About the author

Professor Chandrani Liyanage
B.Sc. (Foods & Nutrition), M. Sc. (Medical Sciences), Ph.D. (Nutrition), R.Nutr.(UK)

Chandrani Liyanage, Professor in Community Medicine and Head of the Nuclear Medicine Unit of the Faculty of Medicine, University of Ruhuna has been serving as an academic for more than 30 years.

She was educated in Buddhist Ladies College, Colombo, obtained the basic degree (B.Sc. specialized with Foods and Nutrition) with a first class from Baroda University, India in 1975; M.Sc. (Medical Sciences) from University of Peradeniya in 1985 and Ph.D. (Nutrition) from University of Ruhuna in 1993.

Prof. Liyanage has obtained registration as a Clinical Nutritionist from the Nutrition Society of United Kingdom in 2003. She has conducted many research programmes in the field of Nutrition mainly on malnutrition, infant feeding, complementary foods, breast milk quality, micronutrient supplementation and absorption, fortification of food with micronutrients etc. As an experienced nutritionist, academic and a researcher she has been supervising many postgraduate research studies leading to doctoral degrees, in the University of Ruhuna, made over 40 publications in indexed & peer reviewed journals and several of scientifically sound presentations in national and international conferences, symposiums and seminars. She has also participated in national activities for the promotion of better nutrition in the Sri Lankan population.

The extensive experience gained in research and teaching applied & clinical nutrition to medical undergraduates and postgraduates has helped her in compiling this book.

ISBN 978-955-590-094-2

NATIONAL SCIENCE FOUNDATION

National Science Foundation
47/5, Maitland Place
Colombo 07

Tele: 011-2696771-3 Fax: 011-2694754 **Rs.300/=**

Infant and Young Child Nutrition

12

Science Books Series

Science Books Series

Infant and Young Child Nutrition

Chandrani Liyanage

NATIONAL SCIENCE FOUNDATION

National Science Foundation

Science Books Series - 12

Infant and Young Child Nutrition

Publications of the Author:

Radionuclides in Biomedical Sciences - An Introduction, 2004, Foundation Books Pvt. Ltd. New Delhi, ISBN 81-7596-246-1

Science Books Series - 12

Infant and Young Child Nutrition

NATIONAL SCIENCE FOUNDATION

Published by

National Science Foundation
47/5, Maitland Place,
Colombo 07.

ISBN 978 - 955 - 590 - 094 - 2

Publication Coordination:
Upuli Ratnayake

Type Setting & Cover Page:
Shyama Vithanage

Printed by
Printing Unit
National Science Foundation
47/5, Maitland Place
Colombo 07.

Dedication

To my beloved father late Mr K.D.E. Weerasinghe and teacher Emeritus Professor T. W. Wikramanayake.

FOREWORD

Professor Chandrani Liyanage, an experienced University teacher and researcher in nutrition has written this book on infant and young child nutrition. It is a well referenced scientifically accurate book which covers the subject, adequately in both breadth and depth. Chandrani has utilized her personal experience as a nutritionist and nutrition researcher in compiling some aspects, especially the locally appropriate recipes for complementary feeding.

As far as I am aware there are no other books published locally which cover these aspects in depth. This book would be primarily of use to nutrition and health care workers with a professional and scientific background for e.g. medical officers, nurses, dieticians, family health workers, non governmental organizational (NGO) officials involved in community nutrition programs or working in pediatric wards and clinics. It could also serve as a reference book for medical, nursing and other paramedical students as well as other undergraduates in nutrition.

Although it has a lot of technical information, educated parents with a scientific background may find some chapters useful and relevant to them. I congratulate Chandrani for her effort and recommend the book for those mentioned above.

Professor Narada Warnasuriya
Professor of Paediatrics
Vice Chancellor
University of Sri Jayawardenapura

FOREWORD

My experience as a consultant paediatrician and a clinical teacher has convinced me that there is still an unfortunate hiatus in the knowledge on nutition among medical students, medical officers and also paediatric trainees.

The comprehensive book by Chandrani Liyanage covering broad spectrum of the subject on nutritional needs of infant and young child, counter this situation by providing valuable and clear information not only to medical profession and also to all those who are involved in nutritional needs of a young child.

In writing this book Prof. Chandrani Liyanage draws on her extensive experience of research in nutrition.

I welcome this book as a useful reference book to the medical profession and also to those who are involved in nutrition.

Dr P.M.G. Punchihewa
Consultant Paediatrician
Lady Ridgeway Children's Hospital
Colombo.

INTRODUCTION

The first years of life are crucial in laying the foundation for good health. A vital need during this period is the nutrition of the mother and infant. Infancy involves the transition from intrauterine to extrauterine life, and to a state of relative physiological independence. It is a period characterized by rapid growth and relative development and changing needs, as such, their energy and nutrient needs are relatively high for their size. Fulfillment of these needs is a basic requirement for survival and healthy development.

Breast feeding is ideally suited to the physiological and psychological needs of the infant. Breast feeding meets all the needs of the young infant and can continue as an important source of nutrients until the child is about 2 years of age. From ages 4 to 6 months onwards however, depending on the growth of the individual baby, it is necessary to introduce progressively semi-solid and later solid foods, but at the same time continuing breast feeding up to 24 months. Specially prepared complementary foods are needed in increasing quantity and variety until the child can eat the regular family diet, which occurs between 18 to 30 months of age, depending on the nature of the family diet.

Cases of malnutrition are more frequently observed during the transitional (6-24 months) period than in the first 4 to 6 months, largely because families may not be aware of the special needs of the child, or may not know how to prepare complementary foods from available ingredients, or because they are too poor. To keep young children healthy during this period, complementary foods should be nutritious, clean and safe, and fed in adequate amounts. In many cases traditional child feeding patterns, which are reasonably satisfactory, can no longer be followed because of urbanization, new patterns of family structure, higher prices of protective foods, changes in the pattern of women's work, and so on.

The first year of life is characterized by rapid growth and changes in body composition. Most healthy infants double their birth weight in the first six months and triple it in a year. Because of the rapid growth of the infant, the period of complementary feeding and eventual weaning is critical because vulnerability to infection and malnutrition are high. The progression from breast milk to solid food is based not only on the infants nutrient requirements, but also on developmental maturation and environmental influences. The foods given in addition to breast milk are called complementary foods, and the process is called complementary feeding. Information on when to start complementary feeding, what to give, how much and how often are included in this book together with information on breast feeding, feeding the sick child, encouraging young child to eat enough, and how to keep food clean and safe.

CONTENTS

1. BREAST FEEDING

Breastfeeding is the optimal method of feeding infants. Child care practitioners consider breastfeeding to be one of the principal elements in maternal and child health, preserved through long standing campaigns to protect mother-infant well-being, particularly in developing countries.

The composition of breast milk changes dramatically in the postpartum period as secretions evolve from colostrum to mature milk. The stages of lactation correspond roughly to the following times of postpartum: Colostrum (0-5 days), transitional milk (6-14 days), and mature milk (15-30 days). Changes in human milk composition are summarized in Table 1.1. The first 3-4months of lactation appear to be the period of most rapid change in the concentrations of protein, calcium, iron and zinc. After that period concentrations appear to be fairly stable except for calcium and zinc levels, which show a gradual decrease with age. Contents of energy and vitamins A, B6 and D do not change with age.

1. Exclusive breastfeeding

Frequent exclusive breastfeeding is important in the early weeks of lactation in order to stimulate optimal milk production. “On demand” feeding leads to earlier maximal milk production than feeding on a fixed schedule. Introduction of any other foods or fluids, including water, is likely to reduce the infant’s demand for breast milk, and to interfere with the maintenance of lactation, resulting in early termination of breastfeeding. No fluids other than breast milk are required by the young infant. When infants are given solid foods, or even non-milk fluids, the prevalence of diarrhea is much higher due to contamination of the bottles or food.

From a nutritional perspective, it is important to recognize that any other foods will displace at least some quantity of breast milk, especially in the first 6 months of life. Because breast milk is generally higher in most nutrients than other foods available to young infants, nutrient intake will be reduced when other foods are introduced too early.

2. Duration of exclusive breastfed feeding

The WHO and UNICEF recommend exclusive breastfeeding for 6 months, with the introduction of complementary foods thereafter. The AAP (American Association of Pediatricians) has also recommended breast milk as the exclusive nutrient source during the first 6 months, and to delay introduction of solid foods until 4 to 6 months of age.

Exclusive breast-feeding upto 6 months is not a common practice in developed countries. In the developing countries too it appears to be rare and documented evidence and evaluation of breast milk fed infants upto 6 months of exclusively breastfed infants is also lacking. However, infants who were exclusively breastfed for 6 months have not shown deficits in weight or length gain from 3-7months, in either clinical or observational trials from developed or developing countries. Further, exclusive breast feeding through 6 months has been shown to be associated with delayed resumption of menses, in settings with high breastfeeding frequency.

Further, prolonged lactational amenorrhoea represents an additional advantage of continued exclusive breastfeeding, which even without iron supplementation may compromise hematological status of the infant by 6 months of age, where maternal iron status (thus new born iron status) may be sub optional. In addition, prolonged and exclusive breast-feeding has been associated with a reduced risk of sudden infant death syndrome, and of atopic diseases. Some studies even suggest acceleration of neuro-cognitive development and protection against long-term chronic conditions and diseases like obesity, type 1 diabetes mellitus, Crohn's disease and lymphoma with prolonged breastfeeding. Maternal health benefits have also been reported in developed countries, including possible protection against breast cancers among postmenopausal women, ovarian cancer and osteoporosis.

The decision to supplement human milk is influenced by the numerous socioeconomic and cultural factors including medical advice, maternal work demands, family pressures and commercial advertising. Biological factors including infant size, sex, development, interest/desire, growth rate, appetite, physical activity and maternal lactational capacity also determine the need and timing of complementary feeding.

Any benefits of introducing complementary foods between 4 and 6 months of age have not been demonstrated, but with the exception in improved iron status. However, an improvement in iron status can be achieved more effectively by medicinal iron supplementation (drops etc.).

It is important that individual infants must still be managed individually, to ensure that insufficient growth or other adverse outcomes are not ignored, and appropriate interventions are provided. WHO (2000, 2005) states that as a general policy there are no apparent risks in recommending exclusive breast feeding for the first 6 months of life in both developed and developing country settings.

3. Breast milk intakes

Mean breast milk intake of exclusively breastfed infants, brought up under favorable environmental conditions, increases gradually throughout infancy from 699g/day at 1 month to 854g/day at 6 months and to 910g/day at 11 months of age. Milk intakes among partially breastfed infants were seen to be around 675 g/day in the first 6 months and 530g/day in the second 6 months.

In the developing countries, gradual increase from 562g/day at 1 month to 804g/day at 6 months, and then a decrease to 691g/day at 8 months has been observed in exclusively breastfed infants. However, the intakes of partially breastfed infants have been around 600g/day during 4-9 months and decreasing to 500g/day by the age of 12 months.

Table 1.1 Breast milk composition

Months[1]	Energy (kcal/g)	Protein (g/L)	Vit. A (µmol/L)	Vit.D (ng/L)	Vit. B6 (mg/L)	Calcium (mg/L)	Iron (mg/L)	Zinc (mg/L)
1	0.67	11	1.7	645	0.13	266	0.5	2.1
2	0.67	9	1.7	645	0.13	259	0.4	2.0
3	0.67	9	1.7	645	0.13	253	0.4	1.5
4	0.67	8	1.7	645	0.13	247	0.35	1.2
5	0.67	8	1.7	645	0.13	241	0.35	1.0
6	0.67	8	1.7	645	0.13	234	0.3	1.0
7	0.67	8	1.7	645	0.13	228	0.3	0.75
8	0.67	8	1.7	645	0.13	222	0.3	0.75
9	0.67	8	1.7	645	0.13	215	0.3	0.75
10	0.67	8	1.7	645	0.13	209	0.3	0.5
11	0.67	8	1.7	645	0.13	203	0.3	0.5
12	0.67	8	1.7	645	0.13	197	0.3	0.5

[1]Period of lactation

4. Nutrient intake of exclusively breastfed infants

Based on the milk intake of exclusively breastfed infants from developed countries, the nutrient intakes from human milk have been derived (Table 1.2) using human milk composition from well nourished women.

Energy content of breast milk

Fat is the major single source of energy in the diet of infants exclusively fed with breast milk. The high intake of fat and the energy density that it provides to the diet are important in providing the energy needed for rapid growth during early infancy. The fat content in breast milk can vary from 20 to 55g/l. However, the adequate intake (AI) for fat has been recommended as 31g in the first 6months and 30g in the second 6 months of infancy. This AI assumes that the energy requirements of the young infant are being met.

The mean energy content of breast milk ranges from 0.62 to 0.80 kcal/g and, a value of 0.67kcal/g have been used. Adequacy of this level of energy has been evaluated by using the sum of total energy expenditure and energy deposition to support the energy needs of exclusively breastfed infants. It has been found that the energy intake based on mean milk intakes of exclusively breastfed infants appear to meet mean energy requirements during the first 6 months of life. Since infant growth potential drives milk production it is likely that the distribution of energy intake matches the distribution of energy requirements. The WHO expert consultation (2000) confirms that women who wish to breastfeed exclusively can meet their infant's energy needs for 6 months.

Table 1.2 Nutrient intakes (per day) derived from breast milk

Months[1]	Breast milk Intake (g)	Intake corrected for IWL[2] (g)	Energy (kcal)	Protein (g)	Vit. A (µmol)	Vit.D (ng)	Vit. B6 (mg)	Calcium (mg)	Iron (mg)	Zinc (mg)
1	699	734	492	8.1	1.25	473	0.10	195	0.37	1.54
2	731	768	514	6.9	1.3	495	0.10	199	0.31	1.54
3	751	803	538	7.2	1.37	518	0.10	203	0.32	1.20
4	780	819	549	6.6	1.39	528	0.11	202	0.29	1.98
5	796	836	560	6.7	1.42	539	0.11	201	0.29	0.84
6	854	897	601	7.2	1.52	578	0.12	210	0.27	0.90
7	867	910	610	7.3	1.55	587	0.12	208	0.27	0.68
8	815	856	573	6.8	1.45	552	0.11	190	0.26	0.64
9	890	935	626	7.5	1.59	603	0.12	201	0.28	0.70
10	900	945	633	7.6	1.61	610	0.12	198	0.28	0.47
11	910	956	640	7.6	1.62	616	0.12	194	0.29	0.48

[1]Period of lactation [2]Insensible water losses

Protein composition

Dietary proteins provide approximately 8.0% of the exclusively breastfed infant's energy requirements and the essential amino acids necessary for protein synthesis. Thus, the quality and quantity of proteins are both important, and long-term negative effects on growth and neurodevelopment are produced due to protein under nutrition. Protein under nutrition adversely affects immune functions; and the impaired immune response in turn increases their risk of infectious episodes. Because protein may serve as a source of energy, failure to meet energy needs decreases the efficiency of protein utilization for tissue accretion and other metabolic functions.

Protein content of mature breast milk is approximately 8-10g/L, and this concentration changes as lactation progresses. By the second week of postpartum the concentration of protein is approximately 12.7g/L; this value drops to 9g/L by the second month and to 8g/L by the fourth month. Of the total nitrogen content (1700 to 3700mg/L) in breast milk, 18–30% is non-protein nitrogen (NPN), and from this amount about 30% are amino acids, which are thus fully available to the infant.

A high protein source of complementary food during 4-6 months of age has not shown any difference in height or weight gain when compared with exclusive breast feeding up to 6 months. Increments in weight and length between 4-8 months have been shown similar in formulated and breastfed groups of infants. Therefore, it has been shown that human milk meets the protein needs for growth of infants from birth to 6 months.

Vitamin A

The vitamin A content of breast milk depends on maternal vitamin A status. Lower amounts of vitamin A of around 0.60µmol/L have been found in mothers in regions where under nutrition is wide spread, and among those who consume vitamin A rich foods less frequently. The mature milk of well-nourished mothers contain approximately 1.7µmol/L of vitamin A, whereas it has been around 0.6µmol/l in some underprivileged environments. There has been evidence of depleted liver stores and lower serum retinal concentrations in infants where mothers had vitamin A concentrations below 1.4µmol/L in their milk. It has also been shown that there is an improvement in concentration of vitamin A in breast milk after supplementation, in areas where vitamin A deficiency is endemic. In addition to vitamin A, breast milk contains carotene that may contribute to vitamin A transfer to the infant and bile salt-stimulated lipase that facilitates vitamin A and precursor carotinoids. The bioavailability of preformed vitamin A from breast milk is 90 %, and therefore breast fed infants are protected particularly against gastrointestinal infections. In addition, the lower risk of xeropthalmia and mortality observed in breast fed infants compared to their non-breastfed counterparts, argues strongly in favour of continued breast-feeding.

Vitamin B

The content of vitamin B_6 in breast milk varies with maternal B_6 status and intake. In populations at risk of vitamin B_6 deficiency, the milk concentration of B_6 may be sub-optimal, with possible adverse effects on growth and neurological development. Lower concentrations of milk B_6 has been shown to be associated with lower birth weight and altered infant behavior. In addition to B_6 status and intake, length of gestation, stage of lactation and the use of B_6 supplements influence the vitamin B_6 concentration in breast milk.

In exclusively breast fed infants the B_6 status has been found adequate and independent of maternal status during the first 4 months. However, by 6 months, the low B_6 status of mothers was reflected in the B_6 status of their infants. Breast milk alone may not sustain vitamin B_6 requirements beyond 6 months, and any compromised linear growth associated with low B_6 status of exclusively breastfed infants was shown reversible through appropriate complementary feeding.

Folic acid and vit.B_{12} are strongly attached to specific binder proteins which are present in large amounts throughout the lactation. This binding of the vitamins may promote their absorption directly as well as by preventing their uptake by intestinal micro organisms.

Vitamin D

Breast milk contains very low levels of vitamin D, and the concentration depends on maternal vitamin D status. Breastfed infants can maintain normal vitamin D status in the early postnatal period only when their mother's vitamin D status is normal and /or the infants are exposed to adequate amounts of sunlight.

Calcium

Breast milk contains 200–300mg/L of calcium with no pronounced change during lactation. Generally, maternal diet does not appear to influence the concentration of calcium in milk. However, recent studies have shown that poorly nourished women have produced milk with low calcium levels, which did not increase with calcium supplementation. The absorption of calcium from breast milk ranges from 40-70%. Based on the estimated calcium intake of exclusively breastfed infants, the breast milk meets the calcium requirements during the first 6 months of life, if the efficiency of absorption remains at 70%.

Iron

Human milk is a poor source of iron and cannot be altered by maternal iron supplementation. The iron endowment at birth adequately provides for iron needs of the breastfed infants in the first half of infancy. The iron available for growth and development should be adequate until iron stores are exhausted.

The concentration of iron in human milk declines from 0.4–0.3mg/L in colostrums to 0.2–0.4mg/L in mature breast milk. The iron content of milk is homeostaticaly controlled by up and down regulation of transferrin receptors in the mammary gland. Iron intakes from human milk are illustrated in Table 1.2. The bioavailability of iron although was shown to be exceptionally high (50%), recent studies have indicated that the absorption of iron from breast milk is more likely to be lower, about 19-20%, with a median absorption of 14% at 6 months of age, 49% in non-iron supplemented infants and 18% in iron supplemented infants at 9 months of age. In breast milk the low protein and phosphorus contents and the high lactose content favors the bioavailability of iron. However, it has been shown that although iron absorption was enhanced, the iron in breast milk alone would not be sufficient to meet estimated iron requirements at any stage of infancy.

Iron status as assessed by the determination of haemoglobin, RBC (red blood cell), transferrin, serum iron and ferritin of exclusively breastfed infants has been found satisfactory up to 6 months of age in many studies, and up to 9-12 months age in one study. However, it is clear that breastfed infants subsidize their requirements from body iron resources. It appears that breastfed infants who do not receive iron supplements are at risk of becoming iron deficient in the second half of infancy.

Zinc

The concentration of zinc in breast milk declines precipitously from 4-5mg/L in early milk, to 1-2mg/L at 3 months postpartum, and to about 0.75mg/L at 7 months. Maternal dietary zinc has not been shown to affect the zinc content of breast milk, and moreover concentration in breast milk is seen resistant and unaffected by zinc supplementation. Nevertheless, there is evidence that chronically low dietary zinc is associated with lower milk zinc concentrations; both dietary zinc intake and serum zinc concentrations have been shown positively correlated with milk zinc concentrations. At the same time, a severe zinc deficiency has been reported in breastfed term infants receiving milk having lower concentrations of zinc. However, neither low serum zinc levels nor low zinc intakes were associated with poor growth in the infant.

Mean zinc intakes from human milk are summarized in Table 1.2. The intakes are also subjected to inter-individual variation in milk zinc concentrations. Since milk intakes are driven by energy needs and not by zinc requirements, and that milk energy and zinc concentrations are not correlated, milk zinc intakes will not be determined by infant size or growth potential.

5. Benefits of breast feeding

I. *Reduced incidence of infection*

Breast feeding protects against gastrointestinal and respiratory infections and decreases the risk of otitis media. Newborn infants breastfed for a minimum of 13-16 weeks had significantly fewer gastrointestinal and respiratory illnesses and fewer episodes of single and recurrent otitis media during the first year of life when compared to formula fed infants. Thus, exclusive breast feeding seems to have a protective effect. In pre-term babies too breastfeeding reduces the incidence of necrotizing enterocolitis.

II. *Prevention of sudden infant death syndrome (SIDS)*
An association between breastfeeding and protection against SIDS has been suggested in many studies. Although household smoke exposure and infant sleeping position are two important risk factors for SIDS, breastfeeding may also give some protection against SIDS.

III *Prevention of allergies*
Breastfeeding appears to decrease the incidence of atopy in infants with no genetic predisposition to atopy. However, even in infants who are at increased risk because of a positive family history (one or both parents or a sibling with atopy) exclusive breastfeeding for at least 4 months has been shown to have a protective effect. Further, maternal avoidance of specific foods (milk, dairy products, eggs, peanut) during pregnancy and lactation has not been proven to be more effective in reducing the incidence and severity of atopy in those infants. For them exclusive breastfeeding even without maternal food restriction has shown similar protection during the first year of life.

A small number of exclusively breastfed infants may develop allergic responses due to the passive transfer of food allergens from the mother's diet through breast milk. Two protein food antigens, bovine IgG and β-lactoglobulin have been detected in breast milk. If exclusively breastfed infants present with clinical signs of atopy, a trial elimination challenge of suspect foods in the mother's diet is recommended to determine whether or not the infant's reaction is to foods eaten by the mother.

IV. *Enhanced cognitive development*
There is evidence that the cognitive development in populations of children who are breastfed is slightly higher compared to bottle-fed infants from similar environments.

V. *Optimum amino acid composition*

a) Human milk is the only source of animal protein that has a methionine cystine ratio close to or below 1:0. This ratio in cow milk is higher by 7 times. Due to the low cystathionase activity in the liver of neonates especially in the premature infants, conversion of methionine to cystine may be affected. Therefore they may become deficient in cystine.

b) Human milk has low contents of phenylalanine and tyrosine. The ability to metabolize phenylalanine and tyrosine is low in neonatal livers. When premature infants are fed with cow milk, a higher percentage of infants with neonatal tyrosinaemia have been reported. The concentration of these two amino acids is about 3-4 times higher in cow milk. An increased amount of phenylalanine in blood affects the brain development.

VI. *Anti infective properties of human milk*

a) Breast milk contains a range of secretary immunoglobulins (IgA) e.g. antibodies to poliomyelitis. IgA is protective against enteropathic bacteria, notably *E coli* viruses. The antimicrobial factors block the entry of potential pathogens across the gut mucosa and reduce risk of infection.

b) Human milk also promotes the growth of an acid forming bacteria (*Lactobacillus bifidus*) in the intestinal tract creating a hostile environment for some pathogenic bacteria.

VIII. *Absorbable fat content of breast milk*

a) The fat in breast milk is better absorbed and palmitic acid is better utilized. Breast milk has a higher level of phospholipids in all lipid fractions and a higher level of unsaturation of the phospholipids.

b) Breast milk contains optimal ratios of long chain polyunsaturated fatty acids required for brain and retinal development. The presence of higher concentrations of short chain and some unsaturated fatty acids in cow milk accounts for the higher incidence of multiple sclerosis among those fed with cow milk during infancy.

IX. *Higher buffering capacity of breast milk*

a) Breast milk yields a soft, flocculent curd in the stomach which permits efficient stomach emptying, full utilization, and minimal losses, where as cow milk produces large, tough curds although the curd tension can be reduced by homogenization, evaporation, drying and acidification etc.

b) The buffering capacity of breast milk is much less than of cow milk or formula. The average pH of gastric contents is 3.6 in breast fed babies and 5.6 in cow milk fed babies. This is too high to inhibit bacterial growth, and activate peptic digestion.

- Breast feeding is recommended for all infants, with very few exceptions. Exceptions include infants with galactosemia or infants of mothers who are HIV antibody positive or have untreated active tuberculosis.

- Breast feeding provides many positive benefits for maternal and child health, and women who breastfed are less likely to suffer from premenopausal breast cancer or ovarian cancers. In non-industrialized countries, infants who are not breast fed are 14 times more likely to die from diarrhea and 4 times more likely to die from respiratory infections compared to infants who are exclusively breastfed. In industrialized countries, infants who are not breastfed experience more episodes of diarrhea and ear infections and higher levels of chronic disease compared to breastfed infants.
- Breast feeding is also an environmentally sound practice. Breast milk is a naturally renewable resource that requires no packaging or transport and results in no wastage as a mother produces exactly the amount that her infant needs.

- Breastfeeding is believed to be so pre-eminent in human nutrition because of its well recognized nutritional, immunological, social and nuturing benefits (as indicated below). Given these benefits, it is important that breastfeeding should continue to be promoted as the standard of infant feeding.

6. Breastfeeding and growth of infants

Assessing the growth of breastfed infants is an important tool for evaluating the adequacy of lactation. It has been widely remarked by health workers that exclusively or predominantly breastfed infants tend to grow faster in the first few (3) months than the usual curves on NCHS growth charts, and then a decline in growth thereafter. The pattern for length gain is also similar but less marked. Breastfed infants have shown more pronounced declines in weight from 6-12 months, than those who were predominantly bottle-fed. When the weight-for-age curves do not parallel the reference lines of NCHS growth charts, the change in slope may be interpreted as growth faltering. The downward crossing of percentile lines prompts some health care providers to conclude that there is growth faltering after the first few months, even if the infant is healthy and thriving. This may lead to misdiagnosis of the adequacy of breast milk and perhaps inappropriate advice regarding the need for complementary foods or fluids.

It has been suggested that breastfed infants self-regulate their energy intake at a lower level than consumed by the formula fed infants. The reasons for this are unknown, but it is known that the body temperature and minimal observable metabolic rate are lower in breastfed than in formula fed infants. Prospective studies indicate that slower weight gain of breastfed infants is not associated with any deleterious functional outcomes with regard to activity or behavioral development, where as there are substantial health advantages to breastfeeding. On the other hand, breastfed infants “catch-up” to the NCHS reference by 2 years of age despite the decline shown after 6 months. Thus the growth differences evident during the first years of life can be considered transitory, with the possible exception of differences in fatness. However, although true growth faltering can certainly occur among breastfed infants, it is difficult to evaluate using the NCHS growth chart, which is based on a sample of predominantly formula fed infants. This situation has prompted WHO to begin creating a new growth chart based on breastfed infants.

7. Breastfeeding and HIV

Recent reviews on the subject of breastfeeding, have consistently shown that breastfeeding protects against infections and reduces infant mortality. With increasing spread of HIV infection the role of breastfeeding has however, recently drawn more attention. Mother-to-child transmission (MTCT) of HIV, partly through breastfeeding is thought to be an important factor in the increased infant mortality rates observed in some countries. The first evidence of vertical transmission from mother to child was shown in 1985. However, in 1987 and 1992 WHO and UNICEF gave recommendations that all mothers breastfeed whatever their HIV status, in circumstances of inadequate hygiene, and where infectious diseases and malnutrition are prominent. Later in 1996 and 1998 WHO and UNICEF jointly issued a new policy recommending widespread HIV testing during pregnancy and suggesting formula feeding with support and training for those mothers who are HIV positive. A study conducted in 1999 however, revealed that exclusive breastfeeding had the lowest MTCT (14.6%) of HIV, versus 18.8% in exclusively formula feeding. A recent WHO pooled analysis of data from developing countries showed that infants who were not breastfed had a 6-fold greater risk of dying from infectious diseases in the first 2 months of life than those who were breastfed. It concluded that it will be difficult if not impossible to provide safe breast milk substitutes to children from underprivileged populations.

8. Breast feeding and environmental contamination

Environmental conditions however, may also have implications for breast feeding and infants health; some concerns have been raised about the risks to infants from breast milk contaminated by environmental pollution.

Chlorinated contaminants are widespread in the global environment and have been detected in breast milk in villages remote from industrial and agricultural areas. They are stored in fat and slowly metabolized. During lactation maternal body fat is mobilized and any contaminants in the fat are incorporated into breast milk. Chlorinated pesticides (DDT, HCH and HCB), polychlorinated biphenyes (PCB) used in electrical transformers and hydraulic fluids, and dioxins and furans from paper and pulp manufacture are the toxic contaminants found in breast milk. In addition, exposure to radioactivity also may have implications for breast feeding. As breast feeding is the main route for elimination of contaminants from the body, the concentration of contaminants are higher in women breastfeeding for the first time and decline over the course of lactation. As a general rule the breast milk of women in industrialized countries has concentrations of PCBs and dioxins higher than in women of developing countries. Women in developing countries however, have relatively higher concentrations of chlorinated pesticides in their breast milk, if exposed to environmental contamination.

It is important to note that the estimated risks associated with contaminants in breast milk do not overweight the benefits of breastfeeding. The risks of not breast feeding are enormous, particularly in settings where the primary causes of infant and child death are infectious diseases and malnutrition. Further, to date no long-term negative health effects have been found to be associated with exposure to contaminants through breast feeding. Despite the higher exposures received by those children in such environments, an increased cognitive and motor development have been observed associated with breast feeding.

2. NUTRITIONAL NEEDS IN INFANCY AND CHILDHOOD

Nutrient requirements for the first six months of life are derived from the mean intake of breast milk consumed by healthy infants, growing at an optimal rate, exclusively breast-fed by healthy, well-nourished mothers. Energy and protein inadequacy and deficiencies of iron, zinc and vitamin A are the most common nutrient deficiencies observed during infancy, and recommendations on complementary feeding have to be focused on their prevention.

1. Energy needs

The peak of the postnatal growth spurt in the normal infant occurs at between 2nd and 4th weeks, but the infant continues to grow rapidly for some months. The median rate of gain in weight between birth and 4 months of age is over 25g/day. By contrast, between 12 and 18 months of age the median rate of gain in weight is about 8g/day.

Energy needs during the first months of life are mainly determined by the rate of growth and by the composition of the newly synthesized tissue. The synthesis of fat requires much more energy than that of lean tissue. Much of the rapid weight gain during the first 4 months is accounted for by fat; energy expenditures of growth are therefore high and non-growth energy expenditures relatively low; growth accounts for about one-third of the infants' total energy needs during this period.

After 4 months, when weight gain is slower, much less is accounted for by fat. At this age growth requires substantially less energy. The energy content of the newly synthesized tissue is less. However, total energy needs are increased to maintain the larger body size and greater activity of the child. Between 12-18 months of age, only 2-3 % of energy needs are accounted for by growth.

The healthy infant or child is the best judge of its own energy needs. Normally, energy intake should neither be restricted below nor increased beyond the child's inclinations, except perhaps in the case of overweight or undernourished children. Estimated energy requirements for infants published recently by the WHO (2000) are presented below. Energy intakes based on the mean milk intake of exclusively breastfed infants, appeared to meet mean energy requirement during the first 6 months of life.

On an average, a baby of 1-2yr needs 1000kcals daily. This is about half of what the mother eats. This, to many people, may sound incredible but is nevertheless true; and unless health workers are convinced of it, they cannot forcefully and persistently give this message to the community.

Table 2.1: Daily energy requirements of breastfed infants (WHO 2000)

Age (months)	**Energy requirement (Kcal/day)**	
	Boys	**Girls**
1	485	430
2	541	486
3	570	522
4	546	511
5	588	548
6	620	578
7	635	584
8	664	610
9	687	635
10	717	660
11	739	678
12	763	698
12-23	1092	1092

Energy intakes of breast fed infants of affluent populations have been found to be significantly lower than that of formula fed infants. This is not due either to inadequate maternal milk or complementary foods, but their ability to self regulate their energy intake at about 80-90 kcal/kg/day. Despite lower energy intakes of exclusively breast-fed infants, they have similar growth and reduced rates of infections compared with formula fed infants.

2. Proteins and amino acids

Protein needs

Dietary proteins provide, approximately 8% of the exclusively breastfed infant's energy requiremnts and the essential amino acids necessary for protein synthesis. Therefore, an infant receives enough protein when its entire energy intake comes from feeding at the breast (even if it is not a well-fed woman).

In developing countries, protein deficiency rarely occurs as an isolated condition but exists in combination with deficiencies of energy, zinc, and potassium, which complicate the condition.

As in the case of energy, growth accounts for a high proportion of total protein needs in the early months of life. At a specific ratio of protein to energy in the diet, the greater energy consumption by rapidly growing infants will assure greater intakes of protein.

Mature human milk contains approximately 8-10g protein per litre, of which approximately 70% is whey proteins. Protein quantity and quality affect both digestibility and the ability to support growth. The chemical properties of casein in human milk promote the formation of a soft, flocculent curd, which is easier for human infants to digest than the casein in other animal milk.

In addition to casein the other proteins in human milk, e.g., the immunologic factors, secretory Immunoglobulin A (SIgA), lactoferrin, and lysozyme, do not contribute to nutritionally available protein, although these proteins are active in the gastrointestinal tract. Their concentration has been estimated to be 3g/L. Thus, nutritionally available protein may approximate to 7g/L. This would provide the normal infant consuming 180ml/kg in the first months of life with approximately 1.3g protein per kg per day, a figure that agrees with theoretical calculations of protein requirements during early infancy.

Table 2.2: Protein requirements recommended by WHO/UNICEF 1998

Age	Median Wt.	Protein intake	
months	**kg**	**g/kg/day**	**g/day**
0-2	4	2.4	9.6
3-5	7	1.2	8.5
6-8	8.5	1.07	9.1
9-11	9.5	1.01	9.6
12-23	11.0	0.99	10.9

Although the recommended protein requirement during the first 3 months of age is as 2.4g/kg/day, it has been accepted that an average intake of 1.68g/kg/day is adequate for the infant to grow satisfactorily. As such, the protein needs of an infant will be met if the energy needs are met, provided the food is human milk.

The protein value of a particular food is determined partly by it's amino acid composition. Proteins of whole egg and human milk are considered the best, in this respect among food proteins, and the pattern of essential amino acids in these foods is usually taken as a standard for comparison with other foods. In comparison with egg protein, the cereal proteins are poor in lysine, one of the essential amino acids, while pulse proteins are poor in methionine, though they are rich in lysine. A judicious mixture of vegetable proteins can therefore produce a well-balanced result: one can make up the deficiency of the other. Consumption of food of animal origin is becoming generally low and infrequent because of their expense and, therefore the vegetable proteins contribute a major portion of the requirement. Legumes such as beans, peas and grams are a rich source and contain 20-25 per cent of protein. Soya bean contains 40 per cent protein. The content of cereal protein varies from 7% in rice to about 12% in wheat. Oil seeds too are a good source of protein and because of their oil content, are rich in energy as well.

Amino acid needs

Needs for essential amino acids, i.e. those which the body is unable to synthesize either at all or in sufficient quantity, have to be considered as much the same way as the need for protein. Growth needs may have to be distinguished from maintenance needs. Growth needs are related to the rate of synthesis of various tissues and to their amino acid composition. Maintenance needs depend on (1) the rate of turnover of various body

Table 2.3: Estimates of requirements for amino acids by infants and preschool children

Amino acid	* Infants mg/100kj	** Pre-schoolers (2 yrs) mg/kg/day
Histidine	6.2	-
Isoleucine	15.8	31
Leucine	31.6	73
Lysine	24.2	64
Phenylalanine	13.6	69
Methionine	5.7	27
Cystine	3.1	
Threonine	14.1	37
Tryptophan	3.8	12.5
Valine	19.9	38

Sources *Fomon (1978), **Torun & Viteri (1981) tissues, (2) their amino acid composition, and (3) the extent to which various amino acids released at protein degradation can be recycled in to anabolic processes. Table 3 shows the estimates of amino acid requirements in infancy and pre-school children, expressed in relation to energy intake and body weight respectively. The true requirement for several of the amino acids is likely to be substantially less than the estimate given for infants.

3. Water

The average daily requirement of water during infancy is approximately 150 ml/kg (175.5 ml/kg in the first 6 months and, 100 m1/kg thereafter). This is provided by breast milk when the energy requirements of the infant are met by the breast milk.

4. Other essential nutrients

The requirements of other essential nutrients have been estimated with varying degrees of accuracy, and recommended intakes for each of them include a margin of safety. Breast fed infants will satisfy their requirements of all essential nutrients, if their energy requirements are met and the mother is healthy and well nourished. However, after 4 months the total requirement of iron and zinc may not be met through breast milk. In addition, meeting the needs for energy and other nutrients, some balance should be achieved between sources of energy. For the infant who is not breast-fed, protein should provide 8-15% of energy intake, fat 20-50% and carbohydrate the remainder. Whether the infant is breast-fed or formula fed, other foods must be introduced into its diet between 4 and 6 months of age to ensure adequate intakes of essential nutrients.

Fats

Dietary fat appears to be essential for human. It is a convenient method of storing energy with minimum weight per unit energy. It has a high fuel value and can be used while sparing more essential dietary ingredients.

Fats are derived from animal or plant sources and supply over twice as many joules per unit of weight as protein or carbohydrate. Fats are expensive and hence eaten in small quantities. In the Asian diet around 13% of energy are derived from fat while in developed countries they provide 30-45%. They are the vehicles for supplying the fat-soluble vitamins, and they also supply the essential fatty acids. However, their most important characteristic is their concentrated energy, so that their use can reduce the bulk of the diet, which as stated above, is a common reason for under nutrition in young children. The requirement of fat of the infant is 2-4g/100ml or 3-6g/100kcal of energy.

The American Academy of Pediatrics (AAP) in 1986 recommended that the total fat intake should not exceed 30% of the total energy intake per day; the energy consumed as saturated fat should be 8% to 10% of total energy intake and that the total cholesterol intake be less than 300 mg per day. The AAP also recommends a total fat intake of no less than 20% of the total energy intake in children older than 2 years. The WHO/ UNICEF in 1998 recommended a total intake of 30-45% of total energy from lipid.

Rigorous and ongoing research shows that atherosclerosis begins in children and the extent of early arterial involvement is strongly associated with LDL –cholesterol levels. If the diets are restricted in components that elevate LDL cholesterol (saturated fat and cholesterol) from the childhood, long-term risk of coronary artery disease in adulthood can be reduced. This amount has also been suggested by Deway and Brown in 2003. However, it has been recommended 10-20g additional fats or oils if animal-source foods are not consumed regularly (WHO 2005).

Certain fatty acids, particularly unsaturated ones are necessary for growth. Essential fatty acids for man are restricted to those of the linoleic acid series. Excess unsaturated fatty acids may increase peroxide formation. This has been noted in infants with a vitamin E responsive hemolytic anaemia.

Micronutrient requirements

The most important (nutrient problem) during infancy are iron, zinc, folate, calcium, thiamin, riboflavin and vitamin C status. Deficiency states of iodine, copper, chromium and selenium also have been identified. In addition, vitamin A too becomes a problem nutrient during the second year of life.

Iron

The body of the human infant contains about 94 mg of iron per kilogram of fat free tissue (75mg/kg of body weight), and most of this is in the circulating red cell mass (50mg/kg), tissue stores being estimated as no more than 20mg. During the first 6 to 8 weeks of life, there is a marked physiological decrease in heamoglobin concentration, and the circulating hemoglobin mass decreases at a rate consistent with that anticipated from the short half-life of foetal red cells. The iron released from the circulation during this time is largely stored in the form of haemosiderin. These stores are subsequently mobilized and there is minimal absorption during this period. It is assumed that storage of iron reach a maximum between 8 and 12 weeks of age. The total content of iron in liver increases from about 30mg at birth to 100mg at age of 3 months.

Within the first year of life the full term infant must almost double its total iron content and triple its body weight. The change in body iron during this period occurs mainly during the 6-12 months of life. Between 1 year and 6 year of age, the body iron content is again doubled.

After 3 months iron content of liver decreases, as needs for erythropoesis exceed the quantity absorbed. By 4 to 6 months when dietary iron absorption becomes important, initial iron stores have been appreciably depleted. The premature or very low birth weight infant may have a lower initial endowment of body iron and needs a dietary source earlier than for a normal infant.

The total body iron is relatively stable from birth to 4 months of age, but the proportion of body iron in distinct compartments shifts dramatically as stores are depleted and demands for iron increase to meet needs imposed

Table 2.4 Daily nutrient intakes recommended by the WHO/UNICEF *: New Dietary Reference Intakes (1997-2001) and FAO WHO 2002)**

Nutrient	6-8 m	9-11 m	12-23 m
Vitamin A (μg RE)	400	400	400
Folate (μg)	80	80	160
Niacin (mg)	4	4	6
Pantothenic acid(mg)	1.8	1.8	2
Riboflavin (mg)	0.4	0.4	0.5
Thiamin (mg)	0.3	0.3	0.5
Vitamin B6(mg)	0.3	0.3	0.5
Vitamin B12 (mg)	0.5	0.5	0.9
Vitamin C (mg)	30	30	30
Vitamin D (μg)	5	5	5
Vitamin K (μg)	10	10	15
Calcium (mg)	400	400	500
Chloride (mg)	500 *	500 *	800 *
Copper (mg)	0.2 **	0.2 **	0.3 **
Fluoride (μg)	0.5 **	0.5 **	0.7 **
Iodine (μg)	90	90	90
Iron (mg) a	9.3	9.3	5.8
Magnesium (mg)	0.6 **	0.6 **	1.2 **
Phosphorus (mg)	275**	275 **	460 **
Potassium (mg)	700 *	700 *	800 *
Selenium (μg)	10	10	17
Sodium (mg)	320 *	350 *	500 *
Zinc (mg)a	4.1	4.1	4.1

a. Assuming medium bioavailability of 10% for iron and 30% for zinc.

from 4-12 months of age by expanding red blood cell and myoglobin compartments. Iron requirements thus rise markedly around 4–6 months of age, estimated to be 0.5mg/day in first 6 months and 0.9mg/day in the second six months.

Although breast-fed infants rarely develop iron deficiency before 6 months of age, the risk of iron deficiency increase rapidly during the following 3 months among infants who continue to be breast-fed. Among infants fed cow milk, unfortified formula, or human milk, whether an individual develops iron deficiency or not will partly depend on other foods in the diet, particularly on whether iron fortified cereal is used, and whether iron absorption is enhanced by ascorbic acid or meat in the same meal. For this reason infants who continue to be breast fed after 6 months of age and who have not consumed much animal foods, should receive an iron supplement. The iron absorption from meals consisting almost entirely of cereals and vegetables may be as low as 1-2%, whereas in meals containing generous quantities of meat, poultry, fish, liver etc. may approach 20-25%.

The RDA for 6 months to 3 years is set at 10mg/day – a level considered adequate for most healthy children during this time. Low birth weight infants and those with a substantial reduction in total haemoglobin mass require 2 mg / kg/day, starting no later than 6 weeks of age.

Zinc

An adequate perinatal zinc nutrition is essential for normal pre-natal and post-natal development. However, term new born does not start life with reserves of zinc that are comparable to those of iron and copper. The infant quickly becomes dependent on an adequate external dietary source of zinc to meet the needs for post-natal growth.

The zinc requirement of a person depends predominantly on that person's zinc status or body pool of metabolic zinc. The premature infant must have a special requirement of adequate zinc during periods of rapid postnatal growth. The zinc content of the foetus increases by nearly 300ug/kg/day during the last 4 months of gestation.

Breast milk is a good source of zinc with 41% absorption. Therefore full term infants consuming only human milk do not show any signs of zinc depletion. Their zinc requirements are satisfied by zinc in their mothers milk plus liver stores. The total requirement for net zinc absorption during infancy is shown in the Table below.

Table 2.5: Zinc requirements of breastfed infants (WHO,2002)

Age (months)	Requirement of absorbed Zinc (mg/day)
1	0.947
2	0.925
3	0.864
4	0.836
5	0.820
6	0.791
7	0.784
8	0.780
9	0.776
10	0.777
11	0.785
12	0.803

During the first months of life breast fed infants consume an average of 2 mg of zinc per day, (2-3mg in 1st month and 1mg in 3 months). Beyond the age of 6 months, infants would receive (from 600ml of breast milk) only 0.6mg of zinc per day which is less than the requirement, and a small amount is received from the solid foods also.

The dietary zinc requirement of infants consuming formula is higher than that of breast fed infants because of lower zinc availability of the formulae (absorption from cow milk is 28%). Infant formulae are supplemented with abut 3.25mg per litre to supply 0.5mg/100kcal. It has been demonstrated that male infants consuming formula supplemented with zinc to a total of 5.8mg/liter grew better than those on an unsupplemented formula containing only 1.8mg/liter.

The physiological requirement of zinc from the 4th month onwards is 0.45mg/day for male infants and 0.4mg/day for female infants. After 3-4 months the dietary requirement of a fully breast fed infant is about 1.6mg/day. An average dietary absorption of zinc from mixed meals is less than 20%, as such with a net absorption of 20% the estimated dietary requirement for weanlings would be 4mg/day.

The composition of the diet has important effects on the bioavailability of dietary zinc. Interaction of zinc with other dietary components such as protein, fiber, phytates, bran and some minerals (iron) have been described. Meat, liver, milk, eggs and sea foods are good sources of available zinc, whereas whole grain products contain the element at a higher level (2-16mg/100g) but in a less available form.

Calcium

Infants thrive on an average intake of 240mg of calcium from 750ml of breast milk, of which they retain approximately two – thirds. When breast milk intake is around 500ml, and allowing 25% for variance, the calcium intake would be about 200mg, from which about 140mg is expected to be absorbed as the rate of absorption is indicated as 40-70%.

The retention of calcium from milk formulae is less than one-half. Therefore the recommendation for formula fed infants is 400 mg/day for the first 06 months of life, and this amount is provided by the typical infant formulae. An allowance of 400mg/day would suffice for the next 06 months and 500mg/day at ages 1-10 years.

The calcium content of the body of the reference infant at birth, at 4 months and at 12 months have been found to be 29.8, 48.7 and 80.4g respectively. Therefore the gain in calcium between birth and four months will be 18.9g (155mg/day), and between 4 and 12 months will be 31.7g (130mg/day).

Calcium requirements are affected substantially by genetic variability and other dietary factors. Calcium content of breast milk is fairly constant throughout lactation and is not influenced by maternal diet. The total requirement for net absorption of calcium during infancy is shown in the Table below.

Table 2.6 Requirement of absorbed calcium

Age (months)	mg/day
1-3	147-156
4-6	160-166
7-12	168-176

Based on the estimated calcium intakes of exclusively breastfed infants, human milk meets the total calcium requirement during the first 6 months of life.

Supplementation to a total calcium intake much above these amounts is not recommended. A high calcium intake may inhibit the intestinal absorption of iron, zinc and other essential minerals. Ingestion of very large amounts may result in hypercalciurea, hypercalcemia and deterioration in renal function in both sexes.

Phosphorus

Phosphorus is an essential component of bone mineral, where it occurs in the mass ratio of 1 phosphorous to 2 of calcium.

Infants absorb from 65-70% of the phosphorous in cow milk and 85-90% of that in breast milk. From the normal diet 50-70% of phosphorous is absorbed in children and it increases to 90% when the intake is low. The major contributors are protein rich foods and cereal grains. Eggs and legumes are also good sources of phosphorous. The phosphorous content of breast milk of 14mg/100g is adequate for the full-term infant. Cow milk contain both of more phosphorous and calcium than does breast milk, and the ratio of calcium to phosphorous in cow milk is 1.3:1 and that in breast milk is 2.3:1. Therefore for formula fed infants the recommendation is 300mg/day up to 6 months, and that for the infants of 6-12 months is 500mg/day. For breast-fed infants it is 275mg/day up to 1 year, and 460mg/day thereafter.

The recommended allowances for phosphorus are based on the calcium - to - phosphorous ratio in breast milk during the first 06 months. The ratio declines with the gradual addition of complementary foods to the basic diet of the infant.

Magnesium

A healthy full-term foetus is reported to contain approximately 1g of magnesium. Human milk contains about 28 to 40 mg magnesium per liter. It is about 20mg in the average volume of 500ml per day. Magnesium requirement of infants is 0.6 mg/day, and this amount is doubled in the 2nd year. In the first 06 months of life, average magnesium intake of breast fed infants is 30 mg/day. The allowance for the second 06 months is increased to 60 mg/day. The allowance recommended for children of both sexes between 01 and 15 years og age is 6.0 mg/kg per day

Trace Elements
Selenium

Recommendations have been extrapolated from adult values on the basis of body weight and maintenance selenium requirements for infants (5μg/day) from birth to 06 months of age. To allow for growth this figure was increased to 10μg/day. A breast fed infant would receive adequate selenium, since consumption of 500ml of breast milk per day would result in an intake of about 8.7μg selenium per day. However, WHO

2002 recommendations are also the same (10µg/day) up to the age of 24 months.

Copper

Bioavailability of copper from human milk is very high. Furthermore, the sizeable hepatic copper reserve built up during foetal development appears to contribute to the early needs of the growing full-term infant. Copper levels in human milk decline from 0.6-0.2mg/liter during the first 6 months of lactation. Therefore introduction of solid foods at 4 to 6 months of age should enable the older infant to meet the copper recommendations, 0.2mg/day in infancy and 0.3mg/day during the 2nd year. These recommended intakes may be inadequate for the premature infant, who is always born with low copper stores.

The AAP has recommended in 1985 that an infant formulae should provide 60µg of copper per 100 kcal. According to this recommendation an infant who is receiving 700 kcal per day would consume approximately 0.4mg copper per day.

Manganese

The neonatal period poses several potential problems with regard to manganese nutrition. In contrast to iron, zinc and copper, manganese stores are not thought to be profited prenatally, thus the infant is dependent on an adequate supply of manganese after birth, since the emergence of manganese co-enzymes occur during postnatal life. However, no cases of documented manganese deficiency in infants have been reported, although concern about the risk for developing manganese deficiency has been discussed, especially in premature and low-birth weight infants. However, there could be a potential risk for manganese deficiency when breast feeding is continued without complementary feeding after 6 months of age.

With the introduction of other foods at an age of 4 months, manganese consumption increases accordingly. It has been reported that the intake of manganese was 0.4mg/day in U.S. reference infants of birth to 6 months, and 0.7mg/day in infants of 6 to 12 months of age. The recommended daily dietary intakes of manganese for these age groups are 0.6mg in infancy and 1.2mg/day during the 2nd year.

Vitamins

Vitamin A

The milk of a well-nourished woman, contains about 60µg of retinol and about 30µg of carotinoids per 100ml. The carotinoids contribute approximately 10% of the vitamin A value of milk. If the breast milk intake is 500ml the average intake of vitamin A is 200–350 µg/day. A daily intake of 400µg of retinol is recommended for healthy infants and children up to 2 years. Signs of vitamin A deficiency and reduced growth rate have been apparent in children receiving as little as 100-200µg of retinol a day.

Preformed vitamin A is present mainly in liver and fish liver oils with appreciable quantities in whole and fortified milk and in eggs. Biologically active carotinoids are found in abundance in carrots and dark green leafy vegetables, and 12µg has been assumed to be nutritionally equivalent to 1µg of retinol. The vitamin A activity in foods is currently expressed as retinol equivalents (RE).

Vitamin A content of human milk is strongly influenced by maternal nutritional status. The concentration of vitamin A in mature milk of women in underprivileged countries has been found to be very low (0.60µmoles/L) as compared to 1.7µmoles/L in well nourished women.

The recommended vitamin A intake level for infants from birth to 6 months was set at 1.4 µmoles/ day and 1.7µmoles/ day, for infants of well nourished mothers.

Vitamin E

Vitamin E content of diets varies widely depending primarily on the type (poly unsaturated fatty acids- PUFA) and amount of fat present. The recommendation for infants from birth through 6 months of age (3mg) has been derived by the tocopherol content of breast milk. Breast milk provides about 6% of calories as PUFA. When smaller volumes of milk are consumed by breast fed infants during the 1st week of life, sufficient tocopherol is provided by colostrum which has a three fold higher concentration compared to mature human milk. Mature milk contains 0.35mg per 100ml.

The RDA for infants older than 6 months has been increased to 4mg/day in proportion to growth. An oral supplementation of 17mg of vitamin E per day may be required by premature infants up to 3 months of age. The requirements for vitamin E increases with increasing body weight until adulthood (6mg for 1-3 years and 7mg for 7 - 10 years).

Vitamin K

The new-born infant has low plasma pro-thrombin levels. Breast milk contains low levels of vitamin K (0.21µg/100ml) and breast fed infants may ingest only about 1µg/day. Because their intestinal flora too are limited, exclusively breast fed infants have been reported to be at risk of developing fatal intracranial hemorrhage secondary to vitamin K deficiency, if they do not receive vitamin K prophylaxis at birth.

The requirement of total intake for infants is 10µg of phylloquinome or menaguinone per day during the first year and 15µg during the second year.

The new born infants are routinely given a supplement of vitamin K (0.5–1.0mg) by intramuscular injection to prevent hemorrhage. Infant formulae should contain 4µg of vitamin K per 100kcal and RDA for children is set at about 1µg/kg body weight.
Cow's milk contains 4-18µg of vitamin K per liter. Green leafy vegetables provide 50-800µg of vitamin K per 100g of food and are the best dietary sources. Small but significant amounts of vitamin K (1-50µg/100g) are present in milk, milk products, meats, eggs, cereals, fruits and vegetables.

Vitamin C

Breast fed infants with vitamin C intakes of 7-12mg/day and formula fed infants with vitamin C intakes of 7mg/day are protected from scurvy. The RDA is set at 30mg/day during the 1st 6 months and a gradual increase to the adult level (60mg/day) beyond 2 years.

The dietary vitamin C may be considerably lower than the calculated amount in the food ingested, largely because of it's destruction by heat and oxygen and its loss in cooking water.

Thiamin

The requirement of 0.3mg/day is met by breast fed infants. The content in breast milk is 16µg/100ml.

Riboflavin

Although clinical signs of ariboflavinosis are rare, the riboflavin allowance for children is an important consideration since inadequacy may lead to growth inhibition.

The amount of riboflavin ingested by a breast fed infant is 30µg/100ml. The requirement is 0.4mg up to 1 year and 0.5mg per day during the 2nd year. Requirement of 0-6 months of age is set at 0.6mg/1000kcal.

Niacin

Human milk supplies 620µg/100ml of milk and appears adequate to meet the niacin needs (4mg per day) of the infant.

Pyridoxine (B_6)

The vitamin B_6 content of breast milk varies with maternal B_6 status and intake. The adequate intake for vitamin B_6 is 0.1mg/day for infants of birth to 6 months and, 0.3mg/day for infants of 6-12 months of age.

The concentration of vit.B_6 in breast milk is 0.13 mg/l, which appears to maintain normal vit B_6 status in exclusively breastfed infants during 4-6 months of age. The risk of B_6 inadequacy could appear beyond 6 months if complementary foods are not rich in B_6.

Folate

The needs of folate are adequately met from breast milk, that contains 5µg/liter. The daily requirement is 80µg during infancy and 160µg during the 2nd year for healthy infants.

Vitamin B_{12}

The requirement of infants is set at 0.5 µg/day and of toddlers at 0.9µg/day Infants of strict vegetarian mothers may show symptoms of B_{12} deficiency. Breast milk contains 0.01µg/100ml.

5. General Considerations

Energy and many nutrients are essential for the infant and young child, and the amounts needed are interrelated. The requirements for one depend on others being available at the right level at the same time, if growth and development are to take place in a normal way.

Protein cannot be used efficiently without energy, which in turn depends on an adequate intake of thiamin and other vitamins. Normal blood needs a balanced mixture of nutrients, including iron. Calcium for bones and teeth cannot be used without vitamin A. Vitamin A cannot be utilized without protein, and vitamin C is involved in most of these processes and probably many more. Thus a good diet is one which provides a good mixture of energy and all the nutrients. It is not possible to provide the recommended amount of each nutrient every day, but an adequate intake over a period of days, or even weeks is practical and feasible.

The tables of recommended intakes are very useful guides or reference for groups but they too may need to be adjusted for individual children or their mothers. In planning diets and calculating the energy and nutrient values, food composition tables give very useful information. However, because of the effects, of cooking on nutrient values and the variation in absorption of different nutrients it is not possible to show exactly how much of each nutrient will actually be absorbed and used. These factors must be taken into account when planning and evaluating diets.

3. COMPLEMENTARY FEEDING

1. Introduction

What is complementary feeding?

Complementary feeding means giving other foods in addition to breast milk. It is defined as the period during which foods or liquids are provided along with continued breast feeding. During the period of complementary feeding, a baby gradually becomes accustomed to eating family foods. At the end of this period (usually around 12 to 18 months), breast milk is entirely replaced by family foods, although a child may still sometimes suckle for comfort. Complementary food is the term used to describe any nutrient containing foods or liquid other than breast milk given to young children during the period of complementary feeding.

There are 2 types of complementary foods.

(a) Specially prepared (transitional) foods

(b) Usual family foods that are modified to make them easy to eat and provide enough nutrients.

Specially prepared porridges, soups multi mixes can be given to the baby while the rest of the family eats rice and curry meals. When the child is a little older, the mother can give the rice mashed with some vegetables picked from curries such as, dhal, potato, pumpkin etc. Small amount of fish also can be mixed in. Mashing modifies the consistency of the family food making it easier for the child to eat. Family meals can also be modified by adding something extra, for example adding a piece of mango to give extra vitamin A (µcarotene) or liver for extra iron, and oil or margarine for extra energy.

Why are complementary foods needed?

As a baby grows and becomes more active, an age is reached when breast milk alone is not sufficient to meet the child's nutritional needs. Complementary foods are then needed to fill the gap between the total nutritional needs of the child and the amounts provided by breast milk.

The energy needed by a child increases as the child becomes older, bigger and more active (see figure 3.1). The figure also shows how much of this energy is supplied by breast milk if a mother breast-feeds frequently. From 6 months onwards a gap is seen between the total energy needs and the energy provided by the breast milk. This gap gets bigger as the child gets older.

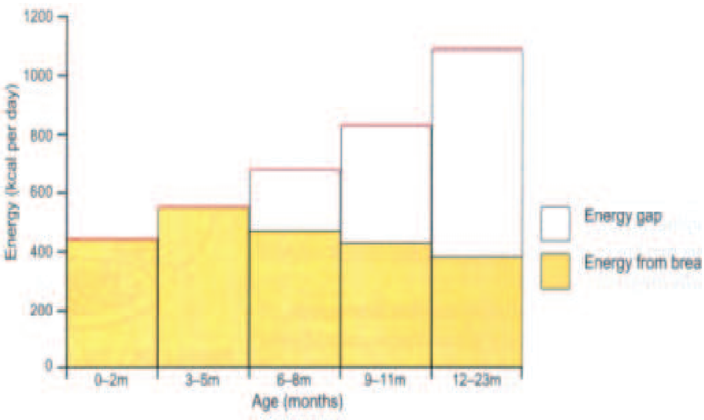


Figure 3.1 Energy required and the amount supplied from breast milk

Therefore,
- complementary foods are needed to fill the energy gap
- the quantity of food needed increases as the child becomes older
- if the gap is not filled, the child will stop growing, or grow slowly

Table 3.1 Breast milk energy intake and energy required from complementary foods (WHO/UNICEF 2001)

Age group (months)	Milk energy intake Kcal/day	Energy required from complementary foods Kcal/day
6-8	413	200
9-11	379	300
12-23	346	550

The energy requirement from complementary foods have been based on age specific total energy requirements plus 2SD minus the amount of energy provided by breast milk. The frequency of feeding of complementary foods depends on the energy density of these foods.

Minimum energy density of a complementary food should be 0.8kcal/g. If the energy density is either 0.8 or 1.0kcal/g, 3 meals of complementary feeding/day is sufficient for babies of 6-11 months and 12-23 month. According to Deway 2004 and WHO 2005, a higher number of meals is needed if energy density is less than 0.8kcal/g (4 meals if it is less than 0.75 kcal/g and, 5 meals if less than 0.65 kcal/g.

On evaluation of the nutritional adequacy of complementary foods in developing countries as well as in USA, it has been emphasized that for certain micronutrients (Ca, Fe and Zn) the amount and density are consistently and substantially less than the corresponding WHO recommendations (Table 2.2). Further, vitamin A, riboflavin and niacin inadequacies have been shown with the 6-8 m age group in certain settings. Inadequacies of vitamin D, E and B_6 have been reported even in more affluent countries. Moreover, deficits may also occur in manganese, iodine and selenium. Accurate data on these are sparse for developing countries.

Table 3.2 Desired nutrient density of complementary foods (per 100kcal) at an average breast milk intake (WHO 2002)

Nutrient	6-8 m	9-11 m	12-23 m
Protein (g)	1.0	1.0	0.9
Vit. A (µg retinol)	31	30	23
Calcium(mg)	115	74	63
Iron(mg)	4	2.4	0.8
Zinc(mg)	1.6	1	0.8
Riboflavin(mg)	0.08	0.06	0.06
Thiamin(mg)	0.08	0. 06	0.07
Niacin(mg)	1.1	0.9	0.9
Vit B (mg)	0.12	0.08	0.08
Folate (mg)	11	9	21
Vit C (mg)	1.5	1.7	1.5

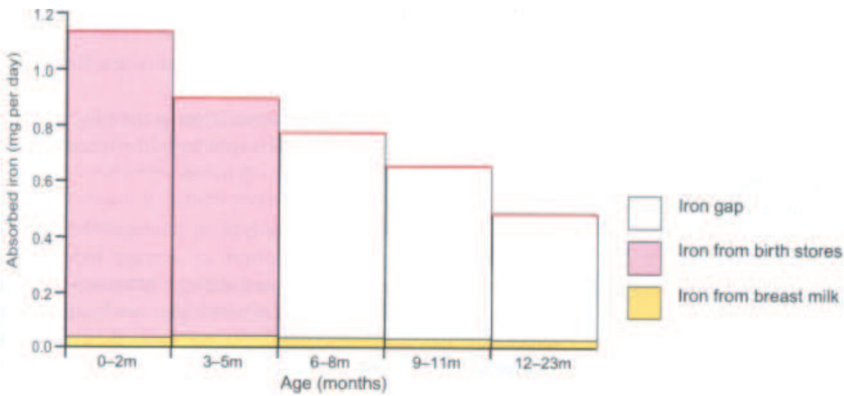


Figure 3.2 Absorbed iron needed and the amount supplied from breast milk and body stores at birth

The daily iron needs of a child gradually becomes less, as the amount of iron needed is related to how much new RBC has a child's body need to make. More new RBC is made in the first year (due to high growth rate) than in the second.

The gap between the iron needed and the amount supplied by breast milk is the amount of iron a child needs to absorb from complementary foods.

As the amount of iron a child receives from breast milk is small, there is a large gap of iron needs during the first year. In full term babies the iron store is used to fill the gap, and is used up by 6 months.

Therefore,

- complementary foods that provide plenty of iron are needed to fill the gap from 6 months of age
- if the iron gap is not filled the child becomes anaemic
- the iron gap is biggest from 6 to 12 months
- as such, risk of anaemia is highest from 6 to 24 months
- pre-term and low-birth weight babies are at increased risk of anaemia because they are born with smaller stores of iron. The gap starts earlier in them, therefore iron drops have to be given from 2 months.
- for calcium like iron the gap is smaller in the second year, but it is still large
- the most difficult gaps to fill are usually for energy, iron, zinc and vitamin A

Transition to solid foods

Infants between 4 and 6 months of age are physiologically and developmentally ready for new foods, textures and modes of feeding. By 1 year of age, the ingestion of a variety of foods from the different food groups is desirable. Malnutrition is more common during this transitional period than in the first 4-6 months of life. Families have to be aware of the special needs of the infant, how to prepare complementary foods from the foods that are available locally, and providing sufficient nutrition. During the transition to solid foods, it is vital that infants continue to ingest an adequate volume of nutrient-dense milk (preferably breast milk). Introduction of solid foods should be based on the physiologic and developmental maturity of the infant in combination with our understanding of nutrient requirements for the rapidly growing infant. Iron containing complementary foods are recommended as the first foods.

2. Developmental issues related to feeding

Four to six months is the age when nerves and muscles in the mouth develop sufficiently to let the baby munch, bite and chew. Before 4 months babies push food out of their mouths because they can not fully control the movements of their tongues. At 4-6 months of age it becomes easier to feed thick porridges, purees and mashed foods because children:

- are interested in new tastes
- can control their tongues better
- start to make up and down munching movements
- like to put things in their mouths
- start to get teeth

Beginning at 6 months and continuing through the 2nd year of life, characteristic patterns follow physiological and neurological maturation (with development of head, trunk, and gross and fine motor control). Feeding milestones with a significant impact on weaning behaviors include taking food from a spoon, chewing foods, self-feeding with fingers, independent feeding from a cup, etc.

Neuromuscular system

The suckling reflex of the baby matures between 30 and 34 weeks of gestation. By 4 months of age the tongue-extrusion reflex has disappeared; by 5 to 7 months the infant can take food from a spoon. By about 8 months increased tongue flexibility, and the ability to sit without support allow greater manipulation of food before swallowing, so that thicker bolus of food can be handled. By 10 months the infant makes definite chewing movements, takes small bits of solid foods, develops a pincer grasp, and begins to experiment with self-feeding. By 1 year most infants are skilled at finger feeding, can eat well from all the food groups, and drink from a cup using two hands. Manual dexterity continues to improve during the 2nd year, and by the end of that year cognitive development usually enables the child to distinguish between food and non-food items.

Digestion and absorption

Intra intestinal concentrations of pancreatic enzymes, amylase, lypase and trypsin are considerably less during the first few months of life than during the later childhood. There is reduced efficiency of fat absorption due to inadequate bile secretion in early infancy, and this may be accompanied by some excess loss of energy. Therefore, an adequate energy intake will compensate for any fecal loss.

However, these age-related changes have limited importance with regard to complementary feeding of normal infants. Most cooked starches are absorbed almost completely during early infancy.

This is also the age that their digestive system is mature enough to digest a range of foods. It is also clear that pleasurable sensations associated with taste and ingestion promotes exploratory behavior and tolerance for the unfamiliar, once the complementary feeding has begun.

Renal function

Most aspects of renal function are either nearly fully developed at birth or mature rapidly within a short period of time after birth. By the time babies reach the recommended age for introduction of complementary feeding, the issue of solute load is of less concern. It may become a concern although not a problem, especially for non-breast fed babies as the protein and electrolyte concentrations are high with unmodified cow milk.

3. When should complementary foods be started? (Age of introduction)

The most appropriate age for introduction of complementary foods is 4-6 months of age. General recommendations for the appropriate time for introducing complementary foods are consistent worldwide.

These recommendations are usually based on:
- perceived nutritional needs,
- physiological maturation,
- behavioral and developmental aspects of feeding,
- immunological safety and
- environmental influences.

Within the age range of 4 to 6 months, because infants develop at different rates, the decision about exactly when to start complementary feeding should be individually determined.

Starting complementary foods too early or starting it too late is both undesirable.

Signs that a child is ready to start complementary foods are that the child:
- is at least 4 months old and
- is not gaining weight adequately

Giving complementary foods too soon is dangerous because -
- a child does not need these foods yet, and if foods are given the child takes less breast milk, and the mother may therefore produce less,. As a result the child does not meet the nutritional needs

- a child receives less of the protective factors in breast milk so the risk of illness increases
- the risk of diarrhea also increases because complementary foods may not be as clean as breast milk
- the foods given instead of breast milk are often thin, watery porridges or soups because these are easy for babies to eat. These foods fill the stomach but provide fewer nutrients than breast milk, and the child's needs are not met.
- mothers are at greater risk of becoming pregnant if they breastfeed frequently.
- Iron absorption from breast milk is depressed when there are other foods in the small bowel. This may increase the risk of iron depletion and anaemia.

Starting complementary feeding too late is also dangerous because -

- a child does not get extra food needed to fill the energy and nutrient gaps
- a child grows slowly
- the risk of malnutrition and micronutrient deficiencies increase
- development of feeding problems (reliance of fluids, refusal to progress to solid foods)

4. Current recommendations

The WHO (2001) at a global consultation on complementary feeding recommended that breast milk should be given exclusively for the first 6 months of age and that supplementary /complementary foods should be introduced at this time (while continuing to breastfeed) to meet the energy and nutrient needs which are no longer met by breast milk.

The WHO consultation also revised the feeding recommendations presented at the WHO/UNICEF scientific review (1998) on complementary feeding. The estimated energy requirements from complementary foods were recommended as 200kcal/day for infants of 6–8 months; 300kcal/day for infants of 9–11 months and, 550kcal/day for children of 12–23 months. No major changes were proposed for the estimated nutrient requirements from complementary foods. However, it was shown that some nutrients, notably iron, zinc and vitamin B_6 are consistently deficient in diets of infants and young children in most populations of low-income countries. Special attention for ensuring the adequacy of these micronutrients in infant foods and feeding recommendations was highlighted. It was also noted that interventions to improve complementary feeding should pay special attention to ensuring the adequacy of these micronutrients in food recommendations.

The global consultation (in 2004) also identified inappropriate feeding behaviors or feeding styles as a major factor contributing to poor intakes. To ensure an adequate consumption of complementary foods by infants and young children, some assistance that is appropriate to their age and development needs, has to be given, and this is called responsive feeding. In responsive feeding, it was stated important to apply principles of psycho-social care. The infants should be fed and the older children should be assisted when they feed themselves, encouraging them to eat but without feeding. Children should be helped to overcome refusal to eat by experimenting with different food combinations, tastes, textures and methods of encouragement. It is also important to talk to the child lovingly during feeding, minimizing the distractions, and thereby creating an awareness of care and love, which are of importance of responsive feeding.

Recognizing these important issues, a set of guiding principles for complementary feeding of the breastfed child was also endorsed at the consultation. These guiding principles (2001, 2005) are current best practice standards that should be widely disseminated and used.

Following is a summary of these ten guiding principles.

1. *Duration of exclusive breast feeding and age of introduction of complementary foods*

   Guideline; Practice exclusive breastfeeding from birth to six months of age, and introduce complementary foods at six months of age (180 days) while continuing to breastfeed.

2. *Maintenance of Breastfeeding*
   Continue frequent, on demand breastfeeding until two years of age or beyond.
3. *Responsive feeding*
   Practice responsive feeding, applying the principles of psycho-social care. Specifically:
   a) feed infants directly and assist older children when they feed themselves, being sensitive to their hunger and satiety cues.
   b) feed slowly and patiently, and encourage children to eat, but do not force them
   c) if children refuse many foods, experiment with different food combinations, tastes, textures and methods of encouragement
   d) minimize distractions during meals if the child loses interest easily
   e) remember that feeding times are periods of learning and love-talk to children during feeding, with eye to eye contact
4. *Safe preparation and storage of complementary foods*
   Practice good hygiene and proper food handling by
   a) washing care givers' and children's hands before food preparation and eating
   b) storing foods safely and serving foods immediately after preparation
   c) using clean utensils to prepare and serve food
   d) using clean cups and bowls when feeding children
   e) avoiding the use of feeding bottles, which are difficult to keep clean
5. *Amount of complementary food needed*
   Starting at six months of age with small amounts of food and increasing the quantity as the child gets older, while maintaining frequent breastfeeding. The energy needs from complementary foods for infants with "average" breast milk intake in developing countries are approximately 200kcal/day at 6-8 months of age, 300kcal/day at 9-11 months of age, and 550kcal/day at 12-23 months of age. In industrialized countries these estimates differ somewhat 130,310 and 580 kcal/day at 6-8, 9-11 and 12-23 months,

respectively) because of differences in average breast milk intake.

6. *Food consistency*
   Gradually increase food consistency and variety as the infant gets older, adapting to the infant's requirements and abilities. Infants can eat pureed, mashed and semi-solid foods beginning at six months. By eight months most infant can also eat "finger foods" (snacks that can be eaten by children alone). By 12 months, most infants can eat the same types of foods as consumed by the rest of the family (keeping in mind the need for nutrient-dense foods, as explained in # 8 below). Avoid foods that may cause choking, (i.e., items that have a shape and / or consistency that may cause them to become lodged in the trachea, such as nuts, grapes, raw carrots).
7. *Meal frequency and energy density*
   Increase the number of times that the child is fed complementary foods as he/she gets older. The appropriate number of feedings depends on the energy density of the local foods and the usual amounts consumed at each feeding. For the average healthy breastfed infant, meals of complementary foods should be provided 2-3 times per day at 6-8 months of age and 3-4 times per day for at 9-11 and 12-24 months of age. Additional nutritious snacks (such as a piece of fruit or bread or chapatti with nut paste) may be offered 1-2 times per day, as desired. Snacks are defined as foods eaten between meals- usually self-fed, convenient and easy to prepare. If energy density or amount of food per meal is low, or the child is no longer breastfed, more frequent meals may be required.
8. *Nutrient content of complementary foods*
   Feed a variety of foods to ensure that nutrient needs are met. Meat, poultry, fish or eggs should be eaten daily, or as often as possible. Vegetarian diets cannot meet nutrient needs at this age unless nutrient supplements or fortified products are used (see #9 below). Vitamin A-rich foods (dark colored fruits and vegetables, red palm oil, vitamin A fortified oil or foods) should be eaten daily. Include vitamin C rich foods (fruits, vegetables and potatoes) vitamin B rich foods (liver, egg, dairy products, dark green leafy vegetables,

soy products) vitamin B_6 sources (meat, poultry, fish, banana, green leafy vegetables, potato, yams) and folate (legumes, green leafy vegetables, orange juice) regularly. If adequate amounts of animal foods are consumed regularly the amount of milk needed is 200-400 ml/day; otherwise 300-500 ml/day. Provide diets with adequate fat (10-20g added fat if animal foods are not consumed and, 5g added fat if animal foods are consumed). Avoid giving drinks with low nutrient value, such as tea, coffee and sugary drinks such as soda. Limit the amount of juice offered so as to avoid displacing more nutrient-rich foods. Dairy products are richest sources of calcium and, if not consumed in adequate amounts good sources of calcium (dried or fresh small fish, carrot, papaw, dark green leafy vegetables, guava, pumpkin) should be included.

9. *Use of vitamin-mineral supplements of fortified products for infant and mother*

   Use fortified complementary foods or vitamin-mineral supplements for the infant, as needed. In some populations, breastfeeding mothers may also need vitamin-mineral supplements or fortified products, both for their own health and to ensure normal concentrations of certain nutrients (particularly vitamins) in their breast milk. Such products may also be beneficial for pre-pregnant and pregnant women. Use of fortified foods or vitamin-mineral supplements that contain iron is recommended if adequate amount of animal foods are not consumed. These supplements or fortified foods should contain other micronutrients particularly zinc, calcium and vitamin B_{12}. Such fortified foods for infants are not widely available in less developed countries. An alternative to commercial fortification, ie, mixing products that contain concentrated amounts of vitamins and minerals such as, sprinkles, crushable tablets or fat based spreads (Deway and Brown, 2003; Nestel et al., 2003 and Zlotkin et al., 2003) directly with the foods prepared at home for infants. The advantages of this approach are that it allows for providing the dose needed regardless of the amount of food consumed, does not alter usual dietary practices and, likely to be safer than administration of liquid mineral preparations.

10. *Feeding during and after illness*
    Increase fluid intake during illness, including more frequent breast feeding, and encourage the child to eat soft, varied, appetizing, favorite foods. After illness, give food more often than usual and encourage the child to eat more.

Feeding the child when he is accustomed to new foods

The meals including the breast milk should provide the recommended intake of all nutrients. Young children must be fed more often during the day than the adults in the family, because their stomachs are small, the volume of the meal must not be too large.

When first given, the food must be mashed smoothly. By nine months most infants like finely chopped foods and by 18 months children can eat most of the normal adult foods.

A child 1-3 yrs can only eat about 200-300ml (1-1.5 tea cupful) at one time. Therefore in order to get sufficient energy and nutrients, the meals must have a high concentration of energy and other nutrients and, be given frequently.

An infant over 6 months needs to be fed around 4-6 times a day in addition to breast feeding. Where it is difficult to add oil, fat or sugar to the meals, the young child may have to get enough nutrients from more meals a day; three main meals and nutritious snacks in between meals.

Energy intake from complementary foods and factors affecting the intake

The amount of energy needed from complementary foods depends on the age of the child and the quantity of breast milk consumed. The recommended figures should be used as general guidelines of the range of energy required from complementary foods, but the best indicator of adequacy will be the infant's growth. Energy deficiency affects growth in weight in the short term. When energy intake from food is low, the intake of many other nutrients will also be inadequate. Further, many complementary foods have a low energy density. It is usually around 0.3kcal/g where as the recommendation is 0.6kcal/g at 6 – 8 months and increasing to 1.0kcal/g at 12 – 23 months. As such, what is important is to increase the energy density of complementary foods and not the number of feeds a day.

5. Macronutrients of complementary foods

Dietary fats provide the young child with essential fatty acids, energy, and fat soluble vitamins (FAO/WHO 1994). Fats may also heighten the palatability in the diet, thereby promoting greater total energy intake.

The breast milk provides a generous supply of long chain fatty acids (1995) and as such young breast fed infant does not require further supplementation. However, FAO/WHO (1994) recommended that linoleic acid provide at least 3% of total energy in the diet. Therefore, if seed oils (corn or soybean oil) are used no more than 6% of the total energy would have to be supplied by these sources. But, if palm oil or coconut oil are used as much as 30% of energy would be required from these sources.

Generally, for children below 2 years of age, fat should range from 30% to 45% of total energy. The desirable fat content of complementary foods depends on the mother's breast milk fat concentration, intake of breast milk and the above guidelines. In order to meet 30% of the total energy from fat, the complementary food should contain about 0-13% energy from fat at 6-11 months and 21% at 12-23 months, assuming that the breast milk intake is average.

Assuming that consumption of breast milk is average, the protein density (g/kcal) of complementary food is not likely to be a limiting factor. However, this generalization may not hold if complementary foods are based on staples of low protein content. The evidence suggests that protein deficit is not a cause of growth faltering in countries, where cereals are the staple.

6. Micronutrients required from complementary foods

Meeting micronutrient needs from complementary foods appear to be the greatest challenge. The lower the concentration of micronutrients in breast milk, the more will be needed from complementary foods. The quantity of nutrients available from complementary foods depends on the bioavailability as well. Micronutrients that have poor bioavailability when consumed in plant products include iron, zinc, calcium and β-carotene. In addition, absorption of βcarotene, retinal, vitamins E and K is impaired when diets are low in fat.

The high prevalence of anaemia in developing countries (WHO, 1994 &1995) has been found to be due to the lack of available iron from unfortified complementary foods to meat the iron requirements of infants. The iron density of the diet is generally around one - tenth of that needed. If iron fortified infant foods are given the density appears 7 times higher. Key iron rich foods are liver, fish and beef; eggs are also high in iron, but its bioavailability is questionable, after the 1st year of life, the practicality of meeting iron needs from foods such as liver (60-80g/day) is questionable.

The situation is the same with zinc during infancy. Among the animal foods liver, dried fish, milk powder and beef are the best sources of zinc. However, an infant of 6-8 months needs to consume 50-70g of such foods per day to supply adequate zinc. It has been found that the low content and bioavailability of zinc in complementary foods may be one reason for growth stunting in developing countries (1998).

The breast milk vitamin A content of women in developing countries has been estimated as 50 µg per liter. However, breast milk retinal concentrations have been reported to be only half of this value in some regions of the world. Therefore, vit. A density of complementary foods needs to be higher. Under these circumstances, maternal vitamin A supplementation to increase breast milk concentration is an important option (beneficial to mother as well).

Good sources include liver, green leafy vegetables, milk, eggs, cheese and some orange or red fruits. For infants of 6-11 months of age the amounts of these foods required are 10-50g per day, in part because breast milk is a rich source of vit. A.

With regard to calcium, milk products and fish are the good sources. Cereals and legumes also contain a considerable amount of calcium but the bioavailability may be poor. Low calcium intake has been associated with stunting.

7. What are good complementary foods?

Good complementary foods are:

- rich in energy and micronutrients (iron, zinc, vitamins A and C and folate) and calcium
- clean and safe with no pathogens
  - no harmful chemicals or toxins
  - no bones or hard bits that can choke a child
  - not boiling hot
- not much spicy
- no added salt
- easy for child to eat
- liked by the child
- locally available and affordable
- easy to prepare

First Foods

The sequence of introduction first food most often followed in Sri Lanka is cereal (rice) gruel, fruits, potatoes, bread, vegetables, rice and curry, and finally meat and alternatives. However, it is recommended that the foods introduced at the early stage should be good sources of iron.

The infant's intestinal tract is relatively permeable, and this would predispose the infant's uptake of foreign proteins. As a result of this, allergic reactions could occur, and therefore it is customary to reduce the allergic load by using a single grain cereal as the first food. The use of single foods make it easier to identify the cause of an allergic reaction, where it to occur. Once it is known that single foods are tolerated, combinations of foods are added to widen the variety of nutrients ingested. Since all processed infant cereals are fortified with iron, they play a major role in preventing iron deficiency anaemia.

An important reason for the introduction of solid foods at the proper time is the developmental readiness of the infant to progress from sucking to spoon-feeding and from ingesting liquids to more textured foods. Adding foods to the bottle should be discouraged, as it dilutes the texture of the food and delays the progression to more advanced feeding skills. It is also thought that infants sucking food or thick liquids through a teat may be at risk for choking and aspiration.

Vegetables and fruits add colour, flavor, texture and variety to infant's diets. It is common practice to introduce fruits before vegetables among our mothers, because it is perceived that fruits are better accepted when introduced before vegetables.

The cooked egg yolk and legumes, cheese, yogurt and other milk products are also introduced from 6 month onwards. Traditionally, meat and alternatives are the last of the food groups to be introduced. The foods in this group include meats, fish, poultry, etc. The egg white which contains at least 23 different glycoproteins is not advisable to be given to infants until 10 months of age, to minimize any possible allergic reactions.

Table Foods

The transition to other solid foods, such as textured mixes, finger foods and table foods eaten by the rest of the family, takes place during the second 6 months of life because infants are ready to chew, and need more texture in their foods. Some infants go from semi-solid cereals and pureed baby food to finger foods and table foods in just a few months. Safe finger foods include bread, buns, crusts, dry toasts, pieces of soft cooked vegetables and fruits, cooked fish, dry fish, meat and poultry. At this time, most infants are developmentally ready to feed themselves and should be encouraged to do so. Important feeding behaviors at this time include taking food from a spoon, chewing, self-feeding with fingers or a spoon, and independent drinking from a cup. By 1 year of age, the ingestion of a variety of foods from the different food groups is desirable.

Home-prepared foods

A considerable interest has been shown by international agencies (WHO, FAO, UNICEF) involved in infant feeding in the last two decades, in home mixing of food components for infant feeding. The efforts have mainly been focused on the production of balanced weaning mixtures suited to the different socioeconomic and cultural environments. It is possible to produce appropriate mixtures by using locally available staples in an efficient manner.

Use of foods from the family pot has been the most practical approach in the prevention of malnutrition among children in the weaning age, even in impoverished families. The small shifts in food distribution within the family is of critical importance for the young child. The practicability of this approach is naturally subjected to cultural variation in the suitability of foods that are being used by other members of the family, eg. high fibre content, strong seasoning or low nutrient density.

Commercial baby foods

The infant food manufactures sometimes use modified starches in making commercial infant foods. These starches provide a means of controlling viscosity, prevent solids separating from liquids and impart a “mouth feel” to these products. These starches provide a source of energy in infant diet. The powdered or granular form of commercial baby foods are generally based on cereals, legumes and skim milk and modified starches, and enriched with vitamins and minerals. These products although are out of reach of an average mother, provide energy and other nutrients to the baby if fed in adequate amounts. These freeze dried food products have to be reconstituted by using boiled cooled water or a fruit juice, just before feeding. It is not necessary to add some form of milk as they already contain skim milk.

There are also other types of infant foods made available in jars, such are multi mixes that consist foods from all the 4 food groups, cut in to pieces and packed for children of each age group separately, according to the nutritional requirements. These foods are quite safe, nutritious, convenient, and palatable for the baby but the cost is far too high for an average family.

Community processed complementary/ weaning foods

The success of community processed complementary/weaning foods using intermediate technology depends on the demand for the product, the price, and marketing. Processed complementary foods have the potential to improve weaning diets, increase feeding frequency, and reduce preparation time and household fuel consumption. Such complementary/weaning foods are made from at least one legume, a cereal, and sugar or fat. The mixtures of these can be packeted and sold within the community and, can be eaten plain, made in to a porridge or mixed with other foods.

E.g. Corn + pea nuts + cow pea
Green gram + rice + peanuts
Soy + rice + jaggery etc.

Both industrially–processed and community processed complementary/ weaning foods are a response to the demand for convenient, nutritious foods for young children. However, in the developing countries, commercial weaning foods have not helped to reduce malnutrition, as poor families with the highest rates of malnutrition, could not afford these foods. Therefore an improvement of traditional weaning foods using local commodities have been recommended.

8. Problems during complementary feeding

The problems during the complementary/weaning process fall in to two broad categories: poor diets and detrimental feeding practices.

Poor Diets

Too few calories: Calorie requirement for children from 6m to 3yrs is about 100kcal/kg body wt. and generally breast milk provides a major proportion. In many cases the intake is lower than this amount, and is due to low calorie density of complementary/ weaning foods.

Foods that are higher in fat and low in water would provide a more nutrient dense source of food. Starchy staples prepared for complementary feeding (porridges, gruels in Asian countries) become highly viscous when cooked; consequently, large quantities of water are typically added to make the consistency appropriate for small children. As a result, the energy and nutrient concentration is greatly reduced. Due to their small stomach size, infants and young children cannot consume sufficient quantities of food to satisfy their nutritional requirements.

Too little proteins: The recommended protein intake is 1.6g/kg body weight for 6m to 1year and 1.2g/kg for children aged 1-3yrs. During the second half of infancy, a child with average weight for age needs 14g of high quality protein per day and for 1-3year olds the requirement is 16g per day; (if only from vegetable sources the requirements are 18g and 20g respectively).

Aside from the quality of protein, the digestibility is also important. Animal protein (from milk, meat, fish and eggs) is the most easily digested. Vegetable protein is more difficult to digest; some of the vegetable protein can not be utilized by the body. However, for a diet composed of rice, beans, vegetables and a small amount of animal protein, the amino acid quality would be 88% of the standard, and digestability would be 92%.

In many cases the protein intake will be adequate if calorie intake is sufficient. Promoting breast-feeding is important because breast milk provides a substantial source of high quality, easily digestible animal protein. It has been recommended that by age of 6m to 1year breast milk or other milk products be given in quantities of at least 500ml/day. With 500ml of breast milk, one third of the protein requirements of older infants are met.

Too few micronutrients: Many weaning diets contain inadequate micronutrient contents. It has been estimated that an adequate dietary intake of vit. A could prevent 23% of infant and young child deaths in developing countries. Other essential micronutrients are also at minimal levels (vit. C & B_{12}, I, Fe, Zn) in the weaning diets. Absence of these micronutrients over an extended period can result in stunted growth, mental and physical handicaps, reduced immunity to infections and death. There is evidence that iron and zinc deficiency can result in anorexia and decreased total dietary intake. Many infant foods available in the developed world are fortified with Fe, vit. A, D and B). A high proportion of animal foods in the diet also help to ensure high intakes of micronutrients.

Vegetable sources of iron (in grains which have high phytate levels) are not easily absorbed (only 1.4% in spinach and, 7% in soy beans) compared to 20% of the Fe from meat (liver). Iron from breast milk, fish and poultry is well absorbed but the iron concentrations in these are lower.

Although, the mean energy and protein intakes (per kg body wt.) can be adequate in certain situations, the micronutrient content may be insufficient, due to low animal protein intake. The low intake of animal products has been associated with inadequate consumption of several micronutrients including vitamins A, B_{12}, Zinc, and iron. Malnutrition (stunting or low ht. for age) is common among such children.

Poor (detrimental) Feeding Practices:

Malnutrition is more than a food issue; it is also a feeding issue. Various behaviors, traditional beliefs about food, and feeding practices affect childhood malnutrition. Detrimental practices include:

- o improper timing of the introduction of complementary foods, sub optimal breast feeding practices,
- o in frequent feedings,
- o inappropriate unhygienic ways of handling and preparing food.
- o non-responsive feeding

The effect of these practices is even more damaging when a child is sick.

Improper timing of the introduction of complementary foods

Early introduction

Breast milk is the complete, perfect food for infants during the first 6 months of life, yet breast milk is frequently replaced in early infancy with contaminated and nutritionally inferior substitutes. Lack of exclusive breast-feeding is a significant cause of infection in early infancy and can result in malnutrition. Pre lacteal feeds and early supplementation reduce breast milk production and introduce pathogens that greatly increase the risk of life-threatening diarrhea and other illness. Another issue related to timing is the appropriateness of the foods that are introduced. For example, sometimes certain foods are introduced before a child can chew them. Feeding whole pulses or soybeans to young babies is another instance, where the whole beans would pass through undigested.

Delayed introduction

Mothers delay introduction of semi-solid foods beyond the recommended age of 4-6months. Traditional guidelines often encourage mothers to wait until a child starts walking or reaches out for food or has teeth to chew. This delay can result in growth faltering and may "mute the learning experience provided from exposure to new tastes and textures of food". There are developmental stages associated with eating behavior. When pureed food is first offered to an infant, the infant depresses the tongue.

Food is pushed towards the back of the tongue, and the child swallows. Rhythmic biting motions begin around 7-9 months, even if no teeth have erupted. Those infants who have not been fed solid foods during the first year, experience difficulty in accepting and chewing the food.

Infrequent feeding

Given the small stomach sizes, young children need to be fed frequently during the day to ensure adequate food consumption and mainly to meet their energy requirements. The traditional weaning foods are not generally calorie dense, and not served even 3 times per day. There should be a higher calorie intake per feed, in the babies. A breast fed infant of 10–12month age requires a weaning food with an energy density of 50kcal/100g if fed four times a day. A non-breast fed infant of the same age needs even a higher calorie intake of 85kcal/100g.

Inappropriate feeding methods

The manner in which the child is fed also affect nutritional outcome. The quality of the social and psychological interaction during feeding can have an impact on the amount of food the child demands and ingests. The mother or the caregiver should have adequate skills, motivation, self-confidence and responsiveness to the child's needs. Responsive feeding is very much advisable. Further, force feeding and distraction should be avoided. A variety of foods should be offered.

9. How to develop recipes for weaning foods?

General considerations:

A meal is usually made from several foods, each food supplies some energy and different nutrients, all of which combine together in the meal. It is important that the foods are in right proportion so that there is an adequate balance between the nutrients, and between energy and nutrients.

The foods chosen for a weaning recipe should be easily available from gardens or local markets, low in cost, and used frequently in most households. The most popular and suitable recipes are those, which have been developed by local mothers with the help of a health or community worker.

Once few sample recipes have been developed, they should be tested on few children in one or two meals daily. From such trials, one can learn how the children like the recipe, whether the stools change in any way, and how much food can be given at one time, and also how long the food can be stored before it spoils etc.

The proportion of staple-supplementary food in the recipe should give the best protein value possible. The simplest recipe for weaning foods is one which has only two ingredients e.g. cereal or root mixed with a legume. This is called basic mix.

Some examples of basic mixes:

Staple	Supplementary	Staple	Supplementary
rice 65 g +	legume 25 g	sweet potato 125 g +	legume 50 g
rice 55 g +	skimmed milk 15 g	sweet potato 100 g +	dried whole milk 30 g
rice 65 g +	chicken 25 g	sweet potato 180 g +	chicken 35 g
rice 70 g +	fish 30 g	sweet potato 210 g +	fish 35 g
rice 65 g +	egg 30 g	sweet potato 180 g +	egg 30 g
		sweet potato 150 g +	soy 25 g
		sweet potato 175 g +	skimmed milk 20 g

If potatoes are used as the staple, the amount of potato can be approximately double the quantity of sweet potato, and the supplement could be slightly less than that of with sweet potato. The above quantities provide the basis of a meal for a child of about 2 yr of age.

Other foods can be added to the same to make a complete meal. To each of these basic mixtures either 10g of oil or 5g of oil with 10g sugar or 20g sugar, can be added in order to improve energy content and palatability. Each mix would then provide about 350 kcal (one third of the daily need of a 2 yr old child) and 5-6g of protein. The volume of the meal makes up to about 150-250 ml, once prepared.

Recipes more suitable for weaning period are called multimixes. A multimix has four basic ingredients:

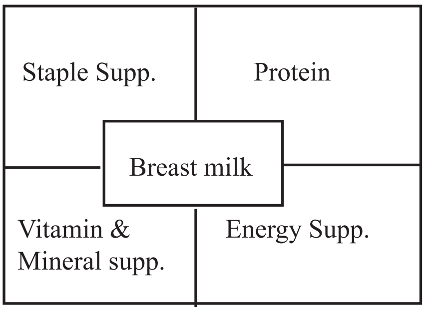
Staple as the main (cereal)
Protein supplement from plant or animal food (beans, groundnuts, milks, meats, chicken, egg, fist etc.).

A vitamin and mineral supplement (vegetable and / or fruit, green leaves)

An energy supplement (fat, oil or sugar to increase the energy concentration of the mix).

When all 4 are mixed in suitable proportions they form a complete meal. This can be illustrated as a food square and it can be a useful concept on how to choose ingredients for weaning foods.

As breast milk is a complete food, it can be considered at the middle of the square. It can be an important food during the weaning period. Although after some time, the daily amount may not be large, it is a valuable source of energy and nutrients.



10. Importance of feeding a mixture of complementary foods:

Other foods must be eaten with the staple to fill the nutrient gaps. The types of foods that fill the gaps best are -

- pulses (beans, peas green gram etc) and oil seeds (sesame, groundnuts)
- foods of animal origin
- dark green leaves and orange - yellow fruits and vegetables
- oils and fats and sugars/ jaggery/ treacle etc.

The staple

Every community has a staple food. It is the main food eaten. E.g. Cereals (rice, wheat, millet), roots (potato, yam cassava) and starchy fruits (plantain and bread fruit). Staple foods provide energy, mostly from starch, cereals also provide protein. Yam and potato provide more protein than other roots but not as much as cereals.

Staple foods are poor sources of iron, zinc and calcium. Cereals contain phytates which interfere in the absorption of iron, zinc and calcium contained in the meal. Fresh roots provide vitamin C. The yellow varieties of maize and sweet potato are good sources of vitamin A (carotinoids).

This means the staple must be eaten with other foods for a child to get enough nutrients.

Problems with porridges/ gruel's made from staples alone:

Porridge or gruel can be made from any staple. When the starch from staples (cereal or cereal flour yam or starchy fruit) is mixed with water and cooked to make a porridge or a gruel, the starch absorbs water and swells up. This makes the preparation thicker. If it is too thick the child does not eat, and therefore a large amount of water is often added to keep it thin, and this dilutes the preparation. As a result it becomes very watery having a low energy and nutrient concentration.
There is a similar problem with soups. Although they may contain nutritious foods, they can be very watery and dilute unless the solid matter of the soup is fed to the child.

Suggestions to make a more energy dense and nutrient rich porridge or a gruel:

- cook with less water and make a thicker porridge/gruel. It should be too thick to drink and be fed with a spoon.
- replace some water with milk
- add extra energy and nutrients to enrich thick porridge/gruel, by selecting some out of milk powder, sugar, margarine, ghee, peanut butter or paste, sesame seed paste.
- adding fatty/oily foods
- roast cereal grains before grinding them in to flour. Roasted flour does not thicken much, so less water is needed to make a gruel / porridge.

In a soup -

o take out solid pieces and mash to a thick puree and mix. Soften with little margarine or butter for extra energy and taste.

o Adding a small amount (1 tsp.) of germinated flour.

The cereal grains can be germinated (sprouted) before being eaten. This practice improves the texture as well as the nutritional quality. After germination, they can be dried and ground into flour. This type of flour does not thicken much during cooking, so less water can be used.

Germination also reduces the phytates present in a cereal, and helps to absorb more iron. Germinated cereal flour can be added to soups, porridges and gruel's when cooked a little, and should be boiled again for few minutes after adding the flour.

Pulses and oil seeds

Pulses and oil seeds are good sources of protein, but they lack vitamin A, and when dried, they lack vitamin C. Oil seeds and some pulses (ground nuts, soy bean) are rich in fat and high in energy too. As with cereals, pulses and oil seeds contain phytates which interfere with the absorption of iron, zinc and calcium.

In addition to phytates, most raw peas, grams and beans contain several other anti nutrients that interfere with the way nutrients are used by the body. Thorough cooking destroys most of these substances, but does not destroy phytates. Soaking dry peas, beans and grams, and throwing away the water before cooking helps to remove anti nutrients, and also reduces phytates. Examples of low fat pulses are - chickpea and dhal (Bengal gram), lentils, cowpea and dhal, red bean (kidney bean) broad bean, mung bean and dhal (green gram), navy bean, long bean etc. Soybean is a high fat pulse. Oil seeds are - ground nut (peanut), sesame seeds (gingerly seeds), cashew nut, pumpkin - sunflower and melon seeds.

Foods of animal origin

Foods from animals, birds and fish (including shellfish) are rich sources of many nutrients but are often very expensive. Their flesh, organs (liver heart, kidney) eggs and blood as well as milk, yogurt, cheese are good sources of protein.

The above foods are also considered best sources of iron and zinc because of the fact that iron and zinc in these foods are very well absorbed. Iron, vitamin A and folate are stored in liver, so even small servings of liver provide large amount of these nutrients. Egg yolk is another store of nutrients and is another rich source of vitamin A. The iron content of egg yolk is high, but it is not well absorbed. Milk fat (cream) contains vitamin A, and as such, milk products made from whole milk (dried milk, evaporated milk, condensed milk, cheese, yogurt and curds) contain vitamin A.

Foods made from milk and food containing bones that are eaten such as small fish, canned fish or pounded dried fish are good sources of calcium.

Dark green leaves and orange/yellow vegetables and fruits

These foods are grouped together because they are all rich sources of provitamin A (carotene). The darker the leaf or stronger the yellow or orange colour, the more β carotene they contain. Dark green leafy vegetables are also rich in folate and iron. Most other fresh vegetables and fruits, and leafy vegetables provide vitamin C, which helps iron to be absorbed from all the plant foods in the meal. The best sources of vegetable carotene are carrot, yellow sweet potato, ripe jack fruit, pumpkin, papaw, mango, passion fruit etc.

Oils fats and sugars

Oils (coconut, soy corn ground nut, sesame palm) and fats (butter, margarine, ghee) are concentrated sources of energy. Adding 1 teaspoonful of oil or fat to a meal gives extra energy in a small volume. Red palm oil is very rich in vitamin A. Butter and ghee also provide vitamin A, white margarines usually have vitamins A and D added to it by the manufacturer. Sugar, jaggery, treacle and honey are also energy - rich food that can be added to porridge, gruel's and other foods in small quantities.

11. Planning a multi-mix (guidelines)

* There should be enough energy concentrated into a small bulk, as well as adequate protein, vitamin and mineral values.
* Choose the staple, preferably a cereal
* Choose one or more than one protein supplement. E.g. legumes with little fish, groundnut with green gram, cowpea with sesame seeds (ground) etc.
* Decide on the amounts of staple and the supplement, considering the volume of solid foods the child can eat and the amount of water that will be absorbed during cooking.
* Calculate the energy value of this basic mix.
* Choose vitamin and mineral supplements. E.g. Dark green leafy vegetables, yellow/ orange fruits and vegetables are most suitable.
* The availability of iron can be increased if foods containing vit. C and/or small amounts of meat or fish are included.
* Choose the energy supplement (fat or oil) to increase energy value

of the multi-mix. But should be within 25-30% of the total energy content in the mix.

* Decide on any foods with good natural flavorings if needed to make the food more accepted by the child.
* Choose a method of cooking that should be simple and save important nutrients.

The multi- mixes can be given to infants from 6 months onwards, depending on the age of the child and the number of weaning meals/day. The amount of a weaning meal has to be decided as indicated below.

Daily Rec. energy intake- (energy value of B.M/day) = energy content that should be provided by weaning meals(x)

If 03 weaning meals are given a day, the energy value of each meal should be one third of "*x*".

Examples for weaning meals (multi-mixes)

	Multi-mix	local measure	
1.	rice 40g	½ teacupful	Energy value –220 kcal
	green gram 10g	1 tab. spoonful	cooked volume-150 ml
	butter/margarine 5g	1 tea spoonful	(for 5-7 m)
2.	Porridge/gruel		
	rulung (roasted) 40g	1/3 tea cupful	Energy – 240 local
	lentils 20g	1 ½ tab. spoonful	cooked volume-150 –200ml
	ground sesame seeds 5g	1 tea spoonful	(for 5-7m)
3.	Porridge		
	wheat flour (roasted) 40g	2 tab. spoonful	Energy – 250 kcal
	oil 5g	1tsp	cooked volume – 150ml
	carrot (grated) 10g	1" cube	(for 6 – 8m)
	sweet potato 40g	1 small	
4.	Leafy gruel		
	rice 35g		Energy – 200 kcal

green leaves 35g
coconut milk(from 20g coconut)
sugar 10g

cooked volume-150 -200 ml
(for 6-8 m)

5. Multi-mix
corn flour 40g
sugar 10g
groundnuts 25g (roasted & ground)
milk 100 ml

Energy – 395 kcal
cooked volume –250 – 300ml
(for 7 – 9m)

6. Multi-mix
potato 150g
green leaves 40g
green gram or chick pea flour 20g
oil 5g

Energy – 300 kcal
cooked volume –200 – 250ml
(for 7 – 9)

7. Multi – mix
rice flour (roasted) 20g
green gram flour (roasted) 8g
milk 50ml

Energy – 140 kcal
cooked volume – 150 ml
(for 5 –7m)

8. Multi – mix
cream cracker biscuits 3
plantain 1 small
milk 50 ml 1

Energy 180 kcal
volume – 100 ml
(for 4 – 5m)

9. Multi – mix
slice of bread (1/2”)
egg yolk
orange juice
margarine 5g

Energy 150 kcal
volume 60 ml
(for 5-6 m)

10. Multi – mix
potato 200g
carrot 15g
½ yolk/fish 20g
green leaves 20g

Energy 200 local
cooked volume 125 –150 ml
(for 5 –7)

11. Soup
rice 15g
lentil 5g

Energy 150 kcal
volume 100 – 150 ml

potato 25g (for 6-7m)
carrot 15g/ pumpkin 15g
tomato 30g/ green leaves 20g
margarine 5g

12. <u>Soup</u>

rice 15g	Energy 170 kcal
lentil 5g	cooked volume 100 – 150 ml
potato 25g	(for 6-7m)
fish 30g	
green leaves 20g/tomato 30g	
margarine/butter 5g	

13. <u>Mix</u>

pumpkin 20g	Energy 100 kcal
sweet potato 60g	cooked volume 60-80 ml
margarine 5g	(for 5 –6 m)

14. <u>Gruel</u>

rice 15g	Energy 70 kcal
lentil 5g	cooked volume 60ml
tomato 20g	(for 5m)

12. How do complementary /weaning foods fill the energy and nutrient gaps?

The difference between the amounts children need and the amounts supplied from breast milk is called the gap. Figures 3.3, 3.4 and 3.5 show the gaps of nutrients for children of 6 to 24 months of age.

The 100% line represents the amounts of energy, protein, iron, zinc and vitamins needed each day by an average child. The dotted sections indicate by how much of the daily needs are supplied by breast milk, only if the child is breast fed frequently. The biggest gaps are seen for energy and iron, and smallest is for vitamin A. However, breast milk appears to provide considerable amounts of energy and nutrients even in the 2nd year of life.

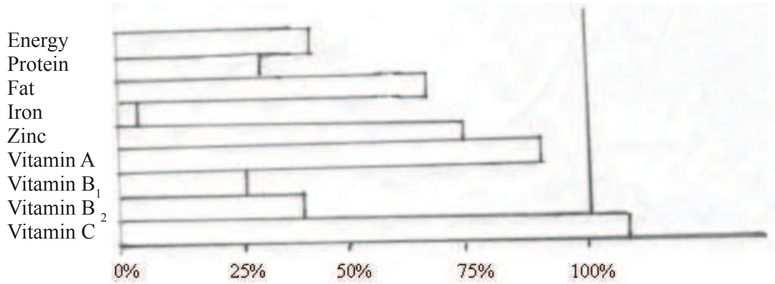


Figure 3.3 Percentages of daily needs at 6-9 months that can be met by breast milk

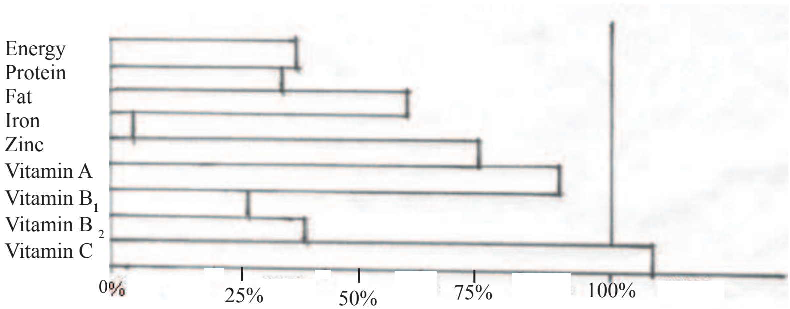


Figure 3.4 Percentages of daily needs at 10-12 months that can be met by breast milk

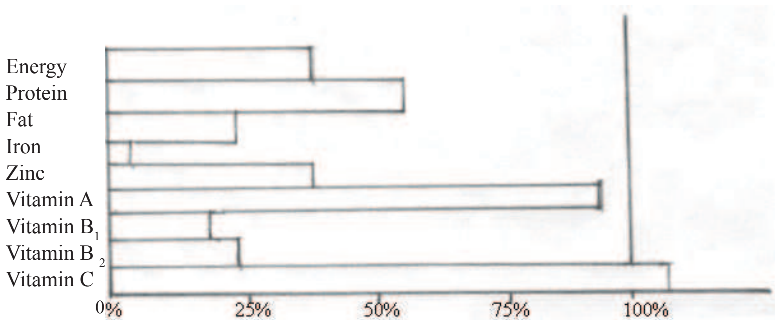


Figure 3.5 Percentages of daily needs at 13-24 months that can be met by breast milk

The gaps can be filled by giving suitable mixtures of complementary foods during the day.

A good mixture is a staple+pulse+animal food+green leaves or orange fruit or vegetable with small amount of oil or fat to give extra energy if none of the other foods in the mixture is energy rich.

Meal 1

Staple (rice cooked) - 3 rounded table spoons
Pulse (cowpea/lentil/mung bean) - 1 rounded tablespoon
Fat (margarine/butter) - 1 tea spoon

Meal 2

Staple (cooked rice) - 3 rounded table spoons
Animal food (fish or liver/lean meat) - 1 rounded table spoon
Green leaves (spinach, amaranth etc.) - 1 rounded tablespoon or orange vegetable (carrot, pumpkin yellow sweet potato or orange tangerine etc.) - 1 rounded table spoon
Fat or oil - 1/2 tea spoon

A days meal plan for the child to fill the gaps.

- o frequent breast feeds
- o 3 meals - a morning meal of cereal porridge
  - • a mid day meal (example meal 2)
  - • a evening meal (example meal 1)
- o 2 snacks - 1 slice of bread with butter or margarine
  - 1 biscuit and a plantain

It is seen in the figure 3.6 how much of the gaps are filled when the child eats the staple alone. This meal contains 3 rounded Table spoons of cooked rice + 1 tea spoon of fat that helps to :

- o fill the energy and protein gaps
- o has only a very small effect on the iron gap
- o has no effect on the vitamin A gap

If potatoes or yams are used instead of rice, a smaller effect on the protein gap would be there. Other roots (cassava or starchy fruits would have almost no effect on the protein gap. When one rounded Table spoon of beans (legumes) are added to the same meal it,

- shows a small effect on the energy gap
- almost fills the protein gap
- has a small effect on the iron gap
- has no effect on the vitamin A gap

If oil or fat has been used or a high-fat-pulse or oil seeds included, more of the energy gap would be filled.

When a fruit (half an orange or a piece of papaw) is given with the meal the absorption of iron is improved from the other foods in the meal.

Adding half an orange
- has a small effect on the energy and protein gaps
- improves the absorption of iron in the rice and beans
- has only a small effect on the vitamin A gap

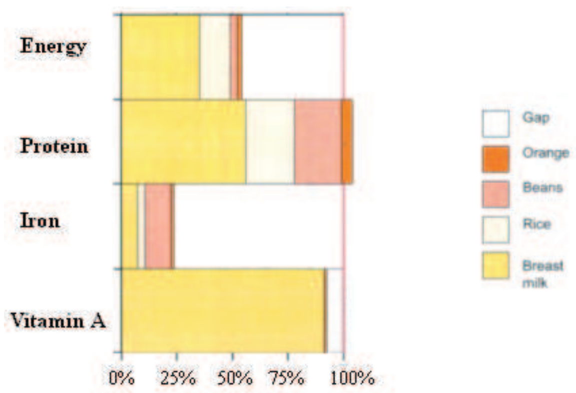


Figure 3.6 Percentage of day's needs at 12-23 months that can be met by breast milk and a meal 1 of (rice + fat + beans / dhal) + orange

If a mango or papaw or passion fruit is used instead of orange, these would have provided a lot of vitamin A as well as vitamin C.

The meal 2 alone with breast milk (Figure 3.7) fills the gaps except in energy and iron. Adding fish (1 rounded Table spoon):

- has a small effect on the energy gap
- fills the protein gap
- has a small effect on the iron gap
- has no effect on the vitamin A gap

If small fish is given with their livers some of the vitamin A gap will be filled. Adding fish improves the absorption of iron from the plant foods in the meal. What happens to the remaining gaps when plant foods are included in the meal? Adding dark green leaves (1 rounded Table spoon):

- has very little effect on the energy gap
- provides some protein
- provides some iron
- provides lots of vitamin A and completely fills the gap

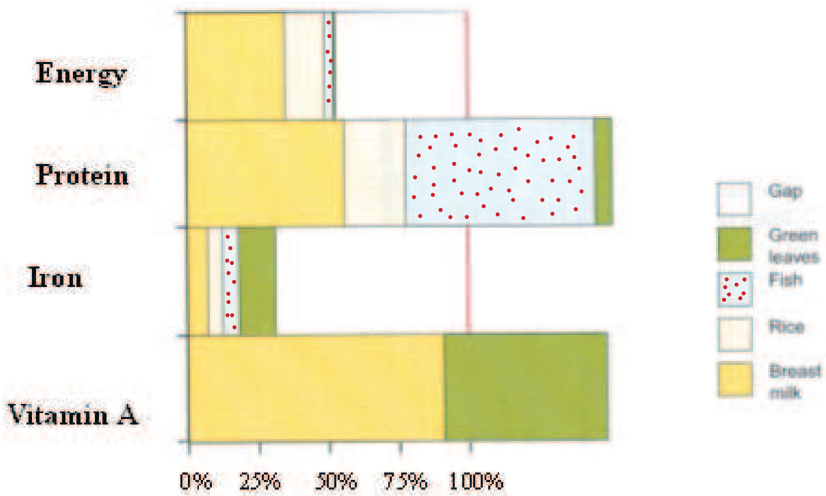


Figure 3.7 Percentage enhancement of protein and vitamin A

When chicken liver is used instead of fish (Figure 3.8) most of the gaps are filled except in the case of energy. Adding liver (1 rounded Table spoon).

- has a small effect on the energy gap
- fills the protein gap
- fills the iron gap
- fills the vitamin A gap with quite a lot of excess vitamin A

When all 3 meals (morning+mid day+evening) and 2 snacks are given all the gaps can be filled except the iron gap. However, if liver or meat (flesh and organs of animals) are included instead of fish, the iron gap too can be filled. This is seen in Figure 3.8.

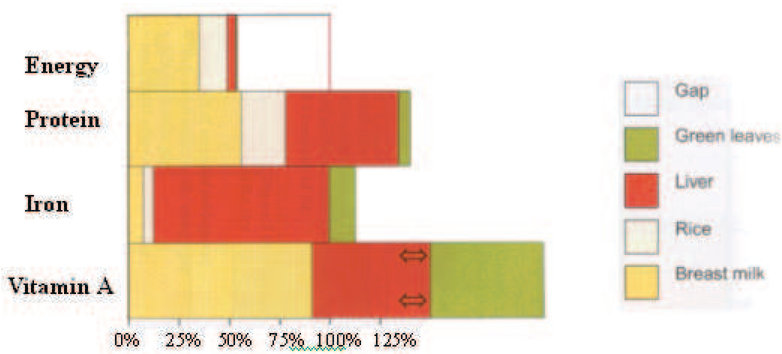


Figure 3.8 Percentage of day's needs at 12-23 months that can be met by breast milk and an evening meal of rice + liver + green leaves

Another way to provide more iron is to give food fortified with iron (cereals, bread, wheat flour etc.). In some countries baby cereals, fish sauce, milk powder, curry powder, sugar and salt are fortified with iron.

Which foods make good snacks?

Children need snacks to fill the energy gap. Snacks are eaten between meals. Good snacks provide both energy and nutrients.

- o mashed ripe banana, papaw, avocado, mango and other fruits
- o yogurt, custards, puddings etc. made with milk
- o bread and buns with butter or margarine
- o biscuits, crackers with a plantain
- o boiled potato, sweet potato
- o cakes, ice cream

Poor value snacks (high in sugar & fat, rots the teeth)

- o aerated waters
- o ice lollies, lollipops
- o sweets, candies
- o chips
- o Tipi-tip

13. Counseling about child's food

When you counsel a family about a child's food you will need to suggest some options for them to consider. They will have to decide what is possible in their circumstances. It is important to find out first whether the baby is being breast- fed and what other foods the baby is being given. Then consider if these make a good mixture that will fill the nutrient gaps. If there are gaps suggest suitable alternatives that families can afford to give. Foods of animal origin being expensive can be given occasionally. Help the mothers to think through what is really possible.

A child who is big for his age may need more food. Children of 6-11 months of age need less complementary food because their energy gap is smaller. But it is very important to remember that their iron gap is bigger, and therefore iron rich foods are especially needed for the younger child.

If children are not breast fed or breastfed infrequently, they will need food of animal origin, and if possible milk products to be certain to make up for the nutrients they miss from breast milk.

It takes time for a young child to learn how to use the lips to clear food off the spoon or to take in to the mouth when fed with fingers, and how to move the new food to the back of mouth for swallowing. Some foods may run down the chin, or be spat out. Mother has to be told to expect this as it does not mean that the child dislikes the food. With encouragement and patience a child soon learns how to eat new foods and enjoy new tastes. The taste of new foods may surprise the child.

As such mothers should be advised to:

- start by giving one or two teaspoons twice a day

- gradually increase the amount and variety (by 9 months child should be eating variety of foods). As the child becomes older:
    - continue to breast feed often
    - increase the amounts of food given at meal times and give as much as the child would eat with active encouragement
    - gradually increase the number of meals.

- complementary foods 3 times daily at 6-7 months, increasing to at least five times (3 meals and 2 snacks) by 12 months
    - at first make the food soft; later mash or cut in to small pieces
    - help and encourage the child to eat

- in nutrition education programmes emphasis should be made on
    - describing changing pattern of feeding as children grow older
    - recommending frequent breast feeding for 2 years
    - suggesting what complementary foods to give, how much, and how often
    - using locally available mixtures of foods
    - showing families actively encouraging their children to eat

14. Fluids in infants and young child feeding

- exclusive breast feeding does not need extra fluids up to 6 months.
- bring all water for feeding infants under 4 months of age to a rolling boil for at least 2 minutes to ensure that it is pathogen free. However, no water is needed in exclusively breast fed infants.
- do not give fruit juice to avoid interfering with the intake of breast milk or infant formulae.
- do not use herbal teas or other beverages
- drinks should not replace solid foods
- if drinks are given with a meal it is best to give after the food is eaten
- boil the cow milk before feeding, if not pasteurized

Non-breastfed infants and young children need at least 400-600 ml/d of extra fluids (in addition to 200-700 ml water estimated to come from milk and other foods) in a temperate climate, and 800-1200 ml/d in a hot climate. The total amount of water needed per day depends on the child's urinary and non-urinary water loss (WHO 2005).

The well water may have naturally high concentrations of nitrates, nitrites, arsenic, fluoride or other heavy metals. Testing for these substances as well as for coliform bacteria is recommended in doubtful areas. Water containing more than the maximum acceptable concentration of nitrate (10ppm) is a health hazard for infants up to the age of 3-6months, since it may result in methaemoglobinaemia. Nitrates are not eliminated by boiling the water. Water containing in excess of 1.5ppm of fluoride may cause dental fluorosis and should not be used.

An excessive consumption of fruit juices may indirectly contribute to inadequate intake of needed nutrients and energy. Because of sorbitol and fructose content of fruit juices, excessive intake may lead to diarrhoea, poor weight gain and failure to thrive. AAP (2004) recommended no more than 180 ml of fruit juice per day. Excessive fruit juice intake may also be associated with dental caries. Although dilution of juice is a common practice, there is no clear rationale for this manoeuvre. Plain water is recommended to satisfy thirst.

Beverages containing caffeine and theobromine (caffeine-related substance) are not recommended for infants. Coffee, tea, some carbonated beverages such as colas and hot chocolate contain these substances, which act as stimulant drugs in the body.

Sodas, commercially made fruit drink and punches are also not recommended for infants because of their high sugar content and lack of nutrients other than carbohydrates. Beverages containing artificial sweeteners such as aspartame are also not recommended for infants.

4. NUTRITION OF PRE TERM AND LOW BIRTH WEIGHT INFANTS

Pre-term and other low birth weight infants require special care. They are a group at high nutritional risk because nutrient deprivation in early life is thought to exert a significant effect on long term outcome.

Low-birth weight infants represent > 30% of births in some developing countries. It is 17.5% in Sri Lanka. Low birth weight infants are more vulnerable to nutritional deficiencies because they are more likely to be born to malnourished mothers and to have lower stores of several key nutrients at birth.

1. Classification

- normal birth weight (2.5-3.5kg in Sri Lanka)
- low birth weight (LBW) (<2.5kg pre term, light for dates or both)
- very low birth weight (VLBW) (<1.5 kg)

Pre-term infants are those born before 37 weeks gestation. Pre-maturity is one cause of low birth weight and, 80% of LBW infants of light for dates born pre-term in Sri Lanka have a size appropriate for gestational age. Rest of LBW infants show intrauterine growth retardation and are "small-for-date". The nutritional management of these two groups are not identical.

2. Nutrient needs

All LBW infants are considered to be at "risk" of nutritional inadequacy. However, the requirements have to be defined and met on an individual basis, as their requirements are influenced by gestation, post-natal age and concomitant illness.

Pre-term infants have

- low nutrient stores eg. Ca, Fe, Zn, glycogen and fat
- immature organ and enzyme systems
- high nutrient requirements

Small-for-date infants

- have lower energy stores (fat and glycogen) than normal birth weight infants
- are prone to hypoglycemia
- have higher nutrient requirements
- risk inadequate bone mineralization
- have vitamin and mineral deficiencies
- have prolonged sub-optimal growth, but not in pre-terms
- need more water soluble vitamins

LBW infants start with a position of nutritional disadvantage. Achieving good catch up growth is dependent on optimum nutrition, which is required from birth. A good nutrition should be maintained throughout the first year as low weight at one year has shown a strong correlation with increased risk of diabetes and coronary heart disease in later life.

3. Early feeding of low birth weight infants

Nutrient needs are determined on an individual basis and feeding methods and regiments vary considerably. The different milks used to feed pre term infants are:

- mothers breast milk (exclusive breast feeding)
- mothers nutrient supplemented breast milk
- banked breast milk (not available in SL)
- specialized "low birth weight" infant milks
- standard infant milks (Formula 1)

Pre-term breast milk

Mother's breast milk is known to confer immunological protection, reduce the risk of necrotising enterocolitis, contribute to gut maturation and enhance neurological development. LBW babies can be fed with breast milk alone. If nutritionally inadequate, optimum pre-term postnatal growth could be achieved by using "low-birth-weight" infant milks, along with breast milk. The average breast feeding frequency and duration, of the LBW infants are generally higher than that of other infants.

Low-birth-weight infants milks

Low birth weight milks have a higher nutrient density than standard infant milks. They are for use in hospitals only and until a weight of 2kg is achieved. The majority of low birth weight milks are fortified with long chain polyunsaturated fatty acids because the capacity of pre-term infants to synthesize these is limited.

It is also important to consider the micronutrient status of exclusively breast fed infants. In low birth weight infants, whose iron reserves at birth are low, medical iron drops are recommended beginning at 2-3months of age. For prevention of iron deficiency anaemia, iron drops are likely to be more effective than provision of complementary foods before 6 months, even if the foods are iron fortified. Similarly, where vitamin deficiencies are concerned, supplements given directly to the lactating mother are likely to be safer than complementary foods given to young infants in environments in which contamination and diarrhoea morbidity are prevalent.

To ensure success in the global efforts to reduce malnutrition, the focus should primarily be on infants and toddlers, as it has been estimated by the WHO that malnutrition contributes to over 25% of the child mortality in developing countries, and occurs mostly during the first 3 years of life.

4. Nutritional Management of LBW infants in the community

A good catch up growth until 2 years of life should be achieved by LBW infants, to prevent a retarded growth. Unless good catch up growth is achieved the growth in them can remain retarded. Accordingly the following should be considered as general information.

- Growth - LBW infants require careful monitoring to ensure that satisfactory growth is maintained.
  - wt. and length should be measured regularly.
  - reduced linear growth can be associated with an inadequate supply of bone minerals (Ca, Zn & P).
  - LBW infants showing either poor weight gain or reduced linear growth should always be referred for immediate assessment.
- Energy requirements - LBW infant should be breast fed often.
  - if the weight gain is inadequate some nutrient enriched milks may be more suited to facilitate better growth and bone mineralization.
  - it is highly desirable that all LBW infants achieve catch up growth in the first year.
- Vitamins and minerals - different combinations of supplementary vitamins and minerals will be required by individual infants.
  - pre-term infants have reduced iron stores, and supplements may be prescribed from 6-8 weeks until the end of first year.
  - excessive iron intake is associated with increased risk of infection. If an iron-supplemented formula is given additional iron supplements are not necessary.
- Complementary feeding – exclusive breast-feeding has been shown to be compatible with normal growth even in low birth weight babies. Commencing complementary feeding is not recommended before 4 months, or before an infant is 5 kg in weight (generally at 19 weeks).
  - the first foods should be bland, thin and with smooth consistency with low allergenicity.

- high-energy dense foods should be given, large quantities of fruits and vegetables are not appropriate.
- delaying the introduction of foods associated with allergic reaction (cow milk, wheat, eggs, soy) until 6 months of age is recommended especially when there is a family history of atopic diseases.
- complementary food can be fortified with special energy supplements (fats such as corn oil, vegetable oil, margarine or butter) if weight gain is poor

5. NUTRITION IN 1-3 YEARS

1. Introduction

Healthy eating is important in the years from one to three in order to:

1. provide energy and nutrients needed to grow and develop
2. develop a sense of taste and an acceptance and enjoyment of different foods
3. instill attitudes and practices which may form the basis of life long health -promoting eating patterns.

The period from 1-3years has been described as the initial phase of diatery transition from infant to adult-style eating habits.

Development of healthy eating skills during this period is a shared responsibility of the parents/caregivers and the toddlers. To encourage healthy eating skills, parents and caregivers have an obligation to recognize and respond appropriately to their toddler's individual verbal and non-verbal hunger cues (restless or irritability), and to satiety cues such as turning the head away, refusing to eat, falling asleep or playing.

Toddlers can be encouraged to feed by themselves at the beginning of a meal when they are hungry, but may need help if they tire later in the meal. Pressurizing the toddlers to eat by using excessive verbal encouragement may lead to negative attitudes about eating.

Small frequent feedings

Small and frequent, nutritious, energy dense feedings are important for meeting the nutrient and energy requirements of toddlers during the second year. Older infants need 4 to 6 small feedings a day in addition to their milk source. Their appetites vary not only according to growth and activity, but also according to factors like fatigue, frustration, minor illnesses and social context. Therefore older infants should be given small servings, along with the opportunity to ask for more if they are still hungry.

Variety

Ingestion of a variety of foods daily from the 4 food groups is recommended to prevent nutrient deficiencies. It has been demonstrated that most young children, if provided access to a varied diet of foods from each of the food groups, will consume adequate amounts of nutrients and energy. No single food even if it is perceived as nutritious should be consumed in excess. As with all the foods, moderation in fluid intake is recommended.

Dietary fat is an important source of energy and the only source of essential fatty acids. Therefore dietary fat restriction during the first 2 yrs is not recommended because it may affect the growth and development.

2. Meeting nutrient needs

The diet of any young child must provide adequate energy and nutrients for growth, building body, nutrient stores, body maintenance and repairs, and day to day activities.

Although rate of growth from 1-3 years is less than in infancy, nutrient needs are still high in relation to body size. Toddlers have a small stomach capacity and often variable of appetites. They therefore require a nutrient dense diet to enable energy and nutrient needs to be met. The period from 1-5 years is particularly important for brain and functional development. A poor diet can have an adverse effect on both growth and development.

A diet considered healthy for adults, which is low in fat and high in fibre, is not suitable for young children because of its low energy density and high bulk. Nutritious high fat foods should not be limited. However, certain high fat foods such as chips, chocolate, sweet biscuits and cakes should be limited, as these foods are of low nutritional value, and a high intake may result in excessive energy intake and weight gain. It is important to develop healthy eating habits in toddlers because many risk factors for CHD, obesity, hypertension and hyper-cholesteroleamia have their origin in childhood.

Dietary fiber is important for the long-term health of the gut and prevents constipation. Foods containing fiber (cereals, vegetables, fruits and pulses) supply a variety of vitamins and minerals. A high fiber diet can be bulky and of low nutrient density. Excessive fiber intake can also interfere with absorption of minerals and can sometimes cause diarrhoea or intestinal discomfort in young children.

It is recommended to reduce sugars other than those found in fruits and milk in the toddler's diet. Sugar is unnecessary as a source of energy in the diet because all starchy foods are digested to supply glucose, the body's main energy source. Sugar supplies no nutrients other than calories, and frequent consumption of foods containing sugar is associated with a high risk of dental caries because the neutralizing capacity of saliva is inhibited.

3. Encouraging young children to eat

Appetite is a good guide to the amount of food a child needs if the child is fed frequently and is encouraged to eat. If the appetite decreases, it is a sign that something is wrong. Perhaps the child is ill or unhappy, or jealous of a new baby, or the child is trying to get extra attention, or is going through a funny stage, sometimes when the diet is the same every day and the child is getting tired of the same taste. If the appetite remains poor for some time, the child may become malnourished.

A mother/father or any other responsible person should actively encourage and help a young child at meal times even when the child is well and has a good appetite. It is especially important to supervise mealtimes from the time a child starts other foods up to two years of age. A child when just left alone it is important that the child has sufficient time to eat enough.

Therefore, the mothers/families should be advised:

- to have the baby's meal in a separate bowl or a plate to make sure child gets a fair share and eats the amount required
- to sit with the child at mealtimes, watch what the child is eating, and actively give help and encouragement when needed. Encouraging a child to eat needs patience and a good sense of humor.
- not to hurry the child. A child may eat a bit, play a bit, and then eat again
- once a child has stopped eating, to wait a little and then offer more
- to give some foods that the child can hold or pick up. Young children want to feed themselves, parents should encourage this but be ready to help to make sure that most of the food is eventually eaten
- to mix foods together if the child picks out and eats only his favorite foods
- to feed as soon as the child is beginning to get hungry. If the child waits too long to eat and gets upset, he may loose his appetite
- not to feed the child when he is sleepy
- not to force-feed. This increases stress and decreases appetite even more, mealtimes should be relaxed and happy occasions.
- to make sure that the child is not thirsty. But not to give too much liquid before or during the meal as the appetite can be reduced.
- to play games to persuade reluctant children to eat more. Imaginative games can be created to help reluctant children to eat more
- offer the meal in an attractive way for the child

A child may refuse food in order to gain attention. Such children need company and they should be helped well praising them for eating well. If the child refuses food, take it away and offer it later. If he continues to refuse, it means that the child dislikes the food, and should be offered something else.

4. Safety issues around feeding

Foods provided to infants must be free of pathogens, appropriate in size and texture, nutritionally sound and fed safely.

To help keep food safe from pathogens, advise the families to:
- wash hands with soap and water before preparing food
- use fresh food that looks and smells good
- keep perishable food (meat, milk, fish, etc.) and cooked food in a refrigerator if available in the family
- cover cooked food and eat within 2 hours if there is no refrigerator. If kept longer, reheat food thoroughly so that it is all boiling hot and any pathogens will be killed
- wash children's hands before meals
- feed the child with clean cup, plate or spoon, never a feeding bottle
- use fermented foods whenever possible to improve the bioavailability of some nutrients as well as to reduce the bulk. This will improve viscosity and the nutrient density of food.
- keep animals outside the house
- keep the house and outside areas clean, to prevent breeding of files, rats and mice
- use potties for young children and remove faeces immediately into a toilet
- wash dirty nappies straightaway or put them in a tightly closed bucket and/or basin.
- protect food and stored water from rats, mice, files, cockroaches, dust.

To prevent choking and aspiration
The risk of choking can be lowered when caregivers (families) are aware of their toddler's chewing and swallowing abilities. They should supervise infants while eating foods with the potential to cause choking (nuts, fruits with seeds, pea etc.), and know how to handle choking if it occurs. Supervision also includes the infant sitting upright, while eating, and not lying down, walking, running or being distracted from the task of safe eating.

5. Feeding the sick child

During the weaning period young children often suffer from chest infections, diarrhea and rarely measles. If their diet has been adequate, their symptoms are usually less severe than those of undernourished children.

A sick child needs food so that he can fight infections without using up all the nutrient reserves in his body. However, often he is not hungry or he feels sick. The mothers mistakenly believe that a sick child should have little or no food.

The breast-feeding should be continued even if the child has diarrhoea or vomiting. An adequate fluid intake is essential especially when there is an infection. Boiled water, cool weak tea, king coconut water, or some fresh clean juice, (orange, lemon tangerine etc.) can be offered. In diarrhoea, oral rehydration fluids should be given.

Infections affect the appetite, and sometimes a sick child has a sore mouth or lips. He might be persuaded to eat foods which are softer, non-irritating and perhaps more tempting than the usual food. Sick children should be given small frequent meals of soft foods such as cereal gruels boiled milk, soft cooked egg, tender fish, banana/plantains (non fibrous fruits) and yoghurt.

Make sure that children with measles, diarrhoea and respiratory tract infections eat plenty of vitamin A rich foods. To those from Vit A deficient areas, a high dose of 200, 000IU should be given. Supplementation with zinc in chronic diarrhoea should be done to prevent growth faltering.

6. Feeding during recovery

When a child is recovering he should be given a well balanced diet with sufficient energy, protein and other nutrients to catch up on growth and replacement of nutrient stores.

A child's appetite usually increases after illness. Therefore this is a good time to give extra food so that lost weight is quickly regained. Mothers should be advised to:

- continue to breast feed frequently
- give complementary foods more frequently
- encourage the child to eat as much as possible at every meal
- continue to give extra food until the child has regained lost weight and is growing well again.

6. OTHER ISSUES IN NUTRITION OF INFANTS AND TODDLERS

1. Food allergies

Whenever possible allergies to food should be prevented. The risk of allergy in infants is decreased with exclusive breast-feeding for at least 4-6 months. When avoiding foods known to cause symptoms, one has to ensure that dietary intake of the child continues to meet nutrient and energy needs.

2. Constipation

In infancy true constipation is infrequent and the cause is usually multifactorial. It can rarely be due to hypothyroidism or Hirschprung's disease. Parents need to be educated about the wide variation in normal bowel function in infants and toddlers to avoid over treatment of normal variants.

Reluctance to evacuate the bowel may be due to:

- distress or pain associated with previous efforts
- fear of the potty or the toilet
- being too busy to respond to the appropriate signals.

Constipation may also be in part due to a child having a naturally sluggish bowel. Dietary advice is relevant in the majority of cases.

- drinks of pure fruit or fruit pulp mixes 2-3 times per day.
- high fiber cereal based meals
- increasing fluid intake (other than milk) about six cups per day
- sitting the child on the toilet after each meal

A mild children's stool softeners (lactulose) with advice on the fiber intake can be suggested if the above processes fail to work. Over use of laxatives will exacerbate the problem of a sluggish bowel by creating dependency on their use. Further, it does not address toilet training problems and can cause loss of important minerals from the body.

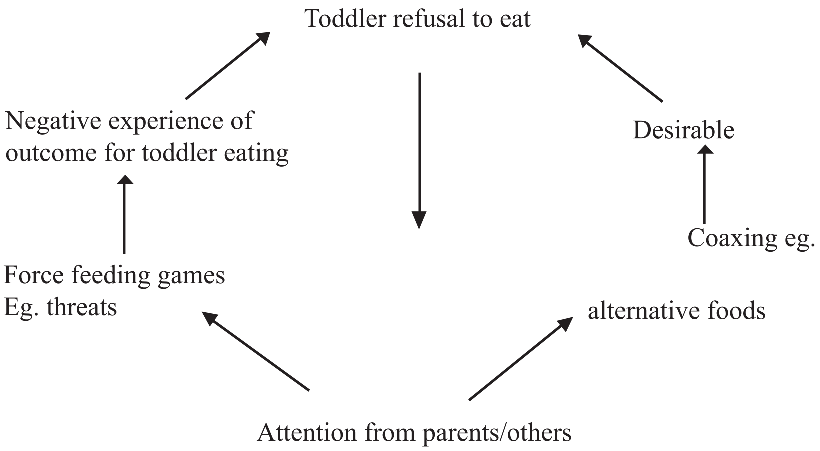
3. Food refusal

What causes toddler food refusal?

- poor appetite - toddlers need less energy per kg/of body weight than infants. Their appetite decreases correspondingly. Lack of hunger may be due to -
  small appetite,
  feeling unwell
  excessive intake of snacks and drinks
  constipation
  anxiety or upset
- limited food appeal
  - if the food looks or smells different
  - if looks difficult to chew (when they are not introduced foods containing lumps during complementary feeding)
  - if too much on the plate (there is a strong disincentive to adult eating)
  - if looks unappealing (colour and contrast provide important visual incentive to eat)
  - if genuinely disliked (they have established likes and dislikes as adults)
- emotional upset - influenced by past experience eg. episodes of choking, force feeding etc. As an emotional outlet to express anxiety or may be to seek attention.
- manipulative development - normal expression of the need for independence.

Toddler mealtimes provide a learning experience, and development of feeding skills. Refusing food can be an equally useful means for a toddler to get what he wants(increased attention or a preferred food item).

Reinforcement of food refusal



Management of food refusal involves

- Excluding organic cause of refusal - This can be done by:
    - monitoring the weight and height
    - asking about child's well being, bowel habits, sleep pattern, any recent illness, past medical conditions
    - referral to a pediatrician if poor growth
    - child is symptom free and growth is adequate, organic cause is unlikely.

- Consideration of non-organic causes - It is not always possible to identify the exact cause(s) of food refusal, but a discussion with parents may help in obtaining the following
    - family eating habits, including food preferences, meal pattern and location of eating
    - toddler's daily food intake, snacks, sweets, drinks etc.
    - onset and duration of feeding problems and potential trigger events
    - parent's and other's response to food refusal

- Reducing parental anxiety
  Is a key to resolving majority of toddler food refusal problems. Parents are anxious and frustrated when a child refuses to eat as their main concern is for the child's health.

  To reduce parental anxiety
    - monitor weight and height and reassure in respect of growth.
    - explore current dietary intake and highlight positive aspects.
    - explain that toddler requirements are less than infant requirements
    - reassure that starving for short periods will do no harm to the child and that he is extremely unlikely to starve himself to any serious consequence.
    - recommend vitamin drops only for infants, and syrup for older child, but should not make them believe that vitamins will improve appetite.
    - emphasize that food refusal always resolves eventually, but it may take time to do so.
    - minor dietary modifications can help to alleviate parental anxiety if food intake is perceived to be increased.

- Refusing to battle on toddler terms. Parents need to understand the importance of not responding to toddler food behavior. The best policy although hard to implement is to ignore it. The following are recommended.
    - regular meals seated at the table
    - prepare simple meals
    - to start with foods known to be well accepted.
    - small quantities presented separately
    - ignore food refusal, do not force to eat and do not get upset when the child does not eat any more, remove it and allow the child to leave the table
    - do not offer preferred alternatives or sweets
    - ignore all bad behavior

- praise highly if food is eaten
- allow toddler to eat with other "good eater" toddlers or rest of the family.

4. Food Fads

Many young children pass through a phase of being faddy about food and refusing to eat certain foods. Faddiness can exist in varying degrees. The apparent lack of dietary variety resulting from faddy eating can be a source of considerable anxiety to parents. However, food faddiness will be resolved naturally if allowed to, and rarely has an adverse effect on the child's health.

What causes food fads?
Food faddiness, like food refusal, is psychologically based and often has many underlying causes. It is commonly used as an attention-seeking device and the behaviour is often reinforced by parent's anxiety. Some of the causes of food refusal are also relevant to food faddiness.

Food likes and dislikes

Food likes and dislikes are influenced by taste, familiarity, food appeal, parents preferences and parent's attitudes.

Most children thrive on routine, and are more content and happy when they live in a structured environment. Familiar foods can provide security and this may contribute to the reluctance of many toddlers to try new tastes. Exposure to a wide variety of tastes during infancy is the easiest means of achieving varied intake in the pre-school years, but if this stage is missed, repeated exposure to a food does increase familiarity and thereby acceptability. The shape, flavour and colour of foods exert a strong influence on children's food choice. Food needs to be interesting to look and non-threatening as well.

Does food faddiness matter?
Food faddiness matters as far as it can be a social disadvantage but it rarely has an adverse effect on the child's nutritional status. Lack of

dietary variety associated with food faddiness does not necessarily result in an inadequate nutrient intake. Eating a wide variety of foods is of course, preferable, but given time and encouragement, it is almost always possible to increase dietary variety eventually.

Management of food fads

The key to management of food fads is reassuring parents in respect of their child's health and minimizing the manipulative effect of the behaviour. In all the cases the adequacy of child's growth should be assessed. If growth is poor, a dietary assessment has to be made, to find out the inadequacies in the nutrient intake.

Some instructions to well motivated mothers are:

- if milk or juice is drunk in excessive amounts, limit intake to about 2 cups of milk and 1 cup of juice a day
- of the 'well eat' foods by the child, serve one choice of foods at each meal
- continue to serve the child foods that the rest of the family are eating
- encourage the child to taste the food, but do not insist that it is eaten
- praise highly when any new food is eaten
- invite the child to serve himself as much as possible
- be seen to eat a wide range of foods and enjoy them
- avoid describing food as good or bad
- do not force or coax the child to eat
- do not react to food left uneaten
- limit meal times to maximum of 20 minutes
- do not give between – meal snacks other than a piece of fruit
- allow plenty of opportunity for social eating (with peers etc.)

5. Dietary fat

Dietary fat is an important source of energy and the only source of essential fatty acids. Dietary fat restriction during the first 2 years is not recommended because it may compromise the intake of energy and essential fatty acids, and adversely affect growth and development.

6. Dental caries

Use of bottle while sleeping or as a pacifier should be avoided. Similarly, nocturnal use of baby bottles containing liquids is also not recommended.

Prevalence of dental caries is lower where infants and children have access to fluoridated water and where long-term exposure of teeth to nutrient-containing liquids is avoided. Excessive fluoride intake can cause dental fluorosis, and therefore, an excessive intake of fluorides is not recommended. For infants between the ages of 6months to 2yrs, who are living in areas where the household water supply contains less than 0.3ppm (µg/L) fluoride, daily supplementation with $\geq$ 0.25mg fluoride is recommended. Supplementation is not recommended where the drinking water source contains > 0.3ppm (µg/L) fluoride.

7. Gastroenteritis

Human milk is well tolerated during diarrhea and may reduce it's severity and duration. Therefore, breast-feeding should be continued throughout the period of diarrhea with additional fluids given. Oral rehydration therapy (ORT) has proven to be safe and efficacious for restoring and maintaining hydration and electrolyte balance in infants with mild and moderate dehydration including those with vomiting.

8. Iron deficiency anaemia

Iron deficiency is most common among infants between the ages of 6 and 24 months. The major risk factors in infants relate to early discontinuation of breast-feeding, inadequate complementary feeding, low birth weight, prematurity, and poor socio economic status.

Iron deficiency is preventable through appropriate feeding choices. As the neonatal iron stores can meet the iron needs only until 4 to 6 months of age, introduction of a good source of available dietary iron (iron fortified infant cereal or complementary food) is recommended. Infants weaned from breast-feeding before 9 months of age should receive an iron fortified formula. Iron fortified formulae may sometimes be beyond the reach of low income groups and therefore, iron drops are recommended. Although dietary iron is not used for hemoglobin synthesis in the first few months of life, its early use contributes to iron stores and helps to prevent later development of iron deficiency.

In older infants, iron deficiency and anaemia can be prevented if foods such as fish, pureed liver, meat, legumes, egg yolk and iron fortified infant cereals are given. It is advisable to delay the introduction of whole cow milk until 9-12months of age. The iron-fortified foods should be continued beyond 1year of age to provide sufficient iron. Supplemental iron is not required unless the diet is lacking good sources of iron. Those infants who do not get good sources of dietary iron may have to be given medicinal iron drops after 8 months of age, after screening for anaemia.

Why may iron intake be poor?

- appetite is small
- iron requirements are high in relation to body size
- infrequent consumption and inadequate intake of good sources of iron
- iron fortified infants foods are generally not part of the diet after 1 year
- parents are uncertain of suitable iron rich foods and the variable absorption from them
- parents are unaware of how iron absorption may be enhanced or inhibited by dietary factors.

Scoring system for foods (in iron assessment)

Liver - 2 table spoons	8	White bread - 1 slice	0.5
Beef - 2 tbls	3	Chappati - one (med)	1.0
Lamb - 2 tbls	1.5	Pasta (boiled)- 3 oz	2.5
Ham - 1 slice	1	Green veg. - 2 tbls	1
Sausage - one	1	Other veg. - 3 tbls	0.5
Chicken - 2 tbls	0.5	dates, raisins - 3 tbls	1.5
Canned fish - 2 sardines	4	milk(whole)-	-
Other fish - 2 tbls	1	infant formulae -	3
Egg - one	2	biscuit- one	0.5
Lentils - 2 tbls	2	chocolate biscuit - one	2
Beans - 2 tbls	2	chocolate - 1 small bar	2

9. Vegetarian diets

Nutritional needs can be met by most well planned vegetarian diets. A carefully selected vegetarian diet can meet all the requirements of a growing child; however, deficiency of iron, vitamin B 12, vitamin D and energy have been reported.

Vegetarianism involves varying degrees of dietary restriction. Therefore, it requires clarification with individual families.

- lacto-ovo vegetarian - excludes all meats fish & poultry
- lacto vegetarian - excludes all meats, fish, poultry, eggs
- vegan - consumes no food of animal origin at all (after breast milk)

The nutrients at risk of deficiency in

- partial vegetarians and lacto-ovo vegetarians-iron, (and energy)
- lacto vegetarians - iron, vit D (and energy)
- vegans - iron, protein, vit. A, D, E, B_2 and B_{12}, calcium, zinc (and energy)

As weaning progresses, nutrients at potential risk of insufficiency include energy, iron, good quality protein and vit. D.

The following advice should therefore be given:

- for energy
  - maintain breast milk, or milk feeding throughout the first year
  - include energy dense foods eg. nuts, butter, margarine, cheese, cooking oil regularly
  - use less bulky, low fiber cereals as well as high fiber varieties.
  - excessive quantities of fruits and vegetables are not advisable
  - regular weighing of body weight provides good monitoring of energy intake
- for iron
  - give iron rich foods daily eg. lentils, chick peas, green gram, ground nuts, ground gingerly seeds, cereals, hard cooked egg yalk, infant cereals, millet, kurakkan, green leaves etc
  - these should be given with vit. C containing fruits and vegetables or well diluted fruit juice with meals.
  - avoid giving tea or excessive amounts of whole grain cereals
- for protein
  - include a variety of cereals, pulses and dairy products
- for vitamins
  - vegetarian mothers who are breast feeding should be given vitamin supplements.
  - all vegetarian infants also should receive vitamin supplements.
  - advise should be sought from a qualified person if there is any doubt about the adequacy of infant's vegetarian diet.

10. Responsive feeding

In practicing responsive feeding the following principles of psychosocial care have to be applied.

- feed infants directly and assist older children when they feed themselves, being sensitive to their hunger and satiety cues
- feed slowly and patiently, and encourage children to eat, but without forcing them
- if children refuse many foods experiment with different food combinations, tastes, textures and methods of encouragement
- minimize distractions during meals if the child loses interest easily
- remember that feeding times are periods of learning and love – talk to children during feeding, with eye to eye contact

There is increasing recognition that optimal infant feeding depends not only on what is fed, but also on how, where, and by whom the child is fed. It has been hypothesized that a more active style of feeding may improve dietary intake. The evidence to date on the impact of feeding behaviors on dietary intake and child health is sparse. Several intervention studies that included feeding behaviors as part of the recommended practices have reported positive effects on child growth (Penny et al., 2005). It is also important to know the types of feeding behaviors that make the most difference to the child health and behavioral development.

REFERENCES

1. Brown KH, Deway KG, Allen LH, *Complementary feeding of young children in developing countries; a review of current scientific knowledge,* Geneva, WHO, 1988
2. Butte NF, Lopez-Alarcon M, Garza C. *Nutrient Adequacy of Exclusive Breastfeeding for the Term Infant During the First Six Months of Life,* WHO, Geneva, 2002
3. Butte NF, Wong W W, Hophingson JH, Heing CJ, Mehta NR, Smith FOB, Energy requirements derived from total energy expenditure and energy deposition during the first 2 years of life. *American Journal of Clinical Nutrition.* 2000; 72; 1558-1569
4. Butte NF, et al. Infant feeding mode affects early growth and body composition. *Pediatrics*,2000 106:1355
5. Canadian Pediatrics Society , Nutrition Committee, Oral rehydration therapy and Early re-feeding in the management of childhood gastroenteritis, *Canadian Journal of Paediatrics.*1994b;1:160-164
6. Canadian Pediatrics Society , *Nutrition for healthy term infants*, Ministry of Public health and Government Services, Ottawa, 1998
7. Cohen RJ, et al. Effects of age of introduction of complimentary foods on infant breast milk intake, total energy intake, and growth; a randomized intervention study in Honduras, *Lancet,* 1994,323:343
8. *Committee on Nutrition,* American Academy of Pediatrics. Pediatric Nutrition Handbook.4th edition Elk Grove Village, Illinois, American Academy of Pediatrics. 1998
9. David L, Katz A. *Nutrition in Clinical Practice,* Lippincott Williams and Wilkins, Philadelphia, 2001
10. Dewey KG. *Approaches for improving complementary feeding of infants and young children.* WHO, Geneva. 2000
11. Droyer JT. Dietary fiber for children: How much; *Paediatrics.* 1995; 96 (s): 1019-1022

12. Fomon SJ, Younoszai MK, Thomas LN. Influence of vitamin D on linear growth of normal full term infants. *Journal of Nutrition,* 1988, 66: 345
13. Fomon SJ, Nelson SE, *Calcium, phosphorus, magnesium and sulfur,* In Fomon SJ (eds) Nutrition of Normal Infants, St louice,Mosby,1993
14. Food and Nutrition Board, 1. *Dietary Reference Intakes,* Washington DC, National Academy Press, 2001
15. Gibson RS, Ferguson BL, Lehrfeld J. Complementary foods for infant feeding in developing countries: their nutrient adequacy and improvement. *European Journal of Clinical Nutrition.* 1998; 52: 764-770
16. Gillespie S. *Supplementary feeding for women and young children; nutrition tool-kit module No.5* (World Bank Nutrition Toolkit), Washington, DC: 1998
17. Heird W. *Nutritional requirements during infancy*, In: Ziegler EE, Filer , LJ. Present knowledge in Nutrition , 7th Ed. Washington , dc : ILSI Press, 1996
18. Horwood L, Forusson D. Breast feeding and later cognitive and academic outcomes, *Pediatrics* 1998,101;e9
19. Jacobs C, Droyer, JT. Vegetarian children: appropriate and inappropriate diets. *American Journal of Clinical Nutrition.* 1988;48: 811- 818
20. Joint FAO/WHO Expert Consultation. *Vitamin and mineral requirements in human nutrition,* Geneva: WHO, 2002
21. Joyce M Thompson , *Nutritional Requirements and Young children,* Blackwell Science Ltd. Victoria, 1988
22. Kramer MS, Kakuma R. *Duration of exclusive breastfeeding, A systematic review* WHO/NHD, 1998
23. Deway KG, Cohen RJ, Rollins NC (2004) *Feeding of non-breastfed children 6-24 months of age in developing countries,* Food and Nutrition Bulletin 25: 377-402
24. WHO (2005) *Guiding principles for feeding non-breastfed children 6-24 months of age,* WHO Library Cataloging – in-Publication Data, ISBN 924 159 3431

25. Deway KG and Brown KH (2003) *Update on technical issues concerning complementary feeding of young children in developing countries,* Food and Nutrition Bulletin, 24: 5-28
26. American Academy of Paediatrics (2004) *Pediatric Nutrition* Handbook, Elk Grove Village, Illenois: AAP
27. Zlotkin S, Arthur P, Schauer C, Antiuwi KY, Yeung G and Piekarz A (2003) *Home fortification with iron and zinc sprinkles alone successfully treats anemia in infants and young children,* Am. J. Nutr. 133: 1075-80
28. Krebs NF et al, Zinc homeostasis in breastfed infants. *Pediatric Research,* 1996, 39; 661
29. Lonnerdal B. Effects of milk and milk components on calcium, magnesium, and trace element absorption during infancy. *Physiological Revives,*1977; 77: 643
30. Lutter C. Length of exclusive breast feeding: linking biology and scientific evidence to a public health recommendation. *Journal of Nutrition.* 2000; 130: 1335
31. Margaret Cameron, Yung Hofvander, *Manual on feeding infants and young children,* UN / ACC Subcommittee on nutrition , Oxford University Press, 1983
32. Michaelson KF et al. Zinc intake, zinc status and growth in a longitudinal study of healthy Danish infants,*Acta. Pediatrica*.1994; 83: 1115
33. Nielson GA, Thomas BL, Michaelson K.F. Influence of breast feeding and complementary foods on growth between 5 and 10 months *Acta Pediatrica.* 1998; 87: 911
34. Paul AA et al. Breast milk intake and growth of infants from two to ten months, *.Journal of Human Nutrition and Diabetes,*1988,1;437
35. *Recommended Dietary Allowances* (10th Ed) National Research Council, National Academy Press, Washington DC. 1989
36. Simondon K. Simondon F. Age at introduction of complementary food and physiological growth from 2 to 9 months in rural Senegal. European *Journal of Clinical Nutrition* 1997; 51: 703
37. *The quantity and quality of breast milk.* Geneva WHO,1985

38. Udipi.SA et al. Vitamin B6, vitamin C and folacin levels in milk from mothers of term and preterm infants during the neonatal period. American *Journal of Clinical Nutrition,* 1985; 42: 522
39. WHO collaborative study team on the role of breast feeding on the prevention of infant mortality. Effects of breast feeding on infant and child mortality due to infectious diseases in less developed countries; a pooled analysis. *Lancet* 2001; 355; 451
40. WHO working group on Growth Reference Protocol and the WHO Task Force on Methods for the Natural Regulation of Fertility. Growth of healthy infants and timing, Type and frequency of complementary foods. *American Journal of Clinical Nutrition.* 2001
41. WHO/ London School of Hygiene and Tropical Medicine *Complementary feeding: family foods for breastfed children.* (WHO/ NHD/ 00.1;WHO/ FCH/ CAH/ 00.6) Geneva, WHO, 2000
42. WHO/UNICEF. *Complementary feeding of young children in developing countries: a review of current scientific knowledge.* (WHO/NUT.98.1) Geneva: WHO 1998
43. Williams PL, Innis SM, Vogel AMP. Breast feeding and weaning practices in Vancouver. *Canadian Journal of Public Health.* 1996; 87: 231–236
44. Penny ME, Creed-kanashiro HM, Robert RC, Narro MR, Caulfield LE, Black RE. (2005) Effectiveness of an educational intervention delivered through the health services to improve nutrition in young children: a cluster randomized control trial, *Lancet*, 365: 1863-1872

INDEX