropriate intervention through modification of diet. Food intolerance demands suitable changes in frequency, composition or consistency of feeds.

Prevention of recurrence is important and monitoring growth and development is vital.

Aggressive nutritional rehabilitation may result in refeeding syndrome – also referred to as nutritional recovery syndrome. In PEM, with breakdown of lean body mass, there is depletion of potassium, magnesium and phosphorus as a result of which, these ions move out of the cell to maintain serum levels within normal limits. During aggressive feeding regime, there is increased uptake of these cellular ions resulting in low serum levels and that may lead to cardiac failure and overloading. This needs to be avoided by gradually increasing feeding regime.

**Dual burden of undernutrition and overnutrition**

Life style diseases are increasing in India and we are on the threshold of epidemic of dual burden of undernutrition and overnutrition with its dire consequences in adulthood. Lack of nutrition during formative stages of life leads to stunting, wasting, lack of immunity resulting in recurrent infections and poor cognitive function with low academic performance. This has an impact on national productivity. This is also the reason why we fall short of strenuous physical performance such as in competitive sports activities. On the other hand, obesity in early childhood is a risk factor for metabolic syndrome with early onset of coronary heart disease, hypertension and type 2 diabetes in young age. Such a situation is mostly irreversible at the time of diagnosis, contributing to national
ill health with its economic implications. Timely intervention during early life is the key to prevent such an outcome.

Overweight and obesity is multifactorial. Genetic predisposition does play a role but it is further aggravated by life style issues. Excess food consumption with imbalanced intake of macronutrients, largely excess of fats and carbohydrates coupled with lack of physical exercise and sedentary life style with “couch-potato” syndrome is a classical recipe for obesity. Most of junk food is unhealthy containing trans fats and saturated fats along with high carbohydrates mainly consisting of monosaccharides. There has always been a debate on “nature versus nurture” and the last word is yet to be spelt. However it is the nurture that one can take care of. Care must start right from pre-conception period and carry on through childhood. It revolves mainly around optimal balanced nutrition and adequate physical exercise. Obese children must be encouraged to eat more vegetables and fruits. They are low in calories and fat and high in micronutrients. Functional components of vegetables and fruits – garlic and onion are immunomodulators and antibacterial and so also most of yellow fruits and green vegetables reduce risk of cardiovascular diseases and cancer.

Obesity besides being a risk factor for insulin resistant type 2 diabetes, hypertension, coronary heart disease and hyperlipidemia, has several co morbid conditions. Obstructive sleep apnoea, poor lung function, osteoarthritis, non-alcoholic fatty liver, gall bladder disease, pseudo-hypogonadism and depression are some of the conditions that may hamper quality of life in obese children.

**Nutrition and infection**

Immunity is innate that is genetically transmitted but further develops competence by repeated exposure to antigens. Immune competence would develop strongly in children with normal nutrition while severely malnourished children may even succumb to serious infections without being able to mount favorable immune response. However children with mild to moderate malnutrition may not succumb but may suffer from repeated infections that would further worsen their nutritional status. Severely malnourished children may not respond to vaccines at all while those with milder degree of malnutrition may respond with lower antibody titers that may not be protective and such a response may wane off within a short time. Specific micronutrient deficiencies are known to enhance the risk of infections and zinc is one of the most important micronutrients associated with immune regulation. Children with subclinical zinc deficiency are more vulnerable to infections that get prolonged with slow recovery. Hence Indian Academy of Pediatrics recommends administration of zinc to every child suffering from diarrhea. Studies showed faster improvement in frequency of stools in children receiving zinc supplements. Vitamin A has been shown to be beneficial in respiratory tract infection though it is debatable and it is not recommended to supplement vitamin A in case of respiratory infections on regular basis. Iron deficiency is also associated with infections; however iron supplement administered to a child with infection is considered to be harmful as bacteria thrive better with iron and it is feared that infection may get worst. In clinical practice, it is not an issue and immune function is more likely to be disturbed by iron deficiency than theoretical possibility of iron promoting bacterial growth causing deterioration.

In general, it is enough to take a note that good nutrition helps develop a strong immune system and poor nutrition increases susceptibility to infection.
Nutrition during illness
During illness, appetite is reduced and it may be of temporary benefit as GI tract is not stressed to work more and in turn there is less stress to liver and kidney. As such in illness, digestibility and absorbability may not be optimum. Thus a sick child should not be forced to eat beyond his ability. However there are hardly any restrictions to be imposed in illness. For example, there is no need to change feeding pattern in a child suffering from diarrhea. Lactose intolerance is a temporary phenomenon and does not call for lactose free diet even when stool sample shows presence of lactose. Similarly, child with acute hepatitis does not need to have any restrictions imposed as during acute illness, child is markedly anorexic and once recovery starts, it is heralded by return of appetite. At such times, the child should be allowed to eat usual family food and undue restrictions often imposed culturally do affect nutritional intake resulting in loss of weight and delayed recovery. So, in general, illness does not warrant change in diet and it should be left to the child to decide his intake. Though understandably, spicy oily food may be avoided. During recovery from illness, the child does need extra nutrition and should be encouraged to eat more as per individual ability. Extra supplements of vitamins and minerals may be ideal especially in children with borderline nutritional status. Oral zinc supplement for 2 weeks is a classical example of such supplementation in case of diarrhea.

Role of parenteral nutrition
Enteral nutrition is always preferred as it is not only natural but also simulates enzymes, gut hormones and vascular and neurogenic integrity to serve better digestion and absorption. Even if oral feeds are not tolerated fully, one may consider several alternatives such as small frequent feeds or modified formula feeds. It is only as a last resort that one considers parenteral nutrition. Because, parenteral nutrition is costly, needs hospitalization and expertise to monitor closely metabolic profile and asepsis. Infections are common with use of intralipids. So partial parenteral nutrition is an alternative wherein one uses carbohydrates and proteins with partial support from oral nutrition. It serves better purpose of maintaining gastrointestinal integrity as well as keeps up nutritional needs for improved outcome. Preterm neonates with very low birth weight may need parenteral nutrition for first few days till they are fit to accept oral feeds. Major abdominal surgery demands temporary parenteral nutrition.

Nutrition challenges in specific diseases
Chronic persistent diarrhea is due to interaction between malnutrition, infection and malabsorption. Weight gain is the final aim in such patients and can be achieved only if nutrients are digested and absorbed. Malabsorption in such situation is multifactorial. Sugars may not be absorbed as lactase and other enzymes are affected in chronic persistent diarrhea. Sugar free diet may be necessary and complex carbohydrates like starch are preferred. Proteins may lead to allergic reaction and so hydrolyzed proteins or hypoallergenic food such as chicken may be considered. Fats are usually well tolerated quite contrary to usual belief and may be used as a source of calories. Multivitamins and mineral supplements are necessary. Once the recovery sets in, gradual introduction of normal diet is attempted.
Celiac disease presents as growth failure with chronic abdominal vague symptoms suggestive of malabsorption. Gluten free diet helps to alleviate symptoms but adequate care must be taken to avoid gluten in any form.

Cholestatic liver disease patients need high calorie diet – 120-150 cal/kg and it may have to be administered by tube feeding. Supplementation of Vitamin A,D,E,K is necessary. There exists reduced absorption of proteins and carbohydrates and adequate attention needs to be paid to such factors.

Cystic fibrosis needs similar approach to feeding as in cholestatic liver disease.

In acute sickness, nutrition is as important as in chronic diseases. However in very sick children, oral feeds may be difficult. In such cases, parenteral nutrition must be considered only after all the alternatives have been tried and failed. It has its own risk of adverse effects. Risk is reduced by meticulous approach and following standard protocols and strict monitoring.

**Fetal origin of adult disease**

There is a link between reduced birth weight and increased risk of coronary heart disease, hypertension, hyperlipidemia and type 2 diabetes. This results from fetal programming based on nutritional stimuli. It is suggested that the fetus makes physiological adaptation in response to environmental changes to prepare itself for postnatal life. This risk is further modified by postnatal growth. Less clear is the fact whether any of these changes can be reversed after birth. Improving maternal nutrition in pregnancy may have mild beneficial effects but it is pre-pregnancy nutritional status of woman that would decide final outcome. This in turn means nutrition of girl child right from birth. This means it would take one full generation for improvement to occur if we embark on the corrective path now.

This led to the second part of hypothesis proposed by Barker and Hales – the idea of “thrifty phenotype”. As an adaptation to under nutrition in fetal life, permanent metabolic and endocrine changes occur which would be beneficial if nutrition remained scarce after birth. If nutrition becomes plentiful, these changes predispose to obesity and impaired glucose tolerance.

It is important to monitor growth of such small birth weight babies who may have an access to better nutrition in later life that may put them in danger of syndrome X. Adequate diet control and physical exercise is necessary and such habits must be inculcated right from early childhood and entire family must follow it. Moderate intensive exercise such as walking for 30-60 minutes in obese inactive individuals does reverse partially or at least prevents further worsening of metabolic syndrome with diet control. Physical exercise is more important than mere diet control and must be regularly followed.

Periodic clinical follow-up for anthropometric measurements and blood pressure record along with biochemical monitoring for impaired glucose tolerance and lipid profile is necessary for such children at risk of development of syndrome X. It may not be possible to avoid occurrence of diseases arising from such a situation as they are already programme in utero but certainly, such events may be delayed by proper management.
Food allergy
Adverse food reaction is an abnormal reaction to ingested food and it may not necessarily be an allergic manifestation, though every reaction to food is often confused as allergy. Such a reaction may be in the form of food intolerance due to contaminated food, pharmacologic property of food such as caffeine in coffee, metabolic defect such as lactase deficiency or food hypersensitivity. Food hypersensitivity may be mediated through different mechanisms – either IgE mediated or non-IgE mediated. Thus food allergy has a wide spectrum of pathogenesis.

Allergy is immune mediated. Type 1 anaphylactic reaction is often immediate and IgE mediated but may be delayed and IgG 4 mediated. Type 2 reaction is IgG mediated as those existing antibodies in blood combine with specific exposed antigen. Manifestations are hematological with either or all of three blood cell series depressed. Type 3 reaction is due to antigen-antibody complex and results in nephritis or leucopenia. Type 4 reaction is the only one that is T cell mediated and may result in malabsorption as in celiac disease. Common food items that result in allergy include animal milk (cow’s milk protein), egg, nuts, fish, soya etc. Some of the allergic manifestations wane over time as happens in case of milk while allergy to fish may never wane.

Food safety
This is an issue that is often ignored in India. There are many food borne diseases prevalent in children in India. Prevention of such diseases is possible through proper hygiene. Children must be offered boiled or steamed food. Raw food eaten without adequate cleaning may result in GI infection. Recurrent GI infections are not uncommon due to faulty hygiene and such episodes contribute to worsening of nutritional state. Repeated GI infections also lead to poor digestion and absorption resulting in nutritional losses. It further aggravates nutritional status and sets in vicious cycle of malnutrition, malabsorption and infection. Thus besides nutritional advice, concept of hygiene must be emphasized for ultimate benefits of consumed diet.

Long term effects of faulty nutrition in childhood
Poor nutrition has a significant effect on cognitive function. This would affect school performance leading to academic degeneration. Education is directly linked to better economic prosperity assuring better nutrition in next generation. Thus economic progress of the country depends upon adequate nutrition in childhood. It is well established that mothers’ education has positive effects on child nutrition in developing countries. Less explored is the effect exerted by the education of other individuals in the family.

Severely malnourished children respond to vaccines suboptimally and hence its protective immunity
may wane off much earlier than expected in normal children. Exposure to an infection after immunity has waned off may risk suffering from disease that may be more serious as happens in varicella and hepatitis A infection. These infections in particular are more serious in adolescents and young adults.

As discussed above, continued poor nutrition throughout childhood ends with stunted adult and often wasted appearance. It in itself leads to reduced productivity and longevity. On the other hand, poor nutrition in early childhood followed by plentiful energy intake may result in syndrome X with its deleterious effect. Thus either way, there would be adverse effects on adult life. Such a population of middle aged unhealthy adults will be detrimental to country’s progress. Besides such a population of women will continue to maintain vicious cycle of transgenerational malnutrition.

Chronic malnutrition delays sexual maturation and affects fertility. Prevalence of infections is increased and recovery from infections is delayed. Hospitalized patients with malnutrition may succumb to serious infections unless they get parenteral nutrition.

**Debatable issues in nutrition**

Nutrition has been linked to variety of diseases but cause and effect relationship is debatable. In fact, diseases without clear etiology are linked with nutrition as one of the possible theories. Iron, zinc and essential fatty acid deficiencies are blamed for attention deficit disorder spectrum, behavior abnormalities and learning disability. However there is no strong evidence in its favor. Most of the experts in this field do not consider diet modification in managing such disorders. Food allergy is presumed to be associated with asthma. However mere avoidance of offending food has rarely proved to be useful in alleviation of asthma. Asthma being a multifactorial problem with inhaled allergens being the main trigger factors, food may play if at all a small part in the causation and therefore in management. In fact, unnecessary restriction of nutritious food does affect nutritional status of the growing child. Some of the food ingredients are thought to have anti-cancer effect and these include commonly used condiments and spices in Indian food. Food has been blamed for acid-peptic disease though again this disorder is multifactorial and in that the role of diet is difficult to isolate.

Vitamin B₆ has been considered to help in calming children.

**Technological advances in nutrition**

Food technology translates science of nutrition into practical application. Preservation of food without losing its nutritive value and making it palatable has been possible. It assures defined amount of nutrition in a hygienic way. This especially helps in managing sick children as balanced nutrition is possible that makes implementation easy. Formula feeds offer significant advantage for
infants and children with specific problems. Classical examples are formula feed for infants with lactose intolerance, or multiple enzyme deficiencies, neonates with inborn errors of metabolism in which specific constituent of milk or food cannot be metabolized properly resulting in toxic effects and children with food allergy where one needs hypoallergenic formula. Advances have been able to deliver breast milk substitutes in the form of special milk formula, closely imitating breast milk. While it must be reiterated that breast feeding must be promoted in every mother and there is no formula that has matched nutrient bioavailability of breast milk, for various genuine reasons, especially in preterm VLBW babies, there arises the need for balanced substitutes. They need to be used judiciously and selectively. Iron and iodine double fortification of salt and “Sprinkles” as discussed above are the results of technological advances.

Biofortification is a biotechnology – genetic technique that increases the content of micronutrients in the plants. One of the greatest benefits of biotechnology is that it allows us to introduce these benefits transparently. Any time we can improve nutritional profile of the foods people eat without having to convince them to change their habits. Thus modern technology will continue to help in nutritional improvement though, as true with all other technological advances, its use must be limited to selective situations. We still depend upon nature’s gift – breast milk and produce from soil tuned into household staple food. Balanced nutrition is the key to success and Indian culture has an inbuilt nutritional wisdom that we need to respect and practice.

**Need for change in nutrition component in medical education and professional medical practice**

Subject of nutrition encompasses all specialties and directly or indirectly influence many diseases. Diseases arise due to faulty nutrition, some other diseases are worsened by nutritional deficiencies while in few others, recovery may be delayed. Morbidity and mortality of all diseases is high in malnourished children. Recurrent infection is a rule in malnourished children that sets a vicious cycle of continued malnutrition and infection. Well nourished children rarely suffer serious infections, further rarely develop complications and recovery from illness is quick that does not compromise nutrition.

Keeping these facts in mind, medical curriculum should have far many hours devoted to science of nutrition. Especially for pediatricians and also for those physicians who look after growing infants and children, science of nutrition becomes a focal point. Nutritional assessment and growth chart should be a part of physical examination of every child visiting a pediatrician for any illness. Unfortunately reality is starkly different. One way to ensure good nutrition is to offer good nutritional advice. It does not cost nor does balanced nutrition cost a lot. It is time we modify medical education that should take care of things that are relevant to our needs and also change professional practice to focus on nutrition in patients.

In summary, nutrition concerns healthy and diseased population alike. Balanced nutrition is necessary to maintain health and physical exercise in addition compliments health. Diseased population needs
nutrition to recover fast and continued nutritional supplements ensure preventing recurrence. Nutrition needs attention right from conception through growing years to achieve total health to last in adult life. Pediatric nutrition exerts direct influence on future adult health and well nourished child ends up into healthy adult. Those who start life with a handicap such as preterm neonates require far more nutritional support for initial period that may stretch for first 2-3 years. This poses a great challenge and the pediatrician has to be creative and flexible in his approach to meet individual nutritional needs. Sick children need more nutrition especially during recovery phase. Present generation of medical professionals are responsible for health of future generation and in turn future of the country. They need to act now because there may not be “tomorrow”.

Common Food Values

<table>
<thead>
<tr>
<th>Per 100 g of Pulses</th>
</tr>
</thead>
<tbody>
<tr>
<td>All of them contain 375–400 calories, 20-25 g protein, 5-10 mg iron and 50-100 mg calcium</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Grains</th>
</tr>
</thead>
<tbody>
<tr>
<td>All of them contain 350 calories and 10 g protein. Oatmeal, barley and whole wheat have fiber while rice flakes have iron</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Milk</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cheese – 350 calories – 25 g of proteins and fats each</td>
</tr>
<tr>
<td>All products are rich in calcium</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Dry fruits</th>
</tr>
</thead>
<tbody>
<tr>
<td>All of them contain 550-600 calories – 20 g protein and 40-50 g fat</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Oils</th>
</tr>
</thead>
<tbody>
<tr>
<td>Monounsaturated – olive, canola, peanut, almonds and cashew</td>
</tr>
<tr>
<td>Polyunsaturated – corn, saffola, soy bean</td>
</tr>
<tr>
<td>Saturated – Butter, palm oil</td>
</tr>
<tr>
<td>Saturated fats are solid at room temperature and also in the refrigerator. Monounsaturated fats are liquids at room temperature but become solid in refrigerator. Polyunsaturated fats are liquid at room temperature as well as in refrigerator.</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Fruits</th>
</tr>
</thead>
<tbody>
<tr>
<td>Fiber – guava, grapes, figs, dates fresh</td>
</tr>
<tr>
<td>Calories – banana, apple and to some extent jack fruit</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Leafy vegetables</th>
</tr>
</thead>
<tbody>
<tr>
<td>Rich in calcium and iron not much fiber</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Root vegetables</th>
</tr>
</thead>
<tbody>
<tr>
<td>Average in calcium and iron</td>
</tr>
</tbody>
</table>
References

6. Quigley E.M. Quera R. Small intestinal bacterial overgrowth: Role of Antibiotics, Prebiotics and Probiotics Gastroenterology 2006;130: (suppl 1) S78-S90
Brief resume

**Dr. Y. K. Amdekar, MD, DCH**

Former Professor of Pediatrics,
Institute of Child Health,
J.J. Group of Hospitals and Grant Medical College,
Mumbai

- Former President of Indian Academy of Pediatrics
- Trustee of Heinz Nutrition Foundation of India
- Member of several committees of IAP
- Author of 3 books and several guest lectures and orations
Dear Doctor,

It has been our endeavour to provide the medical fraternity, the latest thinking on a variety of medical topics, a tradition that we have been following for over 60 years throughout Quarterly Medical Reviews.

This booklet is presented to you by Raptakos Brett, & Co. Ltd.

We would very much like to have your valuable suggestions and comments to make our future issues more meaningful to you.

We will appreciate if you could spend a few minutes to fill in your comments and mail the same to us.

Thanking You,

General Manager (Medical)

---

**FEED BACK Jul. - Sept. 2009**

1. Your comments on this issue of the Q.M.R.

2. Please suggest medical topics for our QMRs which could be printed in future.

3. Any other suggestions / comments.

Name: Dr. ................................................................. M / F
Clinic Address: ..............................................................

City: ............................. State: ..........................Pin: ..........................
Tel: .............................. E-mail: ..........................
Qualifications: ..........................

Please mail this form to: General Manager (Medical)

**RAPTAKOS, BRETT & CO. LTD.**

Dr. Annie Besant Road, Worli,
Mumbai 400 030.