

# Nutrition in childhood

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## INTRODUCTION

Childhood is the stage in a human's life associated with growth and development. Growth proceeds rapidly in early life, slows down in middle childhood and accelerates at puberty before linear growth ceases. With increasing age there is also physical and psychomotor maturation, which influences activity, body composition, feeding skills and food choices (Geissler, 2011). Adequate nutrition is essential for growth, health and development of children. Poor nutrition increases the risk of illness, and is responsible directly or indirectly for one third of the estimated 9.5 million deaths that occurred in 2006 in children less than 5 years of age. Inappropriate nutrition can also lead to childhood obesity (WHO, 2009a).

### Key words

Childhood, Nutrition, Breast feeding, Growth and Development, Serving sizes

## BODY COMPOSITION IN CHILDHOOD

After birth the total body water decreases, and the percentage body weight that is fat increases rapidly to peak at around 6 months of age. Early infancy is then followed by a period of natural slimming until around 5 years of age. This is typically followed by a second phase of relatively rapid fat deposition, the adiposity rebound, which continues almost unabated in girls until growth ceases. In boys the adiposity rebound reverses with rapid lean tissue deposition of late puberty (Geissler, 2011).

## PSYCHOMOTOR MATURATION RELEVANT TO FEEDING

Table 1 outlines some of the important developmental milestones that occur with age, related to a child's ability to feed.

Infancy is associated with almost total dependency on carers for the provision of nutritional needs. As children grow they begin to understand the implications of choices and make their wishes understood. They also use food to manipulate those around them. Once at school children take their cues for food preferences from their friends

besides their families. They are also influenced by media. In adolescence peer approved fashions for certain diets come into play and this could lead to haphazard eating and bizarre diets (Geissler, 2011).

## INFANCY

Optimal infant and young child feeding practices rank among the most effective interventions to improve child health. The WHO and UNICEF's global recommendations for optimal infant feeding state that an infant should be exclusively breastfed for the first 6 months of life. Nutritionally adequate complementary feeding should start from the age of 6 months with continued breastfeeding up to 2 years of age or beyond (WHO, 2009a).

Poor breastfeeding and complementary feeding practices are however widespread. Worldwide it is estimated that only 34.8% of infants are exclusively breast fed for the first 6 months of life, the majority receiving some other food or fluid in the early months (WHO, 2009b). Several studies suggest that obesity in later childhood and adolescence is less common amongst breastfed children, and that there is a dose response effect with a longer duration of breastfeeding associated with a lower risk of obesity (Harder et al., 2005; Burke et al., 2005).

## WHY "BREAST IS BEST"

Human breast milk is specifically designed for the requirements of a human baby. Breast milk contains all the nutrients that an infant needs in the first 6 months of life, including fat, carbohydrates, proteins, vitamins, minerals and water (Butte et al., 2002).

### Carbohydrates

Lactose is the main carbohydrate (80%) in milk. It is well designed to fit its role in providing the infant's nutritional requirements since it is highly soluble, promotes growth of protective intestinal flora and facilitates calcium absorption through the relative solubility of calcium lactate. Other carbohydrates in milk include monosaccharides, oligosaccharides and protein-bound carbohydrates. These provide important protection against infection (Riordan, 2004).

**Table 1:** Age at average development of feeding/ nutrition skills

Age	Feeding skills acquired
36 weeks gestation to birth	Integrated sucking and swallowing reflexes
3 months	Conveys bolus of food from front of mouth to back of mouth
5 months	Conveys objects placed in hand to mouth Drinks from hand-held cup with biting movements
5 to 6 months	Reaches out for objects and conveys them to mouth
6 to 7 months	Begins to make chewing movements Feeds self with biscuit, rusk or other small item Transfers object from one hand to the other
7 months	Learns to shut mouth, shake head and indicates no
9 months	Picks up raisin-sized object with thumb and forefinger Throws food to ground with great enthusiasm and expects someone else to pick it up
10 months	Holds beaker of liquid but drops it when finished
12 months	Tries to spoon feed but unable to stop rotation of spoon before it reaches mouth
15 months	Manipulates spoon and food on spoon to mouth
18 months	Determined to be independent at meal times
2 years	Expresses own self and independence in often irrational food refusal. This spell may last some years
5 years	Eating in company with peers may lead to eating a greater variety of foods than previously accepted. May also lead to strong preferences for 'popular' foods

### Proteins

Breast milk protein differs in both quantity and quality from animal milks and it contains a balance of amino acids which makes it much more suitable for a baby. Human milk protein is 30 to 40% casein and 60 to 70% whey. Human milk casein forms smaller micelles with looser structure than the casein of cow's milk. The structure facilitates enzymic action. Precipitation of tough, undigested casein curds in the stomach is less likely than with cow's milk or unmodified cow's milk formula. Moreover the concentration of protein in breast milk is lower than in animal milks. The much higher protein in animal milks can overload the infant's immature kidneys with waste nitrogen products. Human milk contains alpha-lactalbumin whilst cow's milk contains beta-lactalbumin, to which infants can become intolerant (Riordan, 2004).

### Fat

Although the quantities of fat in human and cow's milk are not very different, the component fatty acids differ greatly. Human milk fat is higher in unsaturated fat, particularly the essential fatty acids linoleic and alpha-linolenic acid and also contain the long chain polyunsaturated fatty acids (LCPUFA). These fatty acids are important for the neurological development of a child. LCPUFA are added to some varieties of infant formula but this does not confer any advantage over breast milk, and may not be as effective. The fats in human milk are more readily digested and absorbed than those in cow's milk.

### Micronutrients

Breast milk normally contains sufficient vitamins for an infant (besides vitamin D which the infant produces on exposure to sunlight). Breast milk contains lactoferrin

and other micronutrient binding compounds. These facilitate absorption of iron, folic acid, vitamin B12, zinc and other micronutrients.

### Anti-infective factors

Breast milk contains many factors that help to protect an infant against infection (Hanson, 2004) including:

- immunoglobulin, principally secretory immunoglobulin A (sIgA), which coats the intestinal mucosa and prevents bacteria from entering the cells;
- white blood cells which can kill micro-organisms;
- whey proteins (lysozyme and lactoferrin) which can kill bacteria, viruses and fungi;
- oligosaccharides which prevent bacteria from attaching to mucosal surfaces.

### INFANT FORMULA

Infant formula is usually derived from industrially modified cow's milk or soy products. During the manufacturing process the quantities of nutrients are adjusted to make them more comparable to breast milk. However the qualitative differences in the fat and protein cannot be altered and the absence of anti-infective and

bio-active factors remain (WHO, 2009a). Soy formula contains phyto-oestrogens which could potentially reduce fertility in boys and bring early puberty in girls (Setchell et al., 1997).

### COMPLEMENTARY FEEDING

From 6 months of age, an infant's need for energy and nutrients start to exceed what is provided by breast milk. Complementary feeding therefore becomes necessary. Ideally parents wait till the baby is 6 months old, since the renal and digestive systems are not fully developed at an earlier age and to decrease the risk of food allergies and choking. Complementary foods need to be nutritionally adequate, safe and appropriately fed. The child should initially be given small amounts of food which increase as the child gets older. The most suitable consistency for an infant's or young child's food depends on age and neuromuscular development (WHO/ UNICER, 1998). Beginning at 6 months an infant can eat pureed, mashed or semi-solid foods. By 8 months most infants can also eat finger foods. By 12 months, most children can eat the same types of food as consumed by the rest of the family. There is evidence of a critical window for introducing lumpy foods; if these are delayed

**Table 2:** Practical guidance on the quality, frequency and amount of food to offer children between 6-23 months of age

Age	Texture	Frequency	Amount of food an average child will usually eat at each meal
6-8 months	Start with thick porridge, well mashed foods Continue with mashed family foods	2-3 meals per day  Depending on the child's appetite 1-2 snacks may be offered	Start with 2 -3 tablespoonfuls per feed, gradually increasing to ½ of a 250ml cup
9-11 months	Finely chopped or mashed foods, and foods that baby can pick up	3-4 meals per day  Depending on the child's appetite 1-2 snacks may be offered	½ of a 250 ml cup/bowl
12-23 months	Family foods, chopped or mashed if necessary	3-4 meals per day Depending on the child's appetite 1-2 snacks may be offered	¾ to full 250 ml cup/bowl

**Table 3:** Characteristics of good complementary foods

Rich in energy, protein and micronutrients (particularly iron, zinc, calcium, vitamin A, vitamin C and folate)
Not spicy or salty
Easy for the child to eat
Liked by the child
Locally available and affordable

beyond 10 months of age, it may increase the risk of feeding difficulties later on. Although it may save time to continue feeding semi-solid foods, it is important to gradually increase the solidity of food with increasing age, for optimal child development (WHO, 2009a). Table 2 summarizes the quality, frequency and amount of food that children between 6 and 23 months should be offered (WHO, 2009a). The characteristics of good complementary foods are highlighted in table 3.

Parents and carers should be advised to give the baby one new food at a time and for three to five days before adding another new food. This will tell what foods the baby might be allergic to or can't tolerate. Carers should begin with small amounts of new solid foods. A teaspoon would be enough at first and slowly this would increase to a table spoon. The infant can be started on dry infant rice cereal, mixed as directed, followed by vegetables, fruits and then meats. When preparing infant foods, salt or sugar should not be added. Canned foods may contain large amounts of salt and sugar and are therefore best avoided. Cow's milk should not be introduced until the baby is 1 year old. The American Academy of Paediatrics recommends not to give fruit juices to infants younger than 6 months of age. Only pasteurized, 100% fruit juices, without added sugar may be given to older infants and children and this should be limited to 180ml a day. The juice should be diluted with water and offered in a cup with a meal (Johns Hopkins Medicine, Health library, 2014).

Another issue which needs to be tackled with parents is to avoid the "clean plate syndrome". Forcing a child to eat all the food on a plate when he or she is full will lead to over eating and it teaches the child to eat just because the food is there not because he or she is hungry. Parents

should also be advised to expect a reduction in appetite and the child might become pickier since the growth rate slows down around the first birthday. Carers should offer a wide variety of foods at this stage to pave the way for good eating habits later on in life. Fat and cholesterol shouldn't be restricted in the diets of very young children. Children need calories, fat and cholesterol for the development of their brains and nervous systems and for general growth (Johns Hopkins Medicine, Health library 2014). After the age of 2 it is recommended that the diet is moderately low in fat, as diets high in fat at a later stage may contribute to cardiovascular disease and obesity later in life (Stettler, 2011). Adult recommendations of fibre intake should not be applied in early childhood. A high fibre content would lead to decreased energy density in foods, and high phytate levels could interfere with micronutrient absorption (Geissler, 2011).

### **FEEDING AFTER THE FIRST YEAR**

Whilst growth rate slows down at this age, nutrition still remains a top priority. It is also time for parents to start removing bottles and move to a stage where children will eat and drink more independently. Toddler years, especially between 12 and 24 months are considered transition years where children learn to eat at table and accept new tastes and textures. If a child rejects a new food, the best advice would be to remove it without fuss and re-introduce it at a later date. Children will be interested in eating what people around them are having. Parents and carers should therefore set a good example by following a healthy diet.

Between 2 to 5 years children seem to eat less with appetite fluctuations during growth spurts. Parents are often concerned whether their child is eating enough.

Table 4: Fussy eater – Parental advice

Be patients
Offer variety of bite-sized foods
Offer food in small and interesting shapes
Choose nutrient dense foods e.g. avocado, broccoli, cheese, eggs, fish, red kidney beans
Do not turn each meal into a battle
No force feeding
Do not punish child
Congratulate him or her for what he or she does eat
The lesser the pressure on the child, the more likely that the phase will pass without problems

Practical advice to parents would be to offer a nutritious selection of foods, remain patient and to give the child freedom to choose, within reason. A common clinical scenario would be parents being concerned that their child has become a fussy eater. Table 4 lists some practical advice to help parents deal with this situation better.

Another common clinical scenario is a parent questioning whether the child requires any multivitamin supplements. Both the American Medical Association and the American Dietetic Association recommend that healthy children should get all their nutrients from foods rather than vitamin supplements. The nutrients that are most likely to be deficient in a child's diet are iron, vitamin C, vitamin A, folic acid, and vitamin B6. The American Academy of Pediatrics does not support routine supplementation for normal, healthy children. However, there is no significant risk if a parent wishes to give their child a standard paediatric multivitamin (Medline Plus, 2014).

### SCHOOL AGE CHILDREN

At about 5 years of age growth rate picks up and children often become even more active. The eating habits of most 5 year olds will have been shaped largely by those of their family, but as they grow older they will begin to accumulate habits from their friends at school. Popular snack foods such as biscuits and crisps are high in fat and sugar. These are fine from time to time but children need to be guided towards choosing snacks that provide a range of essential nutrients as well as energy such as yoghurts and sandwiches with healthy fillings. Snacks

rich in fat and sugar should not be used as a reward.

Breakfast is important to top up children's energy stores for the morning activities. Children who eat a healthy breakfast are less likely to snack on foods that are high in fat and/or sugar later on and tend to have a better nutrient intake across the day. Many studies have also shown that regular breakfast consumption results in children performing better at school, compared to those children who don't eat breakfast (British Nutrition Foundation, 2014a).

Although younger school-age children are often very active, many children are overweight or even obese. In 2008 over a quarter of Maltese children aged 7 years were found to be overweight or obese, with the proportion rising to just over 40% when the same cohort was measured in 2010 at the age of 9 years (Farrugia Sant'Angelo et al., 2011).

It is not usually advisable for children of primary school age to go on a slimming diet as this may interfere with their growth and development. Instead, management usually entails a regimen combining healthy eating and increased physical activity. This needs to be family focused and aims at enabling the child to remain at a constant weight or increase weight slowly, while the height increases. It is also important to review the family's dietary patterns, and to encourage improvement where necessary. Developing a healthy family lifestyle, including a healthy varied diet and regular physical activity is particularly important in the weight management of children (British Nutrition Foundation, 2014a).

Exercise is crucial for health throughout life including

**Table 5:** Food servings according to age group, including examples of 1 serving from each food group

Food group	Age groups			
	1-2 years	3-5 years	6-12 years	13-18 years
Grains/ starchy vegetables	<p><b>4 servings</b> 1 serving = ¼-1/2 slice of bread, 2-4tbsp cooked rice/pasta, 1 small potato</p>	<p><b>4 servings</b> 1 serving = ½-1 slice bread, 4-8tbsp cooked rice/pasta, 1 medium potato</p>	<p><b>5 – 11 servings</b> 1 serving = 1 slice of bread, 3 heaped tbsp cooked rice/pasta, 1 large potato</p>	<p><b>5 -11 servings</b> 1 serving = 1 slice wholemeal bread, 40g high fibre cereal</p>
Vegetables	<p><b>2-3 servings</b> 1 serving = 2tbsp carrots, 2tbsp peas</p>	<p><b>2-3 servings</b> 1 serving = 3 tbsp carrots, 3 tbsp peas</p>	<p><b>2-3 servings</b> 1 serving = medium sized mixed salad, 3 tbsp cooked vegetables</p>	<p><b>2-3 servings</b> 1 serving = medium sized mixed salad, 3 tbsp cooked vegetables</p>
Fruit	<p><b>2-3 servings</b> 1 serving = ½ apple, 1 small banana</p>	<p><b>2-3 servings</b> 1 serving = 1 apple/ 1 banana</p>	<p><b>2-3 serving</b> 1 serving = 1 apple, 150ml fresh fruit juice</p>	<p><b>2-3 servings</b> 1 serving = 1 apple, 150ml of fresh fruit juice</p>
Dairy	<p><b>2 servings or min of</b> 350ml milk 1 serving = 1 small yoghurt, 30g of cheese</p>	<p><b>2 servings or minimum</b> of 300ml milk 1 serving = 150ml yoghurt, 35 g of cheese</p>	<p><b>2-3 servings</b> 1 serving = 35-40g cheese, 200ml milk</p>	<p><b>2-3 servings</b> 1 serving = 40g cheese, 200ml milk</p>
Proteins	<p><b>2 servings</b> 1 serving = 30g chicken, 30g fish, 30g meat, 1tbsp peanut butter</p>	<p><b>2 serving</b> 1 serving = 30-50g chicken, 30-50g fish, 30-50g lean meat, 1 egg</p>	<p><b>2 servings</b> 1 serving = 50- 85g chicken, 50-85g fish, 50- 85g lean meat, 2-3 heaped tbsp cooked lentils</p>	<p><b>2 servings</b> 1 serving = 85g chicken, 85g fish, 85g lean meat, 3 heaped tbsp cooked lentils</p>

childhood. It is recommended that children and young people should engage in at least 60 minutes of moderate intensity physical activity each day. This should include activities that improve bone health, muscle strength and flexibility, for example running, cycling or swimming, at least twice a week. Only 70% of boys and 61% of girls meet these recommendations. Boys tend to be more active than girls and it is common to see a decline in physical activity levels as children reach adolescence, which is more marked in girls (British Nutrition Foundation, 2014a).

All children should be encouraged to choose a variety of foods from all the food groups, in order to achieve a healthy varied diet. Table 5 summarizes the recommended serving sizes for different age groups.

## ADOLESCENCE

During adolescence the child undergoes major physical and psychological changes, leading to high energy and nutrient needs. Teenage years are associated with a tendency for independence and a phase of experimentation including self imposed dietary restraints which could have detrimental effects on health. There is evidence of inadequate micronutrient intakes among teenagers. For example, many teenage

girls (11-18 years) are consuming low amounts of iron (46% below the Lower Reference Nutrient Intake - LRNI) and there is also evidence of low intakes of vitamin A (14% below the LRNI), riboflavin (21% below the LRNI), calcium (18% below the LRNI), magnesium (51% below the LRNI), potassium (31% below the LRNI), selenium (45% below the LRNI), iodine (21% below the LRNI) and zinc (19% below the LRNI). In contrast, micronutrient intakes in younger children are generally not of concern. [The LRNI, lower reference nutrient intake, is the amount judged to be sufficient for only 2.5% of the population](British Nutrition Foundation, 2014b). Adolescence should be counselled regarding healthy nutrition and healthy lifestyle at every opportunity.

## CONCLUSION

During early childhood and school-age years, children begin to establish habits for eating and exercise that remain for their entire lives. If children establish healthy habits, their risk for developing many chronic diseases will be greatly decreased. On the other hand, poor eating habits and physical inactivity during childhood set the stage for health problems in adulthood.

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