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Scientific Recommendations for a National Infant Feeding Policy, 2nd Edition

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FOREWORD

Message from the Chairperson

Infant feeding has an important effect on growth and development, not only in the early period of life, but also on health during childhood, adolescence, adulthood, and older age. There is increasing evidence that many illnesses, which present in adulthood, may have origins in infant feeding during the first year of life. The UN Standing Committee on Nutrition in 2006 stated that the period from conception to two years is a critical period, during which, food and nutrition can promote lifelong health and well being, and protect against many of the chronic diseases such as heart disease, diabetes, and obesity prevalent in Ireland today. Significant efforts are targeted at managing such illness in Ireland today. However, there is much less investment devoted to the prevention of these conditions. As part of this, the promotion of best practice in nutrition, from conception throughout the first year of life, should be considered a priority.

The first year of life is a period of rapid growth which sees the infant triple their birth weight and double their surface area. Breastfeeding is the agreed gold-standard in infant feeding, in addition to the introduction of nutritious complementary foods towards the second half of the first year. This is a sensitive transition in which new skills are developed, and taste preferences and food acceptance is learned, which may influence eating patterns in later years.

Recognition that many parents in Ireland continue to make an informed decision not to breastfeed highlights the importance of implementing the Breastfeeding Strategy to promote and protect breastfeeding whilst protecting the health of mothers and babies in Ireland. Alongside this, there is a need to provide guidance on formula milk feeding for parents who have made an informed decision not to breastfeed, to ensure that the practice of formula feeding is safe for all infants.

It is important to acknowledge that parents have a vital role and responsibility to foster positive eating and lifestyle habits in their children from infancy, and widespread population based promotion of healthy eating guidelines is essential. Parents need guidance on practical aspects of breastfeeding, weaning, and formula feeding. It is essential that healthcare professionals possess up-to-date knowledge of best practice in the area of infant feeding in order to give consistent, evidence-based information to parents, and so, allow them to make the best choices for their infants.

There is no human activity which has greater biological and social significance than feeding. Optimal physical growth signifies the health and vitality of the child, and affirms the skills and competence of the nurturing parents. Eating and drinking; crucial to the survival, maturation and eventual reproduction of the species, is imbued with emotional resonance for the individual, the family and society.

Ms Ita Saul
Chair, 2011

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- Ms Meave Graham, Senior Paediatric Dietitian, AMNCH, Tallaght
- Ms Michelle Hurley, Clinical Specialist Dietitian, Our Lady's Children's Hospital, Crumlin
- Ms Therese Dunne, Senior Paediatric Dietitian, Temple Street Children' Hospital
- Dr Andrew Flanagan, Dr Padraig Burke and staff of the Public Analyst Laboratory

EXECUTIVE SUMMARY

Background

In 1999, the FSAI published *'Recommendations for a National Infant Feeding Policy'*. This report recognised that the period stretching from conception through to the end of the first year of life, is an important period of development. Diet (both maternal and infant) is one of the most critical environmental factors during this stage, influencing both growth and development during infancy, as well as having far-reaching effects on health in adult life. Over the past decade, new scientific evidence relating to infant feeding has emerged, and Ireland has responded by publishing reports and developing new policies, such as the vitamin D supplementation of infants and guidance on the safe preparation of powdered infant formula. In addition, new public health pressures such as rising childhood obesity exist within Ireland today. These changes are not reflected in the original FSAI report, therefore necessitating a revision of *'Recommendations for a National Infant Feeding Policy'* (FSAI, 1999).

Although a number of improvements in infant feeding practices have occurred within Ireland over the past 10 years, recent research has indicated that a number of key issues relating to milk and complementary feeding still exist. Breastfeeding is the biologically normal infant feeding method specifically adapted for optimum human growth, development and health. However, despite this, breastfeeding initiation and duration rates in Ireland remain far below other countries. Also, notwithstanding the continued prevalence of formula feeding, many parents do not know how to handle and prepare formula safely for their infants. Furthermore, the majority of infants continue to begin the weaning process before the recommended age, further highlighting the need for increased awareness of the correct infant feeding practices in Ireland today. More worryingly from a public health perspective, the types of weaning foods used are also inappropriate, and Dublin based research has shown that infants in Dublin receive high-fat, high-sugar confectionary foods more frequently than fruit and vegetables.

The issue of parent and care-giver education needs to be addressed in order to improve this situation, and promote best practice in infant feeding across Ireland. This will help to ensure that infants in Ireland receive the best possible nutritional input; helping to protect their health both now and throughout later life.

Objectives

The objectives of this report are to:

1) Provide clear, unambiguous information on all areas relating to infant nutrition ranging from nutrition for preconception and pregnancy, to milk feeding, and the transition to solid foods. This information is designed to provide healthcare professionals with up-to-date information, enabling them to offer guidance, information, and practical support to parents and carers
2) Encourage infant feeding practices consistent with health promotion needs for the prevention of chronic diseases prevalent in Ireland
3) Provide guidance on areas of infant feeding which require the most focused interventions, in order to improve infant feeding practices in Ireland
4) Highlight specific areas where further research is needed
5) Suggest a system by which best practice recommendations for infant feeding will be reviewed and updated

Issues Addressed

To deliver on the objectives outlined above, this report addresses the following key areas:

- The nutrient requirements for infants throughout the first year of life, including infants with specific nutritional requirements due to prematurity or low birth-weight, physical and mental disability as well as other specific medical disorders, cultural diversity or social disadvantage. Also examined were the nutritional requirements of women of childbearing age during pregnancy and lactation
- How best practice in infant feeding can prevent short-term health problems, as well as playing an important role in health promotion throughout life
- The optimal ways to meet nutrient goals for infants in Ireland through commonly used and easily accessible, affordable foods
- The need for provision of clear advice on what is optimal for infants' health, in areas where several different feeding options exist
- Providing healthcare professionals with an outline of food legislation relevant for the first year of life

- Identification of specific areas where parents and healthcare professionals require guidance and support on the scientific basis for best practice. Practical guidance information developed to address these areas will be published alongside this report
- Infant feeding practices in Ireland today, and ways in which infant feeding practices could be evaluated and monitored to inform future interventions and focus
- The role of parents, community workers, and healthcare professionals in ensuring that infants in Ireland receive the best possible nutritional input
- Highlighting and supporting other existing policies and reports relevant to infant feeding such as:
  - *'Breastfeeding in Ireland: A five-year strategic action plan'* (Department of Health and Children, 2005)
  - *'Vitamin D Supplementation for Infants in Ireland'* (HSE, 2010)
  - *'Irish Oral Health Service Guideline Initiative Report'* (2009)

These were examined within the context of this report and updates provided where necessary.

Nutrition for Pre-conception and Pregnancy

Nutrition for pre-conception

Good nutrition is important throughout the lifespan. This is particularly true for women of childbearing age; having a good nutritional status and maintaining a healthy body weight becomes especially important should pregnancy occur. The recognition that women of childbearing age are a vulnerable group offers some protection for the many pregnancies in Ireland which are unplanned. To help prevent neural tube defects (NTDs), dietary advice directed towards this population group should include the recommendation to take 400µg folic acid daily (preferably as a supplement), as well as promotion of healthy eating guidelines to help achieve adequate intakes of iron, vitamin D and long chain (LC) omega-3 fatty acids. Vitamin D, LC omega-3, polyunsaturated fatty acids (PUFA) and iron can be 'problem' nutrients for all population groups in Ireland. These are key nutrients for a healthy pregnancy, and are also important in protecting the health of the mother throughout her life. Considering this, special care should be taken to ensure adequate intake. Maintaining a healthy body weight is another key recommendation for this group. Research shows that a large proportion of women in Ireland are currently overweight. Active weight loss is inadvisable during pregnancy. Therefore, achieving a healthy body weight prior to conception is sensible. Other lifestyle factors such as not smoking and following healthy intake guidelines for alcohol are important; not only to protect and promote the good health of the woman, but also to ensure that a developing baby is exposed to the best possible environment should pregnancy occur.

Nutrition during pregnancy

During pregnancy, maternal nutrition is a critical factor which can impact the infant's health directly during development, as well as having an influence on health in later years. The mother's diet during pregnancy is also important to protect her own health and to preserve her nutrient stores, and so help her care for her infant after the birth. Generally, healthy eating guidelines are largely the same as for women of childbearing age, however, the requirements for key nutrients such as iron and folate, as well as certain LC omega-3 fatty acids increases during pregnancy. It is important that these and other essential nutrients such as calcium and vitamin D, are present in the diet in adequate amounts to ensure optimal growth and development of the foetus, as well as protecting the health of the mother. Maintenance of a healthy body weight, in addition to the avoidance of harmful lifestyle factors such as alcohol and smoking, also contributes to a good pregnancy outcome.

Whereas it is ideal that women would get any extra nutrients they need from their diet, in some situations a specific supplement may be needed to help meet the recommended intakes. The use of certain food supplements during pregnancy is a key issue, as excessive intakes of vitamins such as vitamin A can be harmful to the developing foetus. There are several products available on the Irish market which provide vitamin A at doses close to the tolerable upper level (UL). To prevent the possible harmful effect on the developing foetus, these food supplements should be avoided during pregnancy. This report recommends that a specific working group should examine the issue of vitamin A supplementation during pregnancy, and make recommendations on how to achieve the recommended daily intake of vitamin A through foods or food supplements without putting the developing foetus at risk. However, as an interim measure, any pregnant woman wishing to supplement her daily diet with a multi-vitamin should be advised to choose only those that contain 500µg vitamin A or less per daily dose. Liver is a food which is particularly high in vitamin A and due to the risk for the developing foetus, pregnant women should be advised to avoid eating liver. Liver is a good source of dietary iron as well as being a rich source of vitamin A. However, intakes of vitamin A greater than 7000µg retinol equivalent per day can lead to hypervitaminosis A and can cause teratogenic effects. Considering the high levels of vitamin A

contained within liver (19,700µg retinol activity equivalent in a standard 100g portion of lambs' liver), it may be prudent to recommend that pregnant women avoid liver during pregnancy, particularly in the first few weeks, as there is high potential that liver consumption will lead to vitamin A intakes which exceed the recommended tolerable upper level of 3,000µg retinol equivalent per day.

Additionally, women may find it difficult to consume adequate amounts of vitamins and minerals such as vitamin D and iron from their daily diet, and food supplements may be required. Iron supplementation during pregnancy is often needed to prevent the negative effects of iron deficiency, in both the mother and infant during pregnancy. However, high dose iron may be associated with short and long-term adverse side effects such as nausea and constipation which may impact on compliance rates. Furthermore, high intakes can lead to iron overload in certain individuals who are predisposed to this disorder. Considering this, high dose iron supplementation may be inadvisable as a routine approach to meeting iron requirements in the general population. This report recommends that a specific working group is convened to give advice and devise recommendations on intakes or avoidance of food and food supplements required to achieve the recommended intake of key nutrients such as iron, vitamin A and vitamin D safely during pregnancy.

As developing infants are considered the most vulnerable population group, particular care with food safety is important during pregnancy, with two aspects of particular note. During pregnancy, it is important to avoid foodborne bacteria such as *Listeria monocytogenes* or parasites like *Toxoplasma gondii* as these can be harmful to the developing foetus. Avoiding the consumption of unpasteurised milks and cheeses, cheese ripened by mould, uncooked cured or smoked meats, e.g. Parma ham, or smoked fish, e.g. smoked salmon, as well as deli-meats, deli-salads, pre-packaged salads and coleslaws can help to minimise the risk of foodborne illness during pregnancy. Other measures such as washing all raw ingredients well before use, ensuring fridge temperature is below 5°C, putting food in the fridge as quickly as possible, avoiding cross-contamination during food preparation, ensuring food is adequately cooked, and always wearing gloves when gardening or changing cat litter will help avoid contamination with these pathogens.

Certain environmental contaminants such as methylmercury may also be detrimental. Large predatory fish such as marlin, ray, swordfish, shark, and tuna can be a source of these contaminants and it is therefore important to reduce consumption of these fish in the diet during pregnancy, whilst continuing to promote other fish as an important part of a balanced, healthy diet, with particular emphasis given to oily fish such as salmon (not smoked) and mackerel to provide LC omega-3 fatty acids.

Milk Feeding

Breastfeeding

Breastfeeding protects the health of infants and their mothers

Breastfeeding is the biologically normal method of infant and young child feeding. It offers significant health and economic advantages to the infant and mother in both the short and long-term. All infants (with very rare exceptions) should be breastfed exclusively up until about 6 months of age, after which, nutritionally suitable complementary foods should be introduced to meet the growing nutritional needs of the infant. Breastfeeding, in conjunction with nutritious solids, should ideally continue until the infant is 2 years or over (Dept of Health). However, it is important to note that any amount of breast milk is beneficial to the infant, even over short time periods. Good maternal health and nutrition, along with a supportive breastfeeding environment, help in the achievement of this best practice recommendation.

Clear guidance and support is needed for breastfeeding mothers

Whilst breastfeeding is a natural part of the reproductive process, the skill of breastfeeding needs to be learned, especially in Ireland, where the experience of breastfeeding has been lost in many families. Many women, particularly first time mothers, may feel apprehensive about breastfeeding and may not feel confident in their ability to breastfeed. There are many things a women needs to know about breastfeeding; practical information on how to attach the infant at the breast; how to know the infant is receiving sufficient nutrition; how to provide milk when they are away from their infant, as well as where to seek support should it be required. It is the responsibility of all healthcare professionals to promote breastfeeding and to help mothers find solutions for potential barriers to breastfeeding. Information and support around breastfeeding should be given ante-natally or even before, as it has been shown that many women make the decision on whether or not they will breastfeed before the birth of their infant.

'Breastfeeding in Ireland: a five year strategic action plan' (Department of Health and Children, 2005) lays out guidance on building a supportive environment to improve breastfeeding rates in Ireland. Supportive breastfeeding structures should also include cost-effective and easy access to breast pumps for all mothers, particularly those with pre-term infants for whom breastfeeding can help to prevent necrotising enterocolitis (NEC). To help support mothers who wish to breastfeed on their return to work, employers should be encouraged to develop a workplace breastfeeding policy statement, and support women to breastfeed for as long as they wish. Under the Maternity Protection (Protection of Mothers who are Breastfeeding) Regulations, 2004 (S.I. No. 645 of 2004) women are entitled to one hour reduction in their working day in order to breastfeed. This applies to breastfeeding women whose date of confinement was not more than 26 weeks earlier. Providing workplace breastfeeding breaks for women beyond 26 weeks would facilitate those who wish to breastfeed throughout the period of weaning onto solid foods, thus helping to ensure that infants in Ireland receive the benefits of breastfeeding for as long as possible.

Formula feeding

Clear guidance is needed for parents and carers

In circumstances where breastfeeding is not possible, or where the mother does not wish to breastfeed, a suitable infant formula is required in order to meet the nutritional and developmental needs of the infant. For the large proportion of mothers who make an informed decision not to breastfeed from birth, and the majority of women in Ireland who offer some infant formula during the first year of life, practical guidance, information, and support on formula feeding are necessary. Infant formula feeding is associated with higher health risks compared with breastfeeding. The most significant immediate risks concern bacterial contamination of powdered infant formula. Infants are among the most vulnerable group for food and waterborne illness. Contamination with *Salmonella enterica* is a common concern, as is the more recently recognised *Cronobacter spp*. (formerly known as *Enterobacter sakazakii*). This is recognised in the new guidance on the safe preparation of powdered infant formula which has been issued.

Parents and carers need to be educated on the correct way to prepare a powdered infant formula feed for their infant, the best type of water to choose, how to correctly wash and sterilise all equipment needed, how to feed their infant and ensure they are receiving adequate nutrition, as well as where to seek support in the community, should it be required. In the ante-natal period, parents and carers should be made aware of the potential risks associated with formula feeding and should be provided with information, support, and practical guidance on preparing a powdered infant formula feed for their infant in the maternity unit. Recent research has indicated that the majority of parents do not receive appropriate advice, and this needs to be rectified to minimise risks associated with formula feeding.

Which type of infant formula is suitable?

Guidance is also needed on the most suitable type of infant formula to choose. For infants who are not breastfed, a standard whey-based infant formula will be suitable for the vast majority, and should be used for the first 6 months of life. This formula is also suitable to use up to 12 months of age. There are a range of infant formulae available for feeding older infants. Follow-on formula is fortified with additional iron, and provides a milk protein profile which is largely casein based. From around 6 months of age, infants are receiving complementary foods, which provide key nutrients such as iron and energy, and also help in developing skills needed to progress towards the mixed diet of a 12 month old (see section on complementary foods below). The choice of which milk is most suitable from 6 months onwards depends on the individual infant.

Apart from follow-on formula, several different infant formulae exist which can be used in specific circumstances where an infant is not breastfed, and where a standard cows' milk protein based formulae is not suitable. These include specialised infant formulae designed for pre-term or low birth-weight infants, formulae designed for infants with specific metabolic disorders, as well as partially or extensively hydrolysed infant formulae.

Legislation relevant to the composition and marketing of infant formula

The composition and marketing of all infant formulae and follow-on formulae are strictly regulated. However, parents can be confused by the wide range of products on the Irish market, the potential for these products to make health claims, as well as the imagery and language used in advertisements for follow-on formula. This area needs to be tightly and continuously monitored both at manufacturing and retail level by the FSAI through their service contract arrangements with official agencies responsible for the enforcement of infant formula regulations.

Vitamin D Supplementation

Research has identified that the Irish population may be at risk of suboptimal intakes of vitamin D. Vitamin D rich foods are not a common feature in the Irish diet and are infrequently offered to infants on a regular basis during the first year of life. Due to Ireland's northerly latitude, it is not possible for the body to make vitamin D in the skin during the winter months, i.e. October to March. Adding to this, it is critical that infants' skin is never exposed to the sun due to the risk of burning, as well as the long-term risk of skin cancer. Breast milk is considered low in vitamin D, and although formula milk and certain cereal-based commercially available baby foods are fortified with small amounts of vitamin D, many infants will continue to be at risk of suboptimal intakes. Infants are viewed as a particularly vulnerable group, and so, following the publication of '*Recommendation for Vitamin D Supplementation of Infants in Ireland*' (FSAI, 2007), it is now national policy that all infants in Ireland receive 5µg (200 I.U.) of vitamin D_3 as a vitamin D only supplement daily, throughout the first year of life (HSE, 2010). Suitable vitamin D_3 only supplements are now available on the Irish market, thus allowing all infants to be supplemented with an adequate and safe dose of vitamin D.

Introduction of Complementary Foods

Timing of first introduction of complementary foods

Throughout the first year of life, infants experience very rapid growth and development, and good nutrition during this time is essential. For the first months of life, milk (either breast milk or formula milk) supplies all the nourishment an infant needs. However, as the infant approaches 6 months of age, stores of several essential nutrients such as iron, decrease. As growth during this stage remains rapid, requirements continue to be high, and it is not possible for an infant to receive sufficient quantities of nutrients from milk alone. Complementary foods should be introduced at around 6 months of age, however, flexibility is important and the exact timing of weaning onto solid foods should be dependent on the individual infant's unique nutritional requirements, and developmental readiness. However, infants should not generally begin the weaning process before 4 months (17 weeks) of age or much later than 6 months (26 weeks), unless under the specific advice and guidance of a healthcare professional. Before 4 months of age, an infant's digestive system is still immature and the best food in every way is breast milk, or if the infant is not breastfed, formula milk. Starting the weaning process before 4 months has been linked with the development of allergy and certain chronic diseases such as coeliac disease, as well as with an increased risk of choking. On the other hand, delaying the start of this process beyond 7 months of age may also lead to problems such as an increased risk of nutrient deficiency, as well as delayed oro-motor development. Delaying the introduction of certain foods, e.g. gluten-containing foods, e.g. breads, pastas and gluten-containing cereals past the age of 7 months, may be associated with an increased risk of developing coeliac disease in later years. Recent research in Ireland has indicated that although the overall age of first introduction to complementary foods is increasing, many infants in Ireland begin the weaning process earlier than 4 months, and this issue needs to be addressed to protect the health of infants in Ireland.

Texture of complementary foods throughout the weaning process

Progression through the weaning process sees the infant introduced firstly to foods of a smooth, puréed or semi-solid consistency, leading to lumpier foods and chopped finger foods towards the end of their first year. During the weaning process, the amounts of foods eaten, as well as the variety of foods offered, should increase so that by the start of the second year of life, an infant's diet should be similar to that of their family with only small modifications, such as no-added salt. Throughout the weaning process, infants learn many new skills which allow them to manage new food textures. These skills are also linked with the development of speech, and delayed texture progression has been associated with an increased risk of developing speech impediments. Parents should be made aware that adding solids, such as baby rice to their infant's bottle, prevents them benefiting from the experience of eating solid foods, as well as being associated with a greater risk of choking, dental caries and hyper-natraemia. This practice may also lead to excessive weight gain which can affect the infant's health, both in the short-term, as well as in later years. Every infant will move through the weaning process at their own pace, in line with their unique requirements for growth and development.

Foods throughout the weaning process

Complementary foods are introduced to the diet to ensure all nutritional requirements are met as the infant continues to grow and develop. Foods in the weaning diet should add nutrients such as energy and protein, iron, and other vitamins and minerals, as well as fatty acids to support optimal growth and development.

Care should be taken with the introduction of certain foods including gluten-containing foods and honey. There has been much discussion surrounding the best time to introduce gluten, and it is now becoming clear that a window of opportunity between 4 and 7 months is most appropriate. Earlier and later introduction of gluten has been linked with the development of chronic disease such as coeliac disease and Type 1 diabetes. The way in which gluten is introduced seems important also, and there is less risk associated with introducing gluten while the mother is still breastfeeding. Considering this, parents and carers should introduce very small amounts of gluten from a time-point close to 6 months of age onwards. The introduction of gluten should not be delayed past 6 or 7 months. Under no circumstances should an infant be introduced to gluten before 4 months (17 weeks) of age.

Inappropriate weaning practices exist in Ireland today, including early weaning onto solids and the presence of foods high in salt and sugar in the weaning diet. Including high-salt, high-sugar foods in the weaning diet may be detrimental both to the immediate health of the infant, as well as health in later life. As eating patterns in infancy have been linked with those of later years, it is important to promote a diet for infants which will lay the foundations for a healthy eating pattern later in life. Parents and carers need information, guidance, and practical support to help them make the best possible choices for feeding their infants.

Dental Care

Healthy teeth are important for eating, speech, smile, and confidence, and must be taken care of to avoid the development of dental caries (early childhood caries). As soon as the first tooth has erupted, parents and carers should be advised on feeding practices which help to preserve good dental health. Allowing the infant to go to bed with a bottle can lead to a condition known as 'nursing bottle caries' and should be avoided. High-sugar foods and drinks, e.g. carbonated drinks, are linked with dental caries and should not be given to infants.

Good dental hygiene practices should be developed as soon as the first tooth appears. Parents should brush their infant's teeth with a small, soft toothbrush and tap water only. Fluoridated toothpastes are not suitable for infants < 2 years old. Good oral health is an important aspect of infant health and development, and the recommendations arising from the Irish Oral Health Service Guideline Initiative Report (2009) should be supported. As there is an appreciable overlap between elements of dental health and nutrition, oral health messages should be included in relevant health promotion interventions and educational resources, such as general weaning, breastfeeding, and formula feeding promotional literature.

Growth

Growth monitoring is essential in childhood, as slow or excessive weight gain can be problematic for both short- and long-term health. Growth monitoring is also important on a population level in order to identify trends, direct interventions to address problems and promote health. Anthropometric measures such as length-for-age, weight-for-age, head circumference-for-age, and weight-for-length should be recorded on an age and gender appropriate chart by trained staff. Individual measurements at a single time point are not sufficient, and so serial measurements are required to effectively monitor growth. Measuring the healthy infant too frequently may be counter-productive as some natural variation in weight will occur, particularly in younger infants. During the first year of life it is expected that an infant will follow a centile channel and not make large or erratic variations. The Programme for Action for Children (PAC) has made specific recommendations for assessment of an infant's growth during the first year of life, recommending that core growth assessments should be carried out at birth, the 6 to 8 week check, and school entry. However, infants and children should undergo a growth assessment at opportunistic times also, which may include immunisations or child health surveillance checks.

Growth patterns differ between breast and formula fed infants, and this should be considered when monitoring growth so that unnecessary investigations or counselling is avoided. Whereas breastfed infants grow more rapidly than formula fed infants in the first months of life (from approximately 6 months onwards, formula fed infants grow more rapidly, and often by the end of the first year of life, formula fed infants weigh more than breastfed infants). Measuring breastfed infants on a chart for formula fed infants may be detrimental as it may lead to excessive weight gain promotion, despite the breastfed infant displaying the more ideal growth pattern.

In the event of a problem, full support should be given to parents to reverse this potentially negative trend. Interventions for problematic growth should be generally community based initially, and should be acceptable to and achievable by the family. The infant should be referred for specialist attention if the problem is persistent or if there is an immediate requirement for specialist attention.

No growth charts based on Irish data for children aged 0 to 12 months are available at present. A growth chart implementation group led by the Department of Health has recommended that the World Health Organization (WHO) growth charts, as recently adapted by the UK, should be used in Ireland for infants and young children from 0 to 4 years of age, a decision which should be fully supported.

Accuracy of growth measurements is key. Only healthcare staff who have been suitably trained and are using regularly calibrated equipment should measure growth. To correspond with the introduction of the new growth charts, a nationwide training programme to promote accurate growth assessment among healthcare professionals is vital. Growth monitoring information should be collated in a central monitoring system, allowing effective and efficient surveillance of growth patterns of infants across the country. Due to fiscal realities within Ireland today, this centralisation of growth information would identify areas in which specific public health initiatives are particularly needed, thus targeting interventions to where they are most needed, and improving effectiveness of same.

Conditions which Arise Commonly in Childhood may Require Nutritional Intervention

Several conditions including constipation, colic, gastroenteritis, gastro-oesophageal reflux, and fussy eating and food neophia can arise during infancy. Many of these such as colic, are transient conditions, resolving as the infant ages.

True gastro-oesophageal reflux in infants is rare and positing in infants is a normal behaviour. Parents and care givers should be made aware of this to reduce the use of potentially unnecessary antacids or specialised pre-thickened infant formula in this group.

Other conditions such as constipation, may require a more long-term change in behaviour and feeding practices to avoid recurrence in the future such as the inclusion of small amounts of fibre and ensuring that adequate fluids are provided. Offering small amounts of fruit juice in boiled water may also be effective in the management of this condition.

For infants with gastroenteritis, the provision of fluids is vital in the form of oral rehydration solutions as well as the continuation of an infant's regular milk feeding.

Although fussy eating is rare in the first year of life, parents and caregivers need to be made aware that certain foods may need to be offered on multiple occasions in order to be accepted. Acceptance of a wide variety of healthy foods during infancy is favourable, as this stage may have an impact on food patterns and choices in later years.

Caregiver support, education and reassurance are an essential part of the management of conditions which frequently arise during infancy and childhood. Further medical attention should be sought quickly if symptoms continue to persist, or if there is uncertainty regarding the presence of an underlying organic cause. A fast diagnosis, as well as early interventions which are acceptable to and achievable by the family, are preferred. A change in infant milk feeding is most often not required, and awareness and promotion of best practice management amongst healthcare professionals in the community is ideal.

Groups of Infants with Medical Conditions may have Specific Nutrient Requirements

All infants reach the same milestones in terms of nutrition during the first year of life, and this report applies to infants with medical conditions also. However, in certain cases, specialised medical and nutritional input care may be required to ensure that growth and development continues as normal, and that the short or long-term health risks associated with these conditions are minimised. Effective growth monitoring is important to ensure feeding is not compromised, as growth can be adversely affected more quickly than in healthy infants.

Infants with special needs who can tolerate a normal diet, e.g., infants with Down syndrome or cleft lip or palate may need texture modification and growth assessments using specialised charts. Additionally, parents of these infants may require extra support and guidance.

Other groups of infants with special needs may require specialised diet, e.g. those with specific in-born errors of metabolism.

For all these infants, prompt action and contact with the specialised unit in the case of a problem is essential. Although infants with these chronic conditions should be under the care of a specialised team, it is important that awareness is present in the community, and that important checks can be carried out if the infant presents for care for a potentially unrelated issue. Caregiver support and reassurance is vital, as is encouraging the family to maintain good contact with the specialised unit, particularly as the infant ages. Support services for these conditions in the community play an important role in the quality of life of parents and infants alike, and should be promoted.

Recommendations

1) **Revision and Update of Scientific Recommendations on Infant Feeding**
   The Food Safety Authority of Ireland (FSAI) should undertake to review and update '*Scientific Recommendations for a National Infant Feeding Policy*' every five years in order to capture relevant advances in the area of infant feeding and guide to best practice.

2) **Guidance on Healthy Eating for Pre-conception and Pregnancy**
   The Health Service Executive (HSE) should ensure that practical healthy eating guidelines are promoted among all women of childbearing age. This should include specific advice to take 400µg folic acid daily (preferably as a supplement) to prevent neural tube defects in their children. The HSE should also ensure that all pregnant women should receive support and guidance on healthy eating, food safety and food supplement use during pregnancy.

3) **A Review of Food Advice and Use of Food Supplements for Key Nutrients during Pregnancy**
   The FSAI should convene a specific working group to give advice and devise recommendations on intakes, or avoidance, of foods and food supplements required to achieve the recommended intake of key nutrients (iron, vitamin D and vitamin A) safely during pregnancy.

4) **Practical Guidance on Best Practice in Infant Feeding for Healthcare Professionals**
   Based on '*Scientific Recommendations for a National Infant Feeding Policy*', the FSAI should provide information for healthcare professionals outlining practical guidance on best practice in infant feeding.

5) **Raising Awareness and Knowledge of Best practice in Infant Feeding**
   a) The Department of Health and the HSE should promote healthy eating guidelines among all groups in the population. This will ensure that the normal diet of the household, in which the infant lives, sets the basis for good eating habits throughout life.

   b) All parents should have access to information, support and practical guidance from the HSE on best practice in infant feeding:
      - During the ante-natal period
      - During the initial days postpartum
      - Post-natally as required

      This information, support and practical guidance should be tailored to the infant's stage, in addition to providing information and advice for the next stages so that parents and carers have all the information needed to make informed decisions.

   c) The Department of Education and the HSE should jointly promote best practice in infant feeding and general healthy eating. This would ensure that all members of Irish society understand the importance of infant feeding and provide a supportive environment for parents to make best practice decisions when feeding their infants.

6) **Recommendation for Industry**
   Food business operators should ensure that all food legislation relevant to infant feeding is abided by. Food business operators in conjunction with the FSAI, should develop a code of practice focusing in particular on the marketing of foods for infants (especially infant formula, follow-on formula and growing-up milk) and food business operators should agree to rigorously adhere to this code.

7) **Continued Strict Enforcement of Infant Formula Regulations**
   The FSAI, through its service contracts arrangements with its official agencies, is responsible for the enforcement of infant formula regulations and should continue to strictly enforce labelling, compositional, nutritional and marketing standards both at manufacturing and retail levels.

8) Ongoing Assessment and Evaluation of Core Aspects of Infant Development and Nutrition

The HSE should ensure that all infants have accurate growth assessments from trained healthcare professionals, using nationally approved growth charts, according to the protocol developed by Programme for Action for Children (PAC). This involves core growth assessments at birth, 6 to 8 week health check, and school entry for all infants and young children, in addition to opportunistic measurements which may occur at times such as immunisation and/or child health surveillance checks.

The HSE should ensure that these growth data, in addition to other core elements of infant feeding practices, should be routinely collected from all infants at key stages of development, such as at growth assessments, in addition to other opportunistic time-points. At a minimum, this needs to include:

- Data on milk feeding (breastfeeding or formula feeding)
- Age of first introduction of solid foods
- Common foods used during the weaning process
- Vitamin supplementation

Standardised methodology and definitions should be used to ensure that information is comparable and provides useful information.

9) Nutritional Support for Infants and their Parents in Primary Care

The HSE should ensure that parents whose infants develop minor conditions such as colic, constipation, mild reflux or gastroenteritis receive information, support and practical guidance on feeding modifications. This should be available at primary care level.

10) Specialised Nutritional Management of Infants with Specific Medical Nutrition Needs

The HSE should ensure that parents of infants with specific medical nutrition needs who require modified approaches to infant feeding should receive information, support and practical guidance from a multidisciplinary healthcare team which includes a specialist paediatric dietitian.

11) Implementation of Recommendations and Policy Relevant to Infant Feeding

Many of the practical implementation of recommendations that underpin key areas of infant feeding in Ireland should continue to be prioritised including:

- *Vitamin D Supplementation for Infants in Ireland* (HSE, 2010)
- *Breastfeeding in Ireland: A five-year strategic action plan* (Department of Health and Children, 2005)
- *Irish Oral Health Service Guideline Initiative Report* (2009)

CHAPTER 1. INFANT FEEDING PRACTICES IN IRELAND TODAY

1.1 Infant Nutrition: The Importance of Good Policy and Practice

Good nutrition during infancy is a vital part of achieving optimal growth, development and health, and can also be involved in laying the foundations for good health in later life. Rising public health challenges, as well as growing scientific evidence on a national and international level, necessitate an expert review of *'Recommendations for a National Infant Feeding Policy'* (FSAI, 1999). From this, the development of an up-to-date national policy, covering all aspects of infant feeding, is essential to promote best practice in this area.

The first 12 months of life for any infant is a period of rapid growth and development. To support these dynamic changes there is a need to progress from a complete reliance on human or infant formula milk, to the consumption of a wider variety of foods from approximately 6 months onwards. This transition is an important stage in an infant's life, and the quality of complementary foods should ensure that the diet continues to provide sufficient nutrition to facilitate growth, as well as fostering a healthy eating pattern throughout life. The nutrient requirements of each infant are unique, and are dependent on many factors including maternal nutrition during pregnancy, the nutrient stores of the infant at birth, in addition to the individual growth and developmental rate of the infant. Although broad recommendations can be made, it is important to maintain some degree of flexibility to ensure that all infants consume a diet best suited to their individual needs.

In 1999, the first National Infant Feeding Committee in Ireland identified key sections within infant feeding, and, based on scientific evidence at that time, provided recommendations for areas in which further attention was needed (FSAI, 1999). Over the past decade, scientific developments and the emergence of new information and policy at both a national and international level have occurred, necessitating the revision of these recommendations. In addition, new public health challenges exist within Ireland today. These new challenges include the dramatic rise in the level of children who are overweight and/or obese, increases in the number of health claims made on commercial infant food products, and the expanded number of these products on the market, concerns over the non-sterile nature of powdered infant formula, as well as the re-emergence of rickets among infants and young children in Ireland. Furthermore, it is recognised that the character of Irish society has fundamentally changed, with a rise in the numbers of live births to non-national women occurring in Ireland between 2004 and 2007 (ERSI, 2004-2009). This increasing ethnic diversity has the potential to influence infant feeding practices on a whole population level.

Considering the changes which have occurred over the past decade, it is necessary to review and revise practical elements of infant feeding. These recommendations should form the basis of a national infant feeding policy which would see all healthcare professionals consistently promote evidence-based, best practice guidelines for infant nutrition throughout the first year of life, and beyond.

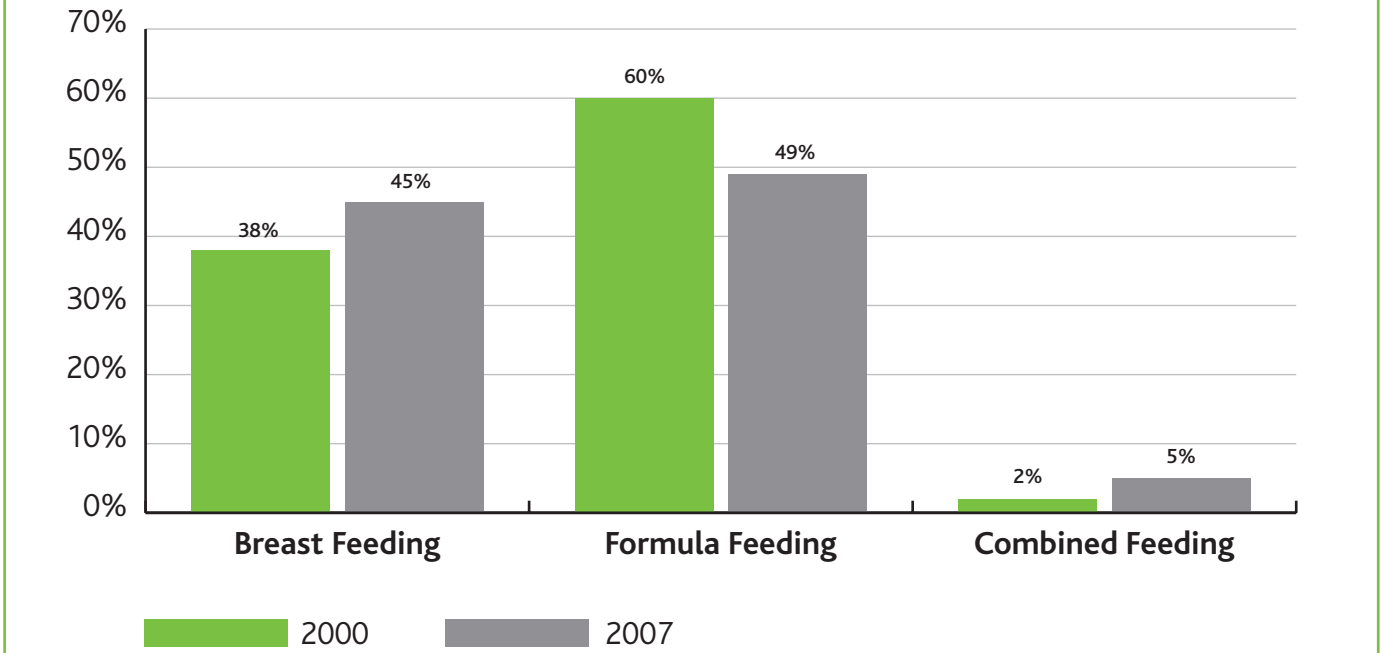
1.2 Infant Feeding Practices and Policies: Past and Present

In order to more accurately evaluate all aspects of infant feeding and guide future policy, an understanding of current infant feeding practices and policies within Ireland is essential.

1.2.1 Breastfeeding in Ireland today

Over the past decade, several important developments in national and international breastfeeding policies to promote, protect and support breastfeeding have occurred. As recommended by 'A National Breastfeeding Policy for Ireland' (Department of Health and Children, 1994), a National Breastfeeding Committee was established in 2001, and a National Breastfeeding Coordinator was appointed. On a global level at this time, the WHO, following systematic review of the benefits and optimal duration of breastfeeding (Kramer & Kakuma, 2002), revised the best practice recommendation for infant feeding and promoted the extension of exclusive breastfeeding duration from 4 to 6 months, to 6 months for all infants; a position which was further endorsed by the 'Global Strategy for Infant and Young Child Feeding' (WHO, 2003). Following this, the Department of Health and Children in Ireland published *'Breastfeeding in Ireland; A Five Year Strategic Action Plan'*, which clearly supports: *"exclusive breastfeeding of infants for the first 6 months, after which mothers are recommended to continue breastfeeding, in combination with suitably nutritious and safe complementary foods semi-solid and solid foods, until their children are 2 years of age or older"* (Department of Health and Children, 2005). Against this backdrop of breastfeeding recommendations, inspection of data available from the National Perinatal Reporting System (ERSI, 2004-2009) detailing breastfeeding rates upon discharge from the maternity unit, indicates an overall increase of 7% in breastfeeding initiation rates over the 7 year period from 2000 to 2007. Formula feeding use at discharge decreased by 19%, and in line with these changes, the prevalence of combined feeding at discharge rose by 4% over the same timeframe (Figure 1.1).

Figure 1.1 Infant feeding practices on discharge from the maternity unit (ERSI, 2000 and 2007)



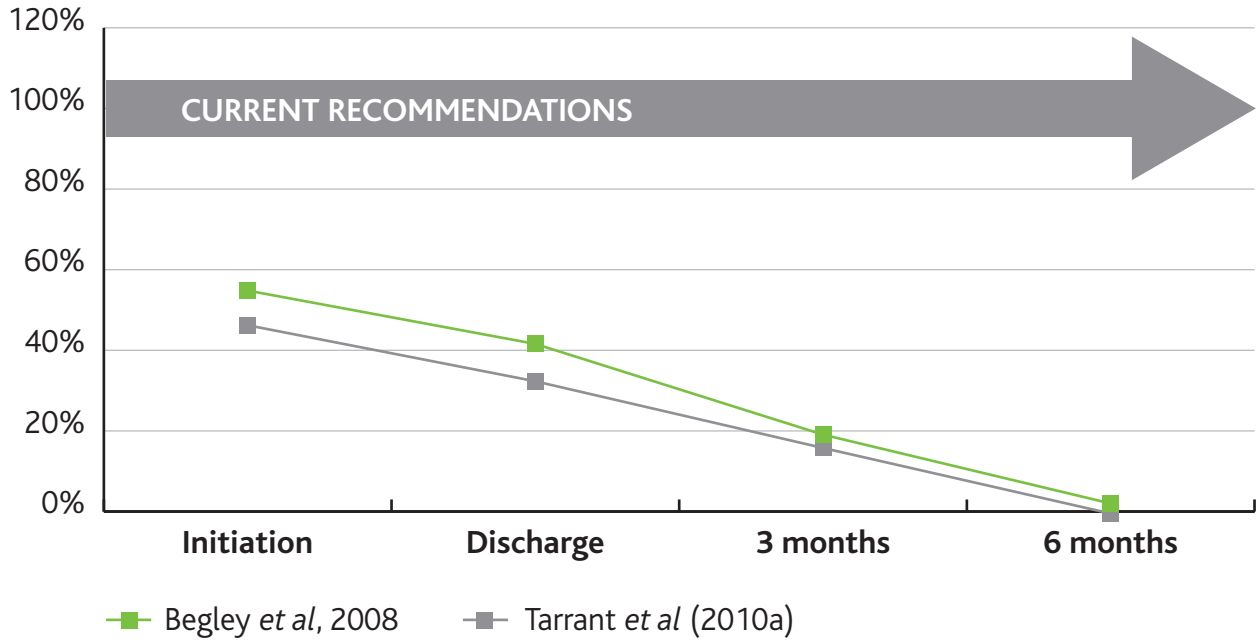
This increase is in accordance with recent data published as part of the 2007 National Survey of Lifestyle, Attitudes and Nutrition (SLÁN) which reported a rise in breastfeeding initiation rates from 32% in 2002, to 42% in 2007 (Morgan *et al*, 2008). These suboptimal levels of breastfeeding were mirrored in results emerging from *'Growing Up in Ireland - National Longitudinal Study of Children'* which reported that 48% of Irish women had breastfed their infant (Williams *et al*, 2010). However, the researchers acknowledge that this figure may be artificially inflated as a result of including non-national women within the sample, as foreign nationality has been shown to positively influence breastfeeding initiation rates (Tarrant *et al*, 2010a; Begley *et al*, 2008; Williams *et al*, 2010).

Until recently, up-to-date and accurate information on post-discharge infant feeding practices in the community has been sparse; a deficit acknowledged previously (Department of Health, 2005). To address this, the HSE commissioned the National Infant Feeding Survey, a nationally representative study to examine infant feeding practices from birth to 6 to 7 months of age, in order to provide information on the spectrum of events which lead to the introduction of complementary foods. The initial sample for this study included 2527 mother-infant pairs recruited from 20 maternity units across the Republic of Ireland. This report highlighted that although 55% of women put the baby to breast initially after birth, breastfeeding rates drop upon discharge and continue to do so over the course of the next 6 months, with results showing that just over 2% of the original group of mothers were exclusively breastfeeding, and a further 9% partially breastfeeding at 6 months (Begley *et al*, 2008). *'Growing up in Ireland- National Longitudinal Study of Infants'*, reported that the average age of breastfeeding cessation was 12 weeks of age (Williams *et al*, 2010), highlighting that the vast majority of mothers in Ireland are currently not breastfeeding for the recommended length of time.

Similar results were obtained from a smaller sample of 401 Irish mothers and 49 non-national mothers recruited in the ante-natal period from a single maternity hospital in west Dublin. Breastfeeding initiation rates were low, and continued to decline up to 6 months of age, with only 1 mother (<1%) from the sample of 450 mothers exclusively breastfeeding at 6 months (Tarrant *et al*, 2010a).

Small differences between these studies may relate to the differing number of non-national mothers included in each sample, as well as the differing geographical location, both of which are known to influence breastfeeding initiation and duration. However, both sources have highlighted that current breastfeeding practices remain well below the recommendations for exclusive breastfeeding during the first 6 months of life (Figure 1.2).

Figure 1.2 Breastfeeding initiation and duration rates are far below the recommendation promoting exclusive breastfeeding for the first 6 months of life



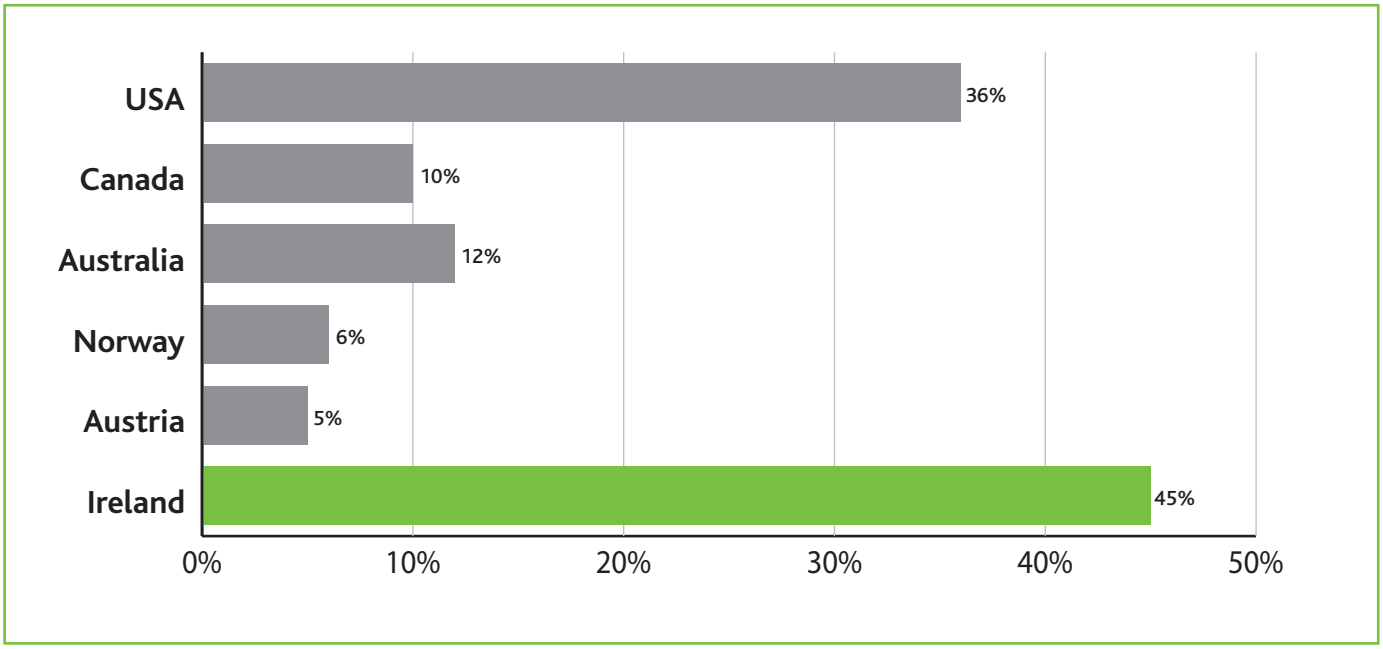
Interestingly, for 74% of these mothers, the decision not to breastfeed had been made in the ante-natal period, with the partner's view, in addition to the views of other family members influencing the decision-making process (Tarrant *et al*, 2010a). The ante-natal period is a key time to promote breastfeeding, and all women should be encouraged to attend ante-natal classes, where breastfeeding should be promoted.

1.2.2 Formula feeding in Ireland today

A formula feeding culture continues to prevail within Ireland today. Despite this, many parents are not provided with information or guidance on how to safely prepare a powdered infant formula feed. This must be recognised and addressed to ensure that the risks associated with formula feed preparation are minimised. The composition and promotion of infant formulae are strictly regulated, and industry is obliged to comply with this legislation to ensure that breastfeeding is the best form of nutrition for an infant.

As a result of the early cessation of breastfeeding, formula feeding rises sharply in the weeks following discharge from the maternity unit. Worryingly, recent data suggest that between 45% (Begley *et al*, 2008) and 53% (Tarrant *et al*, 2010a) of mothers do not initiate breastfeeding, and thus offer formula milks from birth. Recent research within Ireland has highlighted that a formula feeding culture prevails, and in terms of infant formula usage, Ireland remains ahead of international counterparts (Figure 1.3).

Figure 1.3 Use of formula milks at ~48 hours after birth (%) in North America, Australia, Norway, Austria and Ireland



Irish and international exclusive breastfeeding rates at discharge from the maternity unit (~48 hours after birth). References: USA, USA Department of Health, 2005; Healthy People 2010. Maternal, infant, and child health; Canada, Chalmers *et al*, 2009; Australia, Amir and Donath, 2008; Norway, Kristiansen *et al*, 2010; Austria, Cattaneo *et al*, 2005; Ireland, Begley *et al*, 2008)

Despite the large proportion of women who are offering formula milk to their infant during the first months of life, worrying data have emerged from the National Infant Feeding Survey indicating that only 38% of mothers had been shown how to correctly prepare a powdered infant formula feed; of these 54% were shown by a midwife, 17% by a public health nurse, and a further 29% by a family member. Additionally, although 88% of breastfeeding mothers were provided with information regarding infant feeding support services within the community, only 58% of formula feeding mothers received such information (Begley *et al*, 2008). Additional data from mothers in west Dublin (n=239) have indicated that 21% of mothers offering any formula milk at discharge from the maternity unit were dissatisfied with the level of formula feeding information received in hospital. The 'need for practical information on the reconstitution of powdered infant formula' and 'formula-specific information such as differences between formula type and brands on the market' were cited as central reasons for this dissatisfaction (Tarrant, 2007). Mothers who were dissatisfied were 5.76 times more likely to have relied on commercial information during the first 6 weeks post partum (OR 5.76, CI 2.24-14.78), and were 5.46 times more likely to switch the type or brand of formula milk at least twice in the first 6 weeks of life (Tarrant, 2007). This research highlights the specific need to inform parents on practical aspects of formula feeding. Powdered infant formula is not a sterile food product and that certain harmful bacteria such as *Cronobacter spp*. (*Enterobacter sakazakii*) and *Salmonella enterica* have been associated with powered infant formula and illness in infants (FSAI, 2007). This has been recognised in the new guidance on the safe preparation of powdered infant formula which has been issued (FSAI, 2007). It is of utmost importance that guidance on all methods of infant feeding is given to ensure infant feeding practices are safe. The WHO/UNICEF Baby Friendly Hospital Initiative (BFHI) provides guidance on best practice in the promotion and support of optimal infant feeding practices. In doing so, the BFHI also supports a mother's right to make an informed decision not to breastfeed, ensuring that all mothers receive the support and information needed to safely use infant formula products.

Strict legislation governs the composition, labelling and advertising of infant formula and follow-on formula

European legislation (Commission Directive 2006/141/EC) regulates aspects of infant formula and follow-on formula and this has been transposed into Irish law by S.I. No. 776 of 2007. The composition of infant formula and follow-on formula is strictly legislated, as is the labelling and promotion of these products.

There are two main issues relating to the labelling and advertising of infant formulae.

Advertising

The advertisement of standard infant formula, suitable for the first months of life, is not permitted. Strict legislation governs the marketing of infant formula (Directive 2006/141/EC) and includes stipulations such as:

- The labelling should not discourage breastfeeding
- Terms such as 'humanised', 'maternalised', 'adapted' or similar are prohibited
- Packaging on infant formula and follow-on formula should bear a statement concerning the superiority of breast milk
- The advertisement of infant formula should be restricted to scientific publications, and there should be no point of sale advertising or promotions
- Advertisement of formula milk for older infants, such as follow-on formulae is permitted

It is the responsibility of the infant formulae manufacturers and food business operators to comply with this legislation to ensure that potentially misleading messages delivered to parents are minimised. Continued, strict enforcement of these regulations by the FSAI through service contract arrangements with official competent authorities is also essential.

The large range of formula milks available on the Irish market may be confusing to parents. Additionally, labelling and naming of infant formula can vary between brands and is subject to change, potentially further adding to the confusion. Parents need information and support to enable them to make informed decisions around their infants' nutritional intake.

Health claims

Only a small number of nutrition claims are permitted on standard infant formula and these relate to the composition of the formula, e.g. lactose free, and are intended to provide information to parents and carers on the overall composition of the milk. Only one health claim relating to allergy is permitted on these formulae.

Health claim: A health claim is a claim which states that a relationship exists between food categories, a food or one of its constituents, and health, e.g. aids digestion.

Nutrition claim: A nutrition claim is a claim which states, suggests or implies that a food has particular beneficial nutritional properties due to the energy, nutrients or other substances provided, not provided or provided in reduced/increased amounts.

Health claims referring to children's health and development are permitted on follow-on formula only and fall under the scope of article 14 of Regulation 1924/2006/EC. A dossier of scientific evidence supporting these health claims must be submitted to the European Food Safety Authority (EFSA) for scientific assessment. Claims with favourable opinion from EFSA are considered and voted on by EU Member States and Parliament in order to be legally permitted on the European market (http://ec.europa.eu/food/food/labellingnutrition/claims/community_register/authorised_health_claims_en.htm).

It is important to remember that health and nutrition claims on infant and follow-on formulae bring these products closer to breast milk, however, breast milk remains the superior form of nutrition for infants.

Health claims on supplements and foods for infants

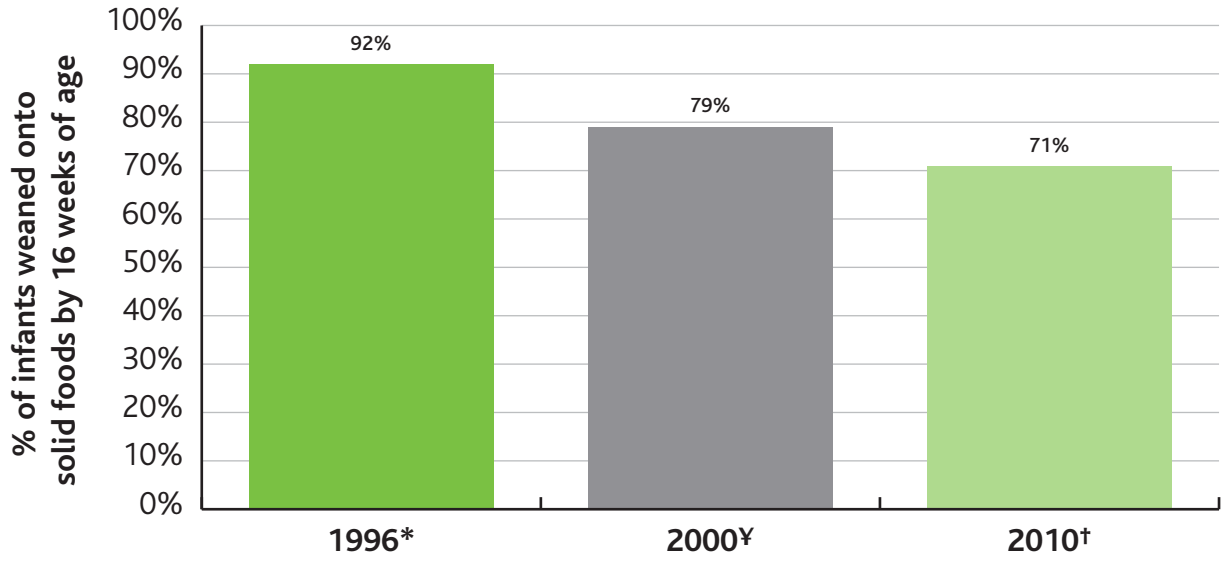
Health claims on food supplements specifically formulated for infants and children, commercially available baby foods and milks for older infants such as follow-on formula, may bear health claims. These claims may refer to children's health and development and fall under the scope of article 14 of Regulation 1924/2006/EC. To date, many of these claims have related to probiotics and the long chain omega 3 fatty acid docosahexaenoic acid (DHA). Although a potentially promising area, to date all claims surrounding probiotics have been rejected by EFSA and there is currently insufficient evidence to recommend the routine use of probiotics in infants.

1.2.3 Introduction of complementary foods in Ireland today

The majority of Irish infants continue to be introduced to complementary foods earlier than recommended. Furthermore, inappropriate weaning foods are used, including high-salt, high-sugar snack foods.

In 1999, the first National Infant Feeding Committee in Ireland made several recommendations regarding the content of the weaning diet, as well as recommending that the first introduction of complementary foods should not occur until the infant is at least 4 months (17 weeks) old (FSAI, 1999). The number of infants weaned onto solid foods by 16 weeks has decreased over the past decade, as illustrated in Figure 1.4, indicating some increase in more appropriate weaning practices. Results from the infant cohort of *'Growing Up in Ireland - National Longitudinal Study of Children'* revealed that the average age of solid food introduction was 19 weeks (just under 5 months) (Williams *et al*, 2010). However, research carried out in Irish mother-infant pairs in west Dublin (*n*=401) has indicated that many infants (>60%) continue to be weaned before the recommended age, with data reporting that 23% of infants were weaned by 12 weeks, and 4% were weaned onto solid foods by 6 weeks of age (Tarrant *et al*, 2010b). Similar to other infant feeding practices, ante-natal expectation of the timing of weaning was a predictor of actual weaning time post-partum (Tarrant *et al*, 2010b). An Irish intervention which provided weaning information in the ante-natal period resulted in more positive weaning practices post-natally (Dunleavy, 2010), underscoring the importance of ante-natal education. Of note, those in lower socioeconomic groups (Begley *et al*, 2008), and those offering formula milks exclusively were more likely to engage in inappropriate weaning behaviours (Tarrant *et al*, 2010b).

Figure 1.4 The percentage of infants in Ireland weaned by 16 weeks has decreased over the past decade however a large proportion continue to be weaned before it is recommended



Data adapted from *Freeman *et al*, 1996; ¥Twomey *et al*, 2000; †Tarrant *et al*, 2010b

Recent research has also drawn attention to other sub-optimal weaning practices (Table 1.2). At 6 months, many infants had a meal pattern more akin to that of an older child, consisting of 3 full meals with several additional smaller portions of foods. Furthermore, infants at 6 months were consuming foods; the consistencies of which are associated with the later stages of weaning.

Table 1.2 Inappropriate weaning practices in a group of infants (*n*=401) in West Dublin who were 6 months of age

Inappropriate Weaning Practice	Proportion of Infants Affected
Consumption of a sweet dessert for evening meal	31% (*n*=110)
Inappropriate snack foods offered: Chocolate Biscuits Crisps Ice-cream	 15% (*n*=35) 13% (*n*=30) 9% (*n*=21) 3% (*n*=7)
Addition of sauces to infants' weaning foods	33% (*n*=47)
Addition of gravy to infants' weaning foods	52% (*n*=74)
Addition of salt to infants' weaning foods	4% (*n*=5)
Addition of sugar and honey to infants' weaning foods	29% (*n*=41)

Data adapted from Tarrant *et al*, 2010b

Worryingly, from a public health viewpoint, more infants consumed baby biscuits greater than 4 times per week (11%) than consumed fruit and vegetables (5%). Snacks, which were offered more frequently than recommended for an infant of 6 months, were often high in fat, sugar, and salt (Tarrant *et al*, 2010b). The inclusion of high-sugar, high-salt foods at this age is a public health risk. If sustained, this eating pattern may increase the risk of overweight and obesity, as well as chronic diseases associated with obesity such as hypertension and type 2 diabetes. This latter condition had up until recently been seen only in adulthood but in line with the growing incidence of childhood obesity, is now seen more and more in children.

Legislation governing commercially available baby foods

European legislation (Commission Directive 2006/125/EC on processed cereal-based foods and baby foods for infants and young children) has laid down regulations relating to the essential nutritional compositional criteria of commercially available baby foods, and this Directive has been transposed into Irish law by S.I. No. 776 of 2007. The presence of contaminants such as pesticides is also strictly regulated, and checks are carried out on a sample of commercially available baby foods sold in Ireland to verify that the levels of pesticides meet these requirements. This legislation makes a distinction between cereal-based baby foods and other types of baby foods. The permitted composition varies accordingly, e.g. whereas vitamin D fortification is permitted within strict limits on cereal-based baby foods, fortification with this vitamin is not permitted in other types of baby food.

This legislation also details labelling requirements for commercially available baby foods and states that all foods should bear a statement indicating what age group the food is suitable for. The presence or absence of gluten should be clearly stated if the food is marketed for infants less than 6 months of age.

Although this area is tightly regulated, many of the foods on the market may send inappropriate messages to parents and carers, e.g. baby juices and desserts are available for infants from 4 to 6 months of age which are not in line with best infant feeding practices for healthy infants. Although these commercially available foods may comply with the nutritional composition requirements laid down in Commission Directive 2006/125/EC and S.I. No. 776 of 2007, if similar foods are prepared in the home, many of these foods may be unsuitable for infants. It is important therefore that parents are aware of those foods which are appropriate to prepare for their infants during the weaning period. Parents should also be aware that although organic baby foods are available, these are not strictly necessary and do not provide extra nutrition.

1.2.4 Recommendations for vitamin D supplementation in Ireland today

All infants should be given a vitamin D only supplement providing 5µg (200 I.U.) vitamin D_3 daily, throughout the first year of life.

Vitamin D is a fat soluble vitamin essential for the absorption of calcium. Calcium is important for bone health, and as infancy is a period of rapid skeletal growth, it is important that both calcium and vitamin D are present in the diet in sufficient amounts to support this skeletal development. The re-emergence of the vitamin D deficiency disorder rickets, in several Dublin-based paediatric hospitals prompted a review of this area, followed by the development of a national policy recommending that all infants receive a vitamin D only supplement providing 5µg (200 I.U.) of vitamin D_3 daily throughout the first year of life (FSAI, 2007; HSE, 2010).

The vitamin D status of an infant depends on the amount of vitamin D transferred from the mother at birth, the amount of vitamin D consumed in the diet after birth, as well as the amount produced by the skin during exposure to ultraviolet (UV) light post-natally (Kovacs and Kronenberg, 1997). Transfer of vitamin D from the mother is largely in the form of calcidiol (25, OH vitamin D), which has a relatively short half life of 3-4 weeks. Therefore, a rapid fall in vitamin D occurs from birth unless additional sources of vitamin D are made available (Suskind, 2009). Furthermore, the intake of vitamin D on a population level is below that which is recommended (Morgan *et al*, 2008), and pregnant women often do not reach the requirement for dietary vitamin D (McGowan *et al*, 2011, unpublished results; Holmes *et al*, 2009; O'Riordan *et al*, 2008). This suggests that optimal transfer of vitamin D to the infant may not be occurring. Due to Ireland's northerly latitude, poor maternal vitamin D status in pregnancy, the relatively low vitamin D content of breast milk and formula milk, as well as the very limited exposure to sunlight which is safe for an infant due to the high risk of sunburn, it is important that all infants receive a vitamin D_3 supplement during the first year of life (FSAI, 2007; HSE, 2010).

1.3 Rational for an Updated Infant Feeding Policy

New public health challenges as well as an expansion of scientific knowledge and research evidence necessitate the revision of the *'Recommendations for a National Infant Feeding Policy'* (FSAI, 1999). A combination of factors contribute to the nutritional status of an infant, and each of these should be explored and addressed to ensure that all infants in Ireland achieve the best possible nutrition.

Since the publication of *'Recommendations for a National Infant Feeding Policy'* (FSAI, 1999), many developments have occurred at both a national and international level. As detailed above, new public health pressures in addition to new scientific developments have emerged. Clinical recommendations and actions such as the extension of the national maternity leave have contributed to improvements in infant feeding practices on a national level. However, further focus on key areas of infant nutrition is required. Infant feeding has profound effects on infant health, growth, and development, both in the short- and long-term. Recommendations for infant feeding practices need to be evidence-based, reviewed regularly and updated as necessary, as well as disseminated widely to users and providers of maternity and child health services across Ireland.

Summary

- In 1999, the FSAI published *'Recommendations for a National Infant Feeding Policy'*. This report recognised that the period stretching from conception through to the end of the first year of life is an important period of development. Diet (both maternal and infant) is one of the most critical environmental factors during this stage, influencing both growth and development during infancy, as well as having far-reaching effects on health in adult life.
- Over the past decade, new scientific evidence relating to infant feeding has emerged, and Ireland has responded by publishing reports and developing new policies such as the vitamin D supplementation of infants and guidance on the safe preparation of powdered infant formula. In addition, new public health pressures such as rising childhood obesity exist within Ireland today. These changes are not reflected in the original FSAI report, therefore necessitating a revision of the *Recommendations for a National Infant Feeding Policy* (FSAI, 1999).
- Although a number of improvements in infant feeding practices have occurred within Ireland over the past 10 years, recent research has indicated that a number of key issues relating to milk and complementary feeding still exist. Despite breastfeeding being the biologically normal infant feeding method specifically designed for optimum human growth, development and health, initiation and duration rates in Ireland remain far below other countries. Also, regardless of the continued prevalence of artificial formula feeding, many parents are not aware of how to safely handle and prepare formula for the infants in their care. Furthermore, the majority of infants continue to be weaned before the recommended age, further highlighting the need for increased awareness of the correct infant feeding practices in Ireland today.
- **Recommendations for infant feeding practices should be reviewed and updated regularly, and form the basis of a national policy which sees all healthcare workers consistently promote evidence-based, best practice for infant nutrition throughout the first year of life and beyond.**

CHAPTER 2. NUTRITION FOR PRE-CONCEPTION AND PREGNANCY

2.1 The Importance of Maternal Nutrition and Lifestyle during Pregnancy

Maternal health before and during pregnancy is important, as programming which occurs *in utero* and early life has an impact on growth and development, as well as health in later life.

Prenatal and early life is a critical period of development, and conditions and events arising during this time can have far-reaching effects on health in later life. Maternal nutrition during this time is an important factor in ensuring the healthy development of the infant, and many nutrients such as folate are required for the proper development of the foetus. Other lifestyle behaviours such as smoking or consumption of alcohol are also important to consider. These substances can reach the infant via the placenta, and so may negatively affect growth and development during this time.

Whilst it was traditionally thought that the foetus was nourished adequately at the expense of maternal stores and needs, it is becoming clearer that this may not always be the case and that foetal development can be less than optimal if certain nutrients are not available during particular sensitive windows of development (Ziesel, 2009). The mother's nutritional status during pregnancy is therefore very important as it has the potential to affect development *in utero*, infant nutrient stores at birth, as well as the health of the infant in later life. For a mother to be well nourished from the time of conception and throughout pregnancy, pre-pregnancy nutritional status is important so a nutritionally complete diet should be promoted amongst all women of childbearing age.

The full assessment of food habits in pregnancy is fundamental in guiding nutritional education and intervention. Ongoing work in the National Maternity Hospital, Holles Street, Dublin (McGowan *et al*, 2011, unpublished results) suggests that many pregnant women may not be reaching their requirements for several essential nutrients during pregnancy. Nationwide assessment of these parameters is required to determine which nutrients are in need of most promotion amongst this population group.

As pregnancy is a time during which many women are motivated to make positive changes to their diet and lifestyle, healthcare professionals should use this time as an effort to encourage lasting dietary changes in women.

The foetal origins of adult disease hypothesis states that many non-communicable diseases prevalent today have origins during foetal life. Foetal programming refers to the concept that an insult or a stimulus applied during a critical or sensitive period of development can have long-lasting effects. The emergence or severity of a condition arising from these circumstances will depend on the underlying genetics of an individual, as well as the timing in which the stressful period occurred (reviewed in Silveira *et al*, 2007). Environmental factors can be sensed by the foetus from signals delivered via the placenta. These may lead to physiological changes which increase the chance of survival in the outside environment (reviewed in Silveira *et al*, 2007). Predictive adaptive responses (PARs) cause persistent changes in the organism's function, probably by means of an epigenetic

mechanism. The PAR theory hypothesizes that the infant then makes a prediction on the environment from these signals, and changes its physiology in order to best survive. If the prediction is right then survival is high, but if it is wrong, disease is more likely. This idea is central to the hypothesis that many diseases in later life have origins during foetal development.

2.2 Energy Intake during Pregnancy

Sufficient energy intake is necessary during pregnancy to support optimal growth and development of the foetus, and so it is important that the mother consumes adequate energy to maintain a healthy body weight during pregnancy. However, excessive energy intakes should be avoided due to the negative impact of obesity and overweight on pregnancy outcomes.

Sufficient energy in the form of calories is required to sustain bodily functions such as circulation, respiration, metabolism, and work. Women who are pregnant and lactating will have an increased need for energy in the form of calories in order to provide the additional energy required for the growth and development of the foetus, as well as secretion of milk at rates which are consistent with good health for both the mother and infant (Institute of Medicine, 2006).

2.2.1 Risks associated with inadequate maternal weight gain in pregnancy

Inadequate maternal energy intake can lead to poor weight gain during pregnancy which can, in turn, lead to maternal restriction of foetal growth. For those women who are under weight before pregnancy, low birth weight and very low birth weight babies are more common, and this problem will be further compounded if insufficient weight is gained during pregnancy. Inadequate weight gain during pregnancy is also associated with small for gestational age infants and pre-term delivery.

Low birth weight is heavily linked with adverse health in later years. Reports in the 1970s hinted that a mismatch between intrauterine conditions and an affluent adult lifestyle impacted on health in later life (Forsdahl, 1977). Data which emerged from the Dutch Famine added to this concept. The offspring of women who experienced food shortages caused by the German blockade towards the end of World War II were followed up in adult life, and it was observed that these individuals exhibited variations in body composition, depending on their stage of intra-uterine development when the famine occurred. If the mother had experienced malnutrition during the final three months of pregnancy, a low incidence of obesity was observed, however, if the under-nutrition occurred early in pregnancy; that is during the first six months, a greater incidence of obesity was observed, highlighting the importance of this developmental stage (Ravelli *et al*, 1976). David Barker developed a hypothesis linking birth weight and early childhood environmental conditions with the prevalence of cardiovascular disease in adult life (Barker *et al*, 1990). Since these initial observations, birth weight has been linked with other metabolic health problems including cardiovascular disease (Kajantie *et al*, 2005), and high blood pressure (Huxley *et al*, 2000).

2.2.2 Risks associated with excessive maternal weight gain during pregnancy

Excessive maternal weight gain during pregnancy, on the other hand, is associated with large for gestational age infants, macrosomia, and higher caesarean section risk, in addition to a greater incidence of neonatal infection, hypoglycaemia, and respiratory distress. Additionally, large for gestational age infants are at a greater risk of developing childhood obesity and hence a spectrum of metabolic complications in childhood and later life. Furthermore, rates of miscarriage are higher in obese women, as is gestational diabetes, hypertension, and deep vein thrombosis (DVT). Active weight reduction is not recommended during pregnancy, and rather, as a guide women entering into pregnancy overweight should aim to gain less weight than a woman of normal body weight (Table 2.2).

Recent figures from the 2007 *Survey of Lifestyle Attitudes and Nutrition* (SLÁN) (Morgan *et al*, 2008) have reported that there is an appreciable proportion of women of childbearing age who are overweight or obese in Ireland (see Table 2.1), and so who may be at an increased risk of adverse pregnancy outcomes should a pregnancy occur. This highlights the importance of population-wide education aiming to promote healthy body weight amongst all women of childbearing age.

Table 2.1 Body mass index (BMI) of women of childbearing age in Ireland

	18–29 yrs	30–44 yrs
Underweight	5%	**2%**
Normal weight	71%	**58%**
Overweight	17%	**7%**
Obese	7%	**13%**

Data adapted from SLÁN 2007 (Morgan *et al*, 2008)
BMI (body mass index) = Weight (kg) ÷ Height (M2). Underweight defined as BMI 15-18.45kg/m^2; normal weight = BMI 18.5-24.99kg/m^2; overweight as BMI 25-29. 99kg/m^2; obese as BMI >30kg/m^2

Following the birth of the infant, mothers often retain some pregnancy weight (Institute of Medicine, 2006), and therefore, every effort should be made to counsel the woman on appropriate ways to reduce it, and maintain a healthy body weight post-pregnancy, as well as providing a supportive environment for this.

2.2.3 Meeting energy requirements and weight gain goals during pregnancy

Considering the risks associated with inadequate or excessive weight gain during pregnancy, it is therefore, important that the mother is both a healthy weight at the beginning of pregnancy, and also gains sufficient weight during pregnancy to support foetal growth during this time. The following pregnancy weight gain goals which have been developed for use during pregnancy depending on pre-pregnancy body mass index (BMI) are presented in Table 2.2. These provide guidance only, and an obstetrician involved in the care of a pregnant woman is best placed to make recommendations on the overall appropriate weight gain.

Table 2.2 Pregnancy weight gain goals based on pre-pregnancy body mass index (BMI)

	Total Weight Gain		Rates of Weight Gain* 2nd and 3rd Trimester	
Pre-pregnancy BMI	Range in kg	Range in lbs	Mean (range) in kg/week	Mean (range) in lbs/week
Underweight (<18.5kg/m2)	12.5-18.0	28-40	0.51 (0.44-0.58)	1 (1-1.3)
Normal weight (18.5-24.9kg/m2)	11.5-16	25-35	0.42 (0.35-0.50)	1 (0.8-1.0)
Overweight (25.0-29.9kg/m2)	7-11.5	15-25	0.28 (0.23-0.33)	0.5 (0.4-0.6)
Obese >30kg/m2	5-9	11-20	0.22 (0.17-0.27)	0.5 (0.4-0.6)

*Calculations assume a 0.5-2kg (1.1-4.4lbs) weight gain in the first trimester
Adapted from the Institute of Medicine and the National Research Council, 2009
BMI (body mass index) = Weight (kg) ÷ Height (M^2); Underweight defined as BMI 15-18.45kg/m^2; normal weight = BMI 18.5-24.99kg/m^2; overweight as BMI 25-29. 99kg/m^2; obese as BMI >30kg/m^2

Energy requirements increase modestly during pregnancy, particularly during the second and third trimesters where they have been estimated to increase by 340kcal and 452kcal respectively (Institute of Medicine, 2006). Although energy requirements increase during pregnancy, particularly in the last trimester, energy expenditure often decreases as the mother becomes less active; hence overall net energy increases are modest. When choosing foods with which to increase energy intake, focus should be given to foods that are rich in essential vitamins and minerals such as fruits and vegetables, milk and milk products, high fibre foods and lean red meat or oily fish. The mother should be encouraged to consume a diet which will meet all her recommended nutritional intakes, rather than focusing on energy intake alone.

Pregnant women may need more calories than usual, particularly during the last trimester of pregnancy. It is a good idea to include an extra 1 to 2 food guide servings each day, e.g. have extra fruit and yoghurt for a snack, or have an extra slice of toast at breakfast and an extra glass of milk in the evening.

2.3 Total Dietary Fat Intake during Pregnancy

High fat diets are generally not suitable during pregnancy as they can increase the potential to gain excessive amounts of weight, which may negatively affect pregnancy outcomes.

As well as being an important energy source, fats in the diet also deliver several fat soluble vitamins including vitamin A, D, E, and K. High-fat diets are not recommended for the general adult population, or during pregnancy, due to the potential to gain excessive amounts of weight, among other reasons. Small amounts of certain fats are required in pregnancy and at all life stages and are necessary for good health. There is currently no evidence to suggest that the intake of total fat should change during pregnancy. However, much evidence suggests that the long chain (LC) omega-3 polyunsaturated fatty acids (PUFAs) may be an exception.

What are long chain (LC) omega-3 polyunsaturated fatty acids?

The human body has very limited ability to make LC omega-3 polyunsaturated fatty acids from other fatty acids, and so they need to be consumed through the diet. These LC omega-3 polyunsaturated fatty acids are very important as they help to prevent blood clots forming and are protective against heart disease. They are also important for brain and eye development in infants during pregnancy, and throughout the first year of life. LC omega-3 polyunsaturated fatty acids are found in oily fish such as herring, mackerel, salmon, sardines, pilchards, kippers, trout, and fresh tuna.

2.3.1 Long chain (LC) omega-3 polyunsaturated fatty acids during pregnancy

LC omega-3 fatty acids are important in pregnancy. All pregnant women should include 1 to 2 portions of oily fish in their weekly diet in order to meet the requirements for these important fatty acids.

There is evidence to suggest that the requirement for certain LC omega-3 fatty acids increases during pregnancy. Docosahexaenoic acid (DHA) has received attention due to its impact on retinal and neural development. DHA is an important component of brain grey matter and rod outer segments of the retina, and must be present in sufficient amounts for deposition in the central nervous system to support the perinatal brain growth spurt. The metabolic demand for DHA appears highest during the 3rd trimester of pregnancy (Makrides, 2009). Although there are some compensatory mechanisms during pregnancy, dietary intake of DHA is important.

The European Food Safety Authority (EFSA) has revised its recommendations for fatty acid intakes in pregnancy, and is recommending that all pregnant women consume an additional 100 to 200mg of DHA per day, corresponding to 700-1400mg/week (EFSA, 2010). This is in addition to the requirement of 250mg/day combined EPA and DHA (corresponding to 1750mg EPA and DHA/week). The EFSA guideline is supported by several international reviews (Koletzko *et al*, 2008; Koletzko *et al*, 2007; Kaiser *et al*, 2008; Kris-Etherton *et al*, 2009). This increased intake can be achieved by consuming 1 to 2 portions of oily fish per week (Table 2.3).

Table 2.3 DHA content (mg) of an average 150g (5oz) portion of fish

Fish	DHA (mg)
Salmon	3106
Tuna (fresh not canned)	3436
Tuna (canned)	101
Mackerel	1884
Rainbow trout	801
Herring	1128

Data adapted from EFSA, 2005

Fish is an important part of a balanced diet; however, certain types of fish can be a source of environmental contaminants such as methylmercury (MeHg) (see Table 2.4). High levels of methylmercury can damage early brain development, and as infancy and early life represent the most susceptible time for methylmercury poisoning (EFSA, 2004), it is of prime importance that excessive contaminants are not present in the diet at this time.

Table 2.4 Methylmercury (MeHg) content (µg) of 150g (5oz) of fish

Fish	MeHg (µg)
Salmon	6.5
Tuna (albacore, fresh not canned)	81.5
Mackerel	6.5
Rainbow trout	6.5
Herring	5.0

Data adapted from EFSA, 2005

The consumption of one or two portions of oily fish per week is unlikely to exceed the tolerable upper level (UL) for these contaminants, and is deemed safe for pregnant women (EFSA, 2005). A report from EFSA (2005) on wild and farmed fish reports that methylmercury and bio-accumulative compounds are greatest in larger fish which are higher in the food chain.

Based on the Joint FAO/WHO Expert Committee on Food Additives (JECFA) (WHO, 2004) Provisional Tolerable Weekly Intake (PTWI) of 1.6µg MeHg/kg body weight/ week, a woman of 60kg should consume not greater than 96µg MeHg per week (60kg x 1.6µg). **Due to the high amounts of MeHg in tuna, pregnant women should not consume more than one portion of fresh tuna per week, and should limit consumption of tinned tuna to 2 x 240g cans (2 x 8oz) per week (FSAI, 2004)**. Women of childbearing age should be aware that many environmental contaminants may build up in the body and should ideally limit their exposure to these during their childbearing years. Women who are planning a pregnancy should also reduce down potential sources of environmental contaminants (EFSA, 2005), and should consume no greater than one portion of fresh tuna per week, or two 240g (2 x 8oz) cans of tinned tuna prior to conception.

No adverse effects of moderate omega-3 PUFA consumption have been observed in pregnancy outcomes such as bleeding (Koletzko *et al*, 2007; Makrides *et al*, 2009). Research is ongoing in the area of omega-3 PUFA and maternal depression and mood, allergy, and BMI; however, the evidence is insufficient to make a recommendation at this time.

2.4 Vitamin D Intake during Pregnancy

Vitamin D is an important nutrient for both good bone and metabolic health. Vitamin D is transferred from the mother to the infant during pregnancy, and maternal vitamin D intake and stores during pregnancy will determine the quantity of the store transferred to the infant. All pregnant women should be advised to include vitamin D rich foods in their diet.

Vitamin D is required for calcium absorption and is therefore essential for good bone health. For calcium to be absorbed effectively from the diet, the active form of vitamin D (1,25-dihydroxyvitamin D) is required. Recent data collected as part of the 2007 *Survey of Lifestyle Attitudes and Nutrition* Survey (SLÁN) (Morgan *et al*, 2008) suggest that the average intake of vitamin D was 3.5µg/day in women of reproductive age, an intake which is well below the recommended intake. Ongoing work in a group of pregnant women in the National Maternity Hospital, Holles Street, Dublin suggests that the majority of pregnant women do not reach the recommended intake of vitamin D (McGowan *et al*, 2011, unpublished results). Additional studies by O'Riordan and co-workers in Cork (O'Riordan *et al*, 2008) and Holmes and colleagues in Belfast (Holmes *et al*, 2009), have also reported suboptimal intakes of vitamin D in pregnancy.

Vitamin D is found naturally in few foods; the flesh of oily fish, some fish liver oils, fortified milks and margarines, and some fortified cereals are dietary sources of this fat soluble vitamin. Although vitamin D can be synthesized in skin above latitudes of approximately 40°N such as Ireland; vitamin D_3 is absent from the skin for during the winter months, i.e. October to March (FSAI, 2007c). Furthermore, sun exposure may increase the risk of melanoma, and so advising sun exposure is not an effective public health strategy to combat low vitamin D levels.

25-hydroxy vitamin D [25(OH)D], which is the storage form of vitamin D, crosses the placenta, and cord blood concentrations of 25(OH)D are equal to or up to 20% lower than maternal levels. For an infant to be born with sufficient vitamin D, their mother will need to be vitamin D sufficient (Kovacs, 2008). Although no studies have examined the optimal amount of vitamin D in pregnancy (Kovacs *et al*, 2008); considering that Irish intakes do not reach the recommended vitamin D intakes, it is possible that vitamin D supplementation may be required.

Pregnant women should be encouraged to consume foods rich in vitamin D including eggs (well cooked) and oily fish. However, it is extremely difficult to achieve adequate vitamin D through dietary intakes alone. It has recently been recommended that a working group should be convened to examine the issue of vitamin D supplementation in all population groups in Ireland. This will include setting specific recommendations for pregnancy (FSAI, 2011). As an interim measure, it has been recommended that all pregnant women take 5µg of vitamin D as a supplement every day.

2.5 Calcium Intake during Pregnancy

Calcium is essential for good bone health. Although the requirement for calcium does not increase during pregnancy, data from Ireland indicate that many women do not reach the recommended daily intake. Including calcium-rich foods such as three servings of milk or milk products in the daily diet will help to meet calcium requirements during pregnancy.

Calcium plays a key role in bone health, forming the structure of bones and teeth, and practically all of total body calcium is localised in the skeleton. Calcium is also found in the blood, extra-cellular fluid, muscle and other tissues, and is involved in vascular contractions and vasodilation, muscle contractions, neural transmission, and glandular secretion (Institute of Medicine, 2006). Chronic calcium deficiency is an important cause of reduced bone mass and is associated with osteopenia, osteoporosis and an increased risk of fractures (Institute of Medicine, 2006).

During pregnancy, pregnancy-induced adaptations to maternal calcium homeostasis occur. For example, the rate of efficiency of intestinal calcium absorption is increased, helping to meet the need for foetal calcium (Kovacs, 2008). Due to these maternal adaptations, the recommendation for calcium intake during pregnancy does not increase (Institute of Medicine, 2006).

However, data from the 2007 Survey of Lifestyle, Attitudes and Nutrition (SLÁN) (Morgan *et al*, 2008) suggest that calcium intakes among women of reproductive age in the population are below the recommendation of 800mg/day, meaning that many women may be at risk of entering into pregnancy with insufficient calcium intakes.

Calcium is important to protect maternal bone during pregnancy, as well as to support foetal bone growth and development (Institute of Medicine, 2006). Low calcium intakes may also have a role in pre-eclampsia during pregnancy (Belizán, 1991; Hofmeyr *et al*, 2006), although not all reports support this relationship (Trumbo & Ellwood, 2007).

Milk and milk products are rich sources of calcium (calcium content of various foods can be seen in Table 2.5) and pregnant women should consume three portions of milk or milk products daily in line with the *'Scientific Recommendations for Healthy Eating Guidelines in Ireland'* (FSAI, 2011). Calcium absorption is reduced from foods high in oxalic acid (spinach, sweet potato, rhubarb and beans) or foods rich in phytic acid (raw beans, nuts, grains and soy isolates). As excessive intakes of calcium can interfere with the absorption of other essential minerals such as iron, it is important to encourage women to meet their requirements, whilst not encouraging unnecessarily large calcium intakes.

Table 2.5 Calcium content of commonly consumed foods

Type of Food	Calcium Content (mg)
1 glass of whole milk (200mls)*	230
1 glass of semi-skimmed milk (200mls)*	240
1 glass of skimmed milk (200mls)*	240
1 pot (¾ cup) of yoghurt (150g)*	300
1 matchbox size piece of cheddar cheese (30g)*	216
1 glass of unfortified soy milk (200mls)	26
1 glass of fortified soy milk (200mls)*	240
1 pot (¾ cup) of fortified soy yoghurt (150g)*	250
1 pot (¾) of unfortified soy yoghurt (150g)	200
1 cup low-fat milk pudding	200
¾ cup of low-fat custard	Trace
100g of sardines (canned in oil, drained)	550
120g of calcium set tofu	200-330
60g of curly kale (boiled)	90
85g of broccoli (boiled)	34
1 slice of white bread (25g)	27.5
150g of baked beans (in tomato sauce)	79.5
100g of okra (boiled)	120
90g of spinach (raw)	153
6 whole almonds (13g)	31.2
12g of sesame seeds	80.4
1 packet of sesame snaps (30g)	100.5

Data adapted from MAFF, Food Portion Sizes 2nd Edition (MAFF, 1993), and McCance and Widdowson's The Composition of Foods, 5th Edition (Holland *et al*, 1995)
*Portion size equivalent to servings in the milk and dairy product food groups - Scientific Recommendations for Healthy Eating Guidelines in Ireland (FSAI, 2011)

For those women who are unable to consume adequate calcium, for example, those on a strict vegan diet, or those who may have an allergy to cows' milk, a supplement may be required. The bioavailability of calcium depends on the size of the dose, the form, and the presence or absence of a meal, with the former improving absorption. Tablet disintegration of supplements is crucial, and the efficiency of calcium absorption from supplements is greatest when calcium is taken in doses of 500mg or less (Institute of Medicine, 2006).

2.6 Iron Intakes during Pregnancy

Iron is essential during pregnancy to support the growth of the foetus. Low iron intakes during pregnancy have been linked with adverse pregnancy outcomes and an increased risk of iron deficiency for the infant during the first year of life. Women should be counselled on the importance of meeting their iron requirement during pregnancy and provided with guidance on choosing iron-rich foods. Iron supplements should also be recommended, if required.

2.6.1 Iron is an essential mineral, the requirement for which increases during pregnancy

During pregnancy, the developing foetus requires a large red blood cell mass to provide sufficient oxygen for development and growth, as well as to combat the relatively lower oxygen environment of the womb (Dewey & Chaparro, 2007). Maternal iron needs during pregnancy increase slowly as the pregnancy progresses because of growth and maintenance of the foetus, uterus and increased red blood cell count, and expected iron losses when giving birth. To help the mother to provide this extra iron, the placenta removes iron from the maternal circulation, and so there should be sufficient iron in the maternal circulation to provide the iron which the developing foetus requires. Some adaptations do occur during pregnancy, and if the mother's iron status is low, the placenta will be more efficient at removing iron from the mother's circulation (Gambling *et al*, 2001). In addition to other adaptations which occur in iron absorption during pregnancy, the increased requirement for iron is offset by the absence of menstrual losses, resulting in a net iron requirement of 15µg/day during pregnancy (FSAI, 1999).

If an infant is born full-term, of normal birth-weight and the mother had adequate iron stores prior to and during pregnancy, the iron stores of the infant will last for approximately six months. As the iron content of breast milk is low (although it is very easily absorbed by the infant), it is important that good iron stores are laid down at birth to last for the time period for which the infant should be exclusively breastfed. It is vital that iron rich foods are introduced early in the weaning process (from around 6 months) to ensure that infants maintain a good iron status.

2.6.2 Iron deficiency during pregnancy is associated with adverse health outcomes

Anaemia, of which the most common cause is iron deficiency (ID), is problematic during pregnancy. Anaemia is associated with adverse pregnancy outcomes which include pre-term birth and low birth weight, as well as maternal mortality and morbidity (WHO, 2001). Outcomes include increased maternal mortality, morbidity (increased fatigue; decreased work capacity; decreased resistance to cold; poor tolerance of heavy blood loss; increased infections) and undesirable pregnancy outcomes (peri-natal death; pre-term delivery; low birth weight; pre-eclampsia). If iron is lacking during pregnancy, deposition of iron stores in the infant will suffer, and a suboptimal iron level may continue after birth; increasing the infant's risk of iron deficiency anaemia (Kilbride *et al*, 1999; Pee *et al*, 2002). Maternal iron deficiency during pregnancy is a risk factor for infant anaemia during the first year of life (Freeman *et al*, 1998), and low maternal iron status during pregnancy is related to impaired infant cognitive function in some studies (Tamura *et al*, 2002), but not others (Parsons *et al*, 2008).

Ongoing work in the National Maternity Hospital, Holles Street, Dublin has highlighted that the majority of pregnant women are not reaching the requirement for dietary iron during pregnancy (McGowan *et al*, 2011, unpublished results). Inspection of data collected as part of the 2007 Survey of Lifestyle, Attitudes and Nutrition (SLÁN) (Morgan *et al*, 2008) also reveals that on a population level, a significant proportion of women of reproductive age do not meet the daily requirement for iron, hinting that many may enter pregnancy with suboptimal intake and stores of iron.

2.6.3 How to achieve an adequate iron intake during pregnancy

Dietary iron intakes

Iron is present in foods as haem and non-haem iron. Haem iron is easily absorbed by the body and sources include red meats such as beef, pork, and lamb. In addition, poultry and fish contain slightly smaller amounts of haem-iron when compared to red meat. Non-haem iron is less readily absorbed by the body, and is found in beans, eggs, leafy green vegetables, wholegrains, as well as iron-enriched foods. Non-haem iron absorption can be increased by including a source of vitamin C such as fruit and vegetables, with citrus fruits such as oranges being particularly rich sources of vitamin C. Iron fortified foods such as certain breakfast cereals, can also significantly contribute to the iron content of the diet. Again, including a source of vitamin C alongside these foods can increase the absorption of iron. Including sources of both haem and non-haem iron in the daily diet can help women achieve good iron status both prior to and during pregnancy (see Table 2.6). More care may be needed with vegetarian women, and more focused and intensive dietary guidance may be required to ensure these women meet their iron requirements during pregnancy. As tannins are present in tea which can inhibit iron absorption, pregnant women should be advised to avoid drinking tannin rich beverages with food.

Liver is a good source of dietary iron as well as being rich source of vitamin A. However considering concerns over high intakes of vitamin A in pregnancy, it may be prudent to recommend that pregnant women avoid liver during pregnancy (see section 2.7 for further details of vitamin A in pregnancy).

Table 2.6 Iron content of commonly consumed foods

Type of Food	Iron Content (mg)
Foods rich in haem iron	
1 medium portion of lean beef (120g)	3.1
1 medium portion of mince (100g)	3.1
1 lamb chop (120g)	2.3
1 medium chicken breast (130g)	0.8
1 medium portion of cod (175g)	0.7
1 medium portion of salmon (170g)	1.4
Foods rich in non-haem iron	
1 slice of wholemeal bread (36g)	0.9
1 medium portion of spinach (90g)	1.8
1 boiled egg (50g)	1.0
1 small can of baked beans (150g)	2.1

Data adapted from MAFF, Food Portion Sizes 2nd Edition (1993), and McCance and Widdowson's The Composition of Foods, 5th Edition (Holland *et al*, 1995)

Iron supplementation during pregnancy

Many women find it difficult to achieve adequate iron intakes during pregnancy. To prevent the negative effects of iron deficiency, iron supplementation during pregnancy is a common practice, with a recent study of 450 pregnant women in west Dublin revealing that 66% received iron supplementation during pregnancy (Tarrant *et al*, 2010c).

Considering the negative impact of low iron status in pregnancy (see section 2.6.2), it is important that iron supplementation is provided for those women who may require it. However, side effects of iron supplementation and the elemental iron as ferrous sulphate contained within the supplements, include gastrointestinal (GI) side effects, impaired mineral absorption, and increased risk of haemoconcentration (Zhou *et al*, 2009); with these side-effects generally more evident with high dose iron supplementation. Additionally, some data emerging linking high doses of maternal iron supplementation with adverse effects of behaviour (Kwik-Uribe *et al*, 2000; Fredriksson *et al*, 1999; Zhou *et al*, 2006) and growth (Dewey *et al*, 2002; Idjradinata *et al*, 1994; Majundar *et al*, 2003; Ziaei *et al*, 2007) in infants suggest that it may be necessary to consider recommending a lower dose iron supplement during pregnancy. Furthermore, high iron intakes pose a risk to individuals who have haemochromatosis –an inherited disorder associated with a mutation in the haemochromatosis gene. This results in dysregulated iron homeostasis, enhanced absorption of iron from food and supplements, and potential iron overload. Iron overload in hereditary haemochromatosis may result in severe systemic disease; such as cirrhosis, restrictive cardiomyopathy, diabetes mellitus, hypertension, and gonadal failure. As Irish individuals are genetically susceptible to hereditary haemochromatosis (Lucotte & Dieterlen, 2003), with the reported frequency of haemochromatosis as high as 1:100 in Ireland, women with a family history of haemochromatosis would ideally have their ferritin levels checked before commencing on iron supplementation, however, the practicability of this is questionable.

In summary, iron supplementation during pregnancy may be necessary to prevent the negative impact of iron deficiency on both the mother and her developing infant, as well as in minimising healthcare costs associated with poor iron intakes, during pregnancy. However, high dose iron supplementation may not be advisable.

2.6.4 Routine supplementation of iron: what is the optimal amount?

Dietary consumption of iron rarely leads to amounts which exceed the advised iron intake in the general healthy population. However, specific supplementation of iron has the potential to increase iron intakes to excessive levels, and this may be detrimental in vulnerable sub-groups of the population.

Routine iron supplementation in pregnancy is common and often necessary to minimise the risk to maternal and infant health, as well as healthcare costs associated with the consequences of low iron intakes in pregnancy.

Studies have indicated that daily supplementation with 18-30mg is as effective as high doses in the prevention of anaemia in pregnancy (Makrides *et al*, 2003; Lee *et al*, 2005). Lower doses are associated with fewer side effects (Makrides *et al*, 2003) and possibly a greater compliance rate.

Zhou and colleagues compared several doses of iron (20, 40 and 80mg iron) for 8 weeks during pregnancy. A dose response relationship was seen between the amount of iron given, and haemoglobin (Hb) and ferritin levels; however, no difference was observed in pregnancy outcomes or neonatal complications, and additionally those receiving a lower dose of iron reported less gastrointestinal side effects. The average Hb levels were within the normal limits in all 3 treatment groups, supporting the efficacy of lower dose iron supplementation (Zhou *et al*, 2009). Furthermore, as discussed by Zhou *et al*, the clinical benefits of Hb concentrations above the cut-off point are currently unclear, and in fact it has been documented that the relationship between Hb concentration in pregnancy and pregnancy outcomes is U-shaped, with Hb at both ends of the spectrum associated with adverse pregnancy outcomes (Zhou *et al*, 2009).

Work conducted recently in Canada has provided evidence-based information on the appropriate reduction in iron supplementation during pregnancy. Cockell and co-workers (Cockell *et al*, 2009) compared data taken from 24-hour recalls from pregnant (n=148) and non-pregnant (n=4540) women aged 19-50 years to the recommended intake levels (Institute of Medicine, 2006). The prevalence of inadequate intake among pregnant women appeared high at 85%; however, supplementing with a high dose of iron generally recommended would move an unacceptable proportion of pregnant women above the tolerable upper level for iron intake. Supplementing with a lower dose (16mg/day) would decrease the proportion of women consuming inadequate iron to <3% without increasing the risk of pregnant women taking an excessive dose. The data presented the safe and efficacious amount of iron that could be given on a population basis to pregnant women, without having adverse effects. Further responsibility could rest with the individual clinician to assess the adequacy of this lower dose, and increase the supplementation dose as they see fit (Cockell *et al*, 2009).

Iron during pregnancy is important and supplementation is a complex issue. This report recommends that a working group should be convened to discuss in more detail the important issue of iron in pregnancy, and devise recommendations around supplementation in order to best protect the health of both mothers and their infants, living in Ireland. As an interim measure, women should be counselled on the inclusion of iron-rich foods to include iron in their daily diet. Given the higher risk of Celtic races to develop haemochromatosis, a family history of haemochromatosis should be ruled out before commencing iron supplementation.

2.7 Vitamin A Intake during Pregnancy

Vitamin A is an essential fat soluble vitamin. High maternal vitamin A intake during pregnancy can be harmful to the developing foetus. Considering this, pregnant women should be advised to avoid very rich sources food sources of vitamin A such as liver and liver products. Due to the risk of vitamin A toxicity, care should also be taken with the type and dose of multivitamin supplement taken during pregnancy.

2.7.1 Recommended intakes of vitamin A during pregnancy

Vitamin A belongs to a group of fat soluble vitamins provided by the diet and is an essential micronutrient which plays a role in many biological processes. It is necessary for vision, embryonic development, and for the regulation of proliferation and differentiation of many cell types. Vitamin A plays a role in reproduction; however, high levels of this vitamin and its metabolites can have a teratogenic effect in humans, causing malformations and birth defects in the developing foetus (Miller *et al*, 1998). The recommended daily allowance (RDA) for vitamin A during pregnancy in Ireland is 700µg/day retinol activity equivalent (RAE) (FSAI, 1999), with a tolerable upper level of 3,000µg/day RAE (Institute of Medicine, 2006).

Pre-formed vitamin A (retinol) is found naturally in animal-based foods, and common sources include liver, dairy products and fish. Foods fortified with vitamin A include margarine and milk. Dietary carotenoids, which are converted to vitamin A in the body, are found in oils, fruits and vegetables. Strongly and brightly coloured fruits and vegetables such as carrots, broccoli, peas, spinach, and red peppers are rich sources of carotenoids (Table 2.7).

Table 2.7 Vitamin A content of commonly consumed foods

Food	Vitamin A content (µg)
1 medium portion of roast beef (medium portion) (150g)	0
1 medium chicken breast (150g)	0
1 boiled egg (50g)	95
1 small packet of butter (10g)	85
1 small packet of spread (10g)	100
1 glass of low-fat milk (250mls)	54
1 glass of fortified low-fat milk (250mls)	300
1 glass of fortified full-fat milk (250mls)	300
1 glass of full-fat milk (250mls)	134
1 pot of low-fat yoghurt (150g)	13
1 pot of full-fat plain yoghurt (150g)	45
1 matchbox size piece of cheddar cheese (30g)	103
1 medium portion of cod (150g)	3
1 medium portion of salmon (150g)	15
1 medium portion of tuna (150g)	0
1 medium portion of carrots (60g)	378
1 medium portion of broccoli (85g)	34
1 medium portion of peas (70g)	15
1 medium red pepper (160g)	512
Boiled spinach (90g)	288

Data adapted from MAFF, Food Portion Sizes 2nd Edition (1993), and McCance and Widdowson's The Composition of Foods, 5th Edition (Holland *et al*, 1995)

Liver is a good source of dietary iron as well as being a rich source of vitamin A. However, concerns over high intakes of vitamin A have arisen in pregnancy, as intakes greater than 7000µg retinol equivalent per day, can lead to hypervitaminosis A which can have teratogenic effects (Institute of Medicine, 2006).

Considering the high levels of vitamin A contained within liver (17,300µg retinol[1] per average portion of lambs' liver (100g)), it may be prudent to recommend that pregnant women avoid liver and liver containing products, e.g. pâté, during pregnancy. This is especially true in the first few weeks of pregnancy, as there is a high potential that liver consumption will lead to vitamin A intakes which exceed the recommended tolerable upper level of 3,000µg retinol equivalents per day (Institute of Medicine, 2006). Pregnant women should be advised to include dairy produce and eggs, as well as a variety of vegetables in their daily diet, to help meet the recommended intakes of vitamin A. Choosing these foods will also contribute to a healthy intake of calcium, vitamin D, and other essential vitamins and minerals required for good health.

2.7.2 Vitamin A containing supplements during pregnancy

Pregnant women should not consume supplements which may result in a daily intake of vitamin A above the tolerable upper level. Supplements specifically targeted towards pregnant women have lower vitamin A content than other vitamin A containing products. There is a large variation of vitamin A containing food supplements on the Irish market, and some of products provide high doses of vitamin A, which are close to the recommended tolerable upper level.

This report recommends that a working group should be convened to discuss in more detail the important issue of vitamin A in pregnancy, and devise recommendations around supplementation in order to best protect the health of both mothers and their infants, living in Ireland. As an interim measure, it is preferable that women who are pregnant or who are actively planning a pregnancy should choose a vitamin and mineral preparation containing not greater than 500µg of vitamin A per daily dose. This will help to ensure that pregnant women do not exceed the tolerable upper level for vitamin A whilst still maintaining a good vitamin A status, if this cannot be achieved through dietary sources.

[1] NetWISP v3.0 Tinuviel Software IUNA Custom Version, 07.11.11

2.8 Intake of Dietary Fibre during Pregnancy

Dietary fibre is important during pregnancy and can help to prevent constipation, as well as helping to maintain a healthy body weight. Pregnant women should be advised to consume wholegrains, in addition to five servings of fruit and vegetables daily, in line with healthy eating guidelines for women in Ireland.

Dietary fibre is found in most fruits, vegetables, legumes, and grains such as oats and bran. Fibre is involved in the delay of gastric emptying, and slows the process of absorption in the small intestine, therefore increasing satiety. Fibre also has a lower energy yield than non-fibre foods, as humans are unable to absorb dietary fibre. For these reasons, high fibre foods are often promoted for healthy weight management. Furthermore, high fibre diets have been promoted for the normalisation of blood glucose and serum cholesterols levels. Finally, as fibre is involved in laxation, including more fibre in the diet may help prevent constipation (Institute of Medicine, 2006).

Fibre during pregnancy is important and may guard against constipation (Jewell and Young, 2001; Anderson and Whichelow, 1985), may be associated with reduced risk of pre-eclampsia (Frederick *et al*, 2005), and may also help maintain a healthy body weight during pregnancy. During pregnancy it has been recommended that women increase their fibre intake from 25g/day to 28g/day (Institute of Medicine, 2006).

Data from the most recent Survey of Lifestyle, Attitudes and Nutrition (SLÁN) (Morgan *et al*, 2008) indicates that fibre consumption among women in the general population may be slightly below that which is currently recommended, and so pregnant women should be specifically advised to increase their fibre intake. This situation is similar to that seen in other populations. In one recent study in Brazil, 50% of the pregnant women studied were found to have fibre intakes below the recommended 28g/day (Buss *et al*, 2009). This mirrors data collected in both the USA (Giddens *et al*, 2000) and the UK (Rees *et al*, 2005).

Ongoing work in the National Maternity Hospital, Holles Street, Dublin suggests that just under half of all pregnant women studied do not achieve the recommended intake of five portions of fruit and vegetables daily (McGowan *et al*, 2011, unpublished results). These foods, as well as being good sources of dietary fibre, will also provide essential micronutrients; are relatively low in energy; and increase satiety, thus helping to control weight during pregnancy if required. Specific advice on fibre is important, as receiving nutritional guidance during pregnancy has been shown to increase the likelihood of meeting the recommendation for fibre intake (Buss *et al*, 2009).

It is important that pregnant women drink sufficient fluids during their pregnancy to reduce the risk of developing constipation. Large volumes of sugary drinks may not be appropriate, as they may lead to excessive weight gain. Also caffeinated drinks providing >200mg caffeine per day (see section 2.9) or alcohol (see section 2.11) are not recommended. Plain water, low-fat milks or milk based drinks, or small servings of fruit juices are more ideal during pregnancy.

2.9 Folate Intake during Pregnancy

The B vitamin folate is essential for the development of the foetus. To prevent neural tube defects, all women of childbearing age should take a daily folic acid supplement of 400µg/day prior to conception, and for the first 12 weeks of pregnancy. To prevent recurrence of neural tube defects, 4mg (4000µg) of folic acid should be taken daily for the first 4 months of pregnancy and at least 1 month prior to conception. High folate foods, in addition to foods fortified with folic acid, should also be consumed.

Good folate status during pregnancy is essential. Insufficient folate during pregnancy is recognised as a leading cause of neural tube defects (NTDs), and up to 70% of NTDs can be prevented by taking a folic acid supplement (FSAI, 2006). Poor folate status is also linked to a lower birth weight (Scholl *et al*, 1996; Goldenberg *et al*, 1992; Relton *et al*, 2005; Rao *et al*, 2001; Baker *et al*, 1977), and so it is important to maintain good folate status both prior to and during pregnancy to avoid NTDs, as well as to reduce the risk of foetal growth restriction.

Neural tube defects (NTDs) are severe abnormalities of the central nervous system which develop in babies during the first weeks of pregnancy. NTDs are a major cause of mortality and morbidity, especially in childhood. Furthermore, high proportions (85%) of the infants who survive have disabilities that can include major limitations in mobility, bowel and bladder incontinence, hydrocephalus or intellectual disability. Ireland has a high incidence of NTDs relative to other European countries with 49 to 93 infants born yearly with NTDs, with many more foetuses lost as miscarriages. The most common NTD is spina bifida, which accounts for 51% of NTDs. NTDs are the most common major malformation of the CNS. They arise at a very early stage of pregnancy between 21 to 28 days after conception - a time when most women are only beginning to suspect that they may be pregnant. At this stage in early pregnancy, the cells are developing; forming a tube-like structure known as the neural tube from which the entire nervous system develops. This neural tube eventually becomes the brain and spinal cord. The development and closure of the neural tube is vital to development, as failure to close properly results in NTDs. Folate is essential in the proper development and closure of the neural tube (FSAI, 2006).

Since the early 1990s it has been known that taking folic acid before conception and for the first few weeks of pregnancy can prevent approximately 70% of NTDs. In 1993, the Department of Health and Children advised all women of childbearing age to consume 400µg of folic acid in a supplement form daily if there is any chance that they may become pregnant, and to continue taking this during pregnancy, in addition to consuming foods which were high in folate (Department of Health, 1993). Due to the low uptake of supplementation despite this policy being in place, mandatory fortification of flour to increase folic acid in the food chain was discussed. However, this was put on hold due to the emergence of evidence linking high intake levels of folic acid with risks of various types of cancer; particularly colon cancer (Cole *et al*, 2007; Mason *et al*, 2007; Mason *et al*, 2008). Furthermore, high dose folic acid supplementation and intakes may mask vitamin B12 deficiency (FSAI, 2006).

A number of foods are available on the Irish market which are voluntarily fortified with folic acid (FSAI, 2008). Analysis has highlighted that approximately 25% of breads available on the Irish market are fortified with folic acid. Additional sources of folic acid fortification in the food chain include cereals, breads, soups, cereal bars, fruit juices, milk, fat spreads, and yoghurts. This voluntary folic acid fortification has improved the folate status of the Irish population over the past number of years and may also be responsible for the reduction in NTDs in Ireland over the same time period (FSAI, 2008).

All women who are of childbearing age and who are sexually active should take 400µg/day of a folic acid only containing supplement prior to conception and continue to do so for the first 12 weeks of pregnancy. Those women who have been affected by a NTD pregnancy in the past may require additional folic acid. These women should take 4mg (4000µg) of folic acid daily for at least 4 weeks before pregnancy, and until the fourth month of pregnancy (FSAI, 2006) to prevent recurrence.

However, there is still an ongoing need to promote the folic acid supplementation programme, and more comprehensive public education programmes are required. Folic acid has been included in the 'Scientific Recommendations for Healthy Eating Guidelines in Ireland' (FSAI, 2011). Recent research has revealed that the use of folic acid supplements 'at the right time' i.e. preconception and during the first month post conception, was suboptimal, with only 44.4% (n=200) of the sample of 450 mothers in west Dublin reporting this level of folic acid supplement use during pregnancy (Tarrant *et al*, 2010c). Social class appears to influence folic acid supplement consumption with the proportion of women consuming supplements 'at the right time'. Whereas 61% of women in social class I reported taking folic acid supplements at the right time, this dropped to 54% of women in social class II and to 27% of women in social class III, thus indicating the need for more targeted promotion amongst women in lower socioeconomic groups (Tarrant *et al*, 2011).

Pregnant women, and those of childbearing age, should be aware of those foods on the market which are fortified with folic acid, and choose these to increase folate status, in addition to taking a supplement. In addition, women are advised to eat foods which are rich in folate daily to ensure folate needs during pregnancy are met. As food sources of folate are not as easily absorbed by the body as folic acid, it is important not to rely solely on food sources of this important nutrient during pregnancy, and to take a folic acid supplement throughout the first 12 weeks of pregnancy. Women on long-term medication for diabetes, or those taking anti-seizure medication, are advised to consult their doctor as they may have different requirements for folic acid (FSAI, 2008).

2.10 Caffeine Intake during Pregnancy

Caffeine intake during pregnancy has been linked with adverse health outcomes and so caffeine intake should be limited to <200mg/day during pregnancy.

Caffeine is a mildly addictive stimulant which is found naturally occurring in foods and drinks such as coffee, tea, and cocoa. Caffeine is also used as an additive in soft drinks, energy drinks, some chewing gums, and medications. It is therefore possible that pregnant and lactating women may consume caffeine from multiple sources.

Caffeine can be absorbed freely across the placenta but cannot be broken down by either the placenta or the foetus. Therefore, maternal caffeine consumption is closely linked with placental and foetal caffeine concentrations, and the foetus can be exposed easily to the effects of caffeine.

Cytochrome P450 1A2 (CYP1A2), the principal enzyme involved in caffeine metabolism in humans is absent in the placenta and foetus (Aldridge *et al*, 1979), and only begins to be expressed in the infant's liver during the first three months of life (Sonnier *et al*, 1998).

Previous guidelines for caffeine consumption in pregnancy have been based on studies which have reported that heavy caffeine intakes (>400mg/day) can increase the risk of miscarriage (Fenster *et al*, 1991) and sudden infant death syndrome (SIDS) (Ford *et al*, 1998). Additionally, a caffeine consumption of >300mg/day has been shown to have a negative effect on birth weight (Martin *et al*, 1987; Fenster *et al*, 1991; Bracken *et al*, 2003). However, recent research suggests that caffeine intake during pregnancy should be even more strictly limited.

In a recent study which examined caffeine consumption amongst pregnant women (n=2500), it was observed that the adverse effects on foetal growth increased progressively as daily caffeine intakes increased from 200 to 299mg/day. Importantly, this effect was seen even in women who were non-smokers (CARE, 2008) (smoking during pregnancy is well known to adversely affect foetal growth). These negative effects of caffeine on foetal growth were also apparent in a previous study which observed a significant negative effect of caffeine intake below 300mg/day on foetal birth weight (Vlajinac *et al*, 1997).

Besides the effect of caffeine on foetal growth, many caffeine containing foods such as tea contain significant amounts of tannins which may negatively impact iron absorption. Iron is an essential nutrient but it has limited bio-availability, i.e. the human body only absorbs a limited amount of the iron in the food. The requirement for iron rises during pregnancy and many pregnant women find it difficult to consume and absorb sufficient dietary iron. Lack of sufficient iron during pregnancy can adversely affect foetal growth. Therefore, factors which reduce the bio-availability of dietary iron (such as tannins in tea and coffee) should be avoided.

Although not all studies have reported a link between caffeine and negative foetal outcomes, there is sufficient evidence to suggest that caffeine may be harmful, and therefore it is best not to consume excessive amounts. Considering this, the guideline for the upper limit of caffeine intake in pregnancy should be reduced from 300mg/day to 200mg/day throughout pregnancy.

Caffeine consumption is a modifiable behaviour and based on recent evidence, pregnant women should aim to reduce their caffeine intake to 200mg/day or below. Care should be taken not to replace caffeinated drinks with sugary or alcoholic drinks. In other words, caffeine containing foods and beverages should be minimised but not replaced with unhealthy alternatives (Olsen & Bech, 2008).

Many women naturally develop an aversion to caffeinated drinks during pregnancy; however those who do not, as well as those women who are planning a pregnancy, should be advised to reduce their caffeine intake if necessary to below 200mg/day.

Appendix B outlines the caffeine content of beverages and foods that are the common sources of caffeine in the Irish diet. From this table the daily limit of 200mg of caffeine can still include one cup of brewed coffee and two cups of tea per day.

2.11 Alcohol Consumption during Pregnancy

There is no safe known alcohol intake in pregnancy and due to the negative effects on pregnancy outcomes, consumption of even small amounts of alcohol is not recommended during pregnancy.

There is no known safe alcohol intake in pregnancy and ceasing all alcohol consumption is best (Department of Health and Children, 2008). Alcohol is a teratogen (a substance which is harmful to the developing foetus), and can lead to the development of foetal alcohol spectrum disorders, as well as increasing the risk of miscarriage and pre-term delivery (Department of Health and Children, 2008). Along with many other countries, Ireland recommends to completely abstain from alcohol intake during pregnancy.

- 3 drinks/day increases the risk of miscarriage
- 1 drink per week increases the risk of pre-term birth
- Binge drinking is particularly risky

(Department of Health and Children, 2008)

Current research suggests that >95g of pure alcohol per week (1 standard drink = 10g of pure alcohol) places the baby at risk of serious, lifelong developmental and cognitive disabilities (Stade *et al*, 2009). Although studies have shown a positive effect on abstaining from alcohol during pregnancy (such as supportive counselling sessions and brief educational sessions), there has been insufficient evidence to determine which interventions are the most effective (Stade *et al*, 2009). Alcohol use among women of childbearing age constitutes a leading, preventable cause of birth defects and developmental disabilities.

Studies from the Coombe Hospital, Dublin, discovered that 63% of women drink alcohol during pregnancy and that 7% consume greater than 6 units per week (Barry *et al*, 2006). Donnelly and co-workers (2008) examined women (n=1011) at their booking visit to the Rotunda Hospital, North Dublin. 5% admitted to using illegal drugs in the first trimester; 28% were smoking during pregnancy, with 31% of these still smoking more than 10 cigarettes per day, although many women had cut back once it was confirmed that they were pregnant. 54% continued to drink alcohol after a positive pregnancy test with 2% of those still drinking, consuming greater than 10 units of alcohol per week. These figures were similar over all clinics (private, semi-private, public) and age groups. Data which emerged from the Lifeways study confirmed that many women do not stop drinking in pregnancy (Murrin *et al*, 2007), and recent data from women in west Dublin also confirms this, revealing that 35% (n=159) of women reported drinking alcohol during pregnancy, with no significant differences observed across socioeconomic groups (Tarrant *et al*, 2011). Results emerging from the *Growing Up in Ireland – National Longitudinal Study of Children* (Williams *et al*, 2010) indicated that 20% of women reported drinking at some stage during pregnancy, with 6% drinking throughout all 3 trimesters.

2.12 Food Safety during Pregnancy

Food safety is essential during pregnancy in order to prevent foodborne illnesses which may harm the mother and the developing foetus.

Good food preparation and hygiene practices are important at all stages of life in order to prevent potentially harmful foodborne illnesses. However, during pregnancy this is particularly important, as certain bacteria in food (such as *Listeria*), or parasites (such as *Toxoplasma gondii*) can reach the developing infant and can be extremely harmful.

Listeria monocytogenes is a bacterium which is ubiquitous in the environment. It is a pathogenic bacterium which causes a group of diseases collectively known as listeriosis. The consumption of contaminated food is the main route of transmission of listeriosis (80-90% of cases).Invasive listeriosis affects high-risk individuals including pregnant women and the developing infant, and is characterised by diarrhoea, fever, headache, myalgia (muscle pain), meningitis, septicaemia, as well as spontaneous abortion.

L. monocytogenes is unusual because it can grow at refrigeration temperatures. It is however, killed by cooking food and by pasteurisation (FSAI, 2007a). Unpasteurised milk (raw milk) and dairy products made from unpasteurised milk may be contaminated. Certain foods with a long shelf life under refrigeration (typically greater than 5 days) and consumed without further treatments, e.g. cooking, also have a higher risk of contamination. These include soft cheeses (even those made with pasteurised milk), paté, smoked salmon, deli meats, e.g. fermented raw meat sausages, luncheon meats and prep-prepared salads, e.g. coleslaw, (FSAI, 2007a).

Toxoplasmosis is caused by the parasite *Toxoplasma gondii*. Humans can become infected by ingestion of *Toxoplasma oocystes* excreted in cat faeces, or by eating raw/undercooked meat containing visible cysts from infected food animals. When primary infection occurs during pregnancy, the organism may be transmitted to the foetus and may lead to spontaneous abortion or serious handicap in the newborn.

Raw and undercooked meat, poorly controlled cured and fermented meat products, and poorly washed salads and vegetables are potential sources of *Toxoplasma gondii*.

Hand washing and good hygiene practices are important, in particular after handling raw meat and or unwashed vegetables. Meat should be well cooked and served piping hot with no visible pink meat. It is also important that pregnant women wear gloves when gardening or changing the cat litter, and wash hands afterwards (FSA, 2006).

To minimise the risk of becoming infected, pregnant women should follow the following advice:

- Eat only freshly cooked food and well-washed freshly prepared fruit and vegetables. If eating out, it is safer to order hot dishes
- Avoid consuming the following foods:
  - Unpasteurised milk and any dairy products made with unpasteurised milk all soft cheeses and mould ripened cheese, (even those made with pasteurised milk), e.g. Brie, Camembert, Port-Salut, Goat's cheese Stilton, Blue cheese, Roquefort, Gorgonzola etc.
  - Pâté made from meat, vegetables or fish
  - Pre-packed salads, coleslaw, and ready-to-eat foods from salad bars and delicatessens
- Foods which can be eaten safety if they are cooked or reheated fully:
  - Smoked fish, such as smoked salmon
  - Chilled pre-cooked meat, such as ham and chicken
  - Cured and smoked meats, such as salami and Parma ham
- When preparing food:
  - Wash fruits and vegetables very well before eating
  - Keep raw and cooked meats separate and wash hands, knives, and chopping boards after handling uncooked food, e.g. raw meat, raw vegetables etc.
  - Ideally, use different knives, chopping boards and other kitchen utensils when preparing these foods to avoid cross-contamination
  - Cook all food thorough, especially meat, and serve when still hot
  - Ensure the refrigerator temperature is below 5°C, and put food in the refrigerator as quickly as possible
  - Follow storage instructions and don't eat foods past their 'use-by' dates
- Always wear gloves when gardening or changing the cat litter, and always wash hands very well after these activities

2.13 Allergy in Pregnancy

There is currently insufficient evidence to recommend that mothers of infants who are at risk of developing an allergy should avoid potentially allergenic foods during pregnancy, unless she herself is allergic to a certain food.

The period of *in utero* development represents the earliest possible time for the influence of maternal nutrition on the infant. Although previous recommendations have advised that pregnant women avoid potentially allergenic foods such as nuts, cows' milk, and eggs. A review of the evidence suggests that overall there is insufficient evidence to support a maternal exclusion diet during pregnancy. However, it remains extremely important that the mother herself does not consume foods which she may be allergic to.

Unnecessary elimination of foods from the diet may also increase the risk of not consuming sufficient amounts of a particular nutrient, as these potentially allergenic foods are rich sources of important nutrients; fish can be a low-fat source of high biological value protein, as well as being a good source of LC omega-3 fatty acids such as DHA; milk is an important source of calcium and protein, and fortified milks may also provide significant amounts of folic acid and vitamin D; eggs are an important source of iron and protein in the diet. Elimination of these foods may make it more difficult for the pregnant woman to achieve the optimal amounts of these nutrients in her daily diet. Unless a woman is herself allergic to a particular food, there is currently no evidence to recommend the avoidance of these foods during pregnancy.

2.14 Adolescent Pregnancies

Pregnant adolescents may require additional nutritional input as their requirements must cover both their own growth, in addition to the growth and development of the foetus. Adolescents should receive tailored nutritional advice during pregnancy and should be given access to appropriate nutritional supplements in order to improve their pregnancy outcomes.

Pregnancy during adolescence carries a higher risk of poor obstetric outcomes, particularly foetal growth restriction and pre-term delivery (Chen *et al*, 2007). Competition between maternal and foetal growth has been suggested to contribute to the higher prevalence of foetal growth restriction observed (Scholl *et al*, 1996).

Nutritional intake may also be poor in this group and one study of pregnant 14 to 18 year olds (n=500) revealed a higher prevalence of anaemia and iron deficiency, in addition to low plasma vitamin C and low plasma vitamin D concentrations (*About Teenage Eating Study*). Compliance with folic acid supplementation during early pregnancy has also been reported to be low among this population group (Baker *et al*, 2009). Pregnant adolescents should have access to individual nutritional advice and supplements if required.

2.15 Socioeconomic Groups and Pregnancy

Dietary intakes of women in lower socioeconomic groups may not be as rich in the essential nutrients which contribute to a healthy pregnancy as other groups. It is important that all women receive practical advice on the importance of nutrition and lifestyle during pregnancy. This should also be facilitated through the direct provision of foods or food supplements to help alleviate health inequalities.

Social inequalities in relation to low birth weight, pre-term delivery and low birth weight for gestational age exist. Smoking is known to account for some of the social inequality in birth weight but nutrition is also thought to be a contributing factor.

In a recent study by Haggarty and co-workers, pregnant women from lower socioeconomic groups had diets containing less protein and fibre, as well as a range of essential nutrients, e.g. iron and vitamins such as folate, vitamin B6, niacin, vitamin C and beta-carotene. The diets of these women were also higher in sodium, as well as saturated fats. In addition, the diet contained lower intakes of fruit, vegetables and oily fish (Haggarty *et al*, 2009). In a study of 1,777 pregnant women in the USA, it was observed that younger women who were less educated, and who had higher pre-pregnancy BMI had poorer quality diets during pregnancy with lower intakes of vegetables, high-fibre foods and calcium (Rifas-Shiman *et al*, 2009).

The consequences of adverse pregnancy outcomes can be lifelong, and therefore, it is important to try to eliminate or reduce food poverty and improve the diet of pregnant women in poorer socioeconomic groups, thereby helping to alleviate health inequalities brought about due to poor maternal diet during pregnancy.

A programme such as 'The Healthy Start Programme' which recently commenced in the UK provides free fruit and vegetables, in addition to vitamin supplements to pregnant women in low-income families could be considered.

Summary

- Good nutrition prior to and during pregnancy is critical for the healthy development of the foetus and can help establish adequate infant nutritional stores at birth. Maternal nutrition during pregnancy may also have an impact on the health of the infant in later years.
- The requirement for many nutrients such as iron, folate, and certain fats increases during pregnancy. It is also important that other essential nutrients such as calcium and vitamin D are present in the diet in adequate amounts to ensure optimal growth and development of the foetus, as well as protecting the health and nutritional status of the mother.
- Maintenance of a healthy body weight, in addition to the avoidance of harmful lifestyle factors such as alcohol and smoking also contributes to a good pregnancy outcome.
- **All pregnant women should receive up-to-date, evidence-based nutrition and lifestyle information during pregnancy. Support structures should be in place to ensure that all women, particularly vulnerable groups such as adolescents and women in lower socioeconomic groups, have access to the nutritious foods and supplements required for a healthy pregnancy.**
- **As the mother's nutritional status from the time of conception is important, population wide promotion of a healthy diet and lifestyle is necessary to ensure that women are entering into pregnancy with adequate stores of all the essential nutrients required.**
- **As pregnancy is a time during which many women are motivated to make positive changes to diet and lifestyle, healthcare professionals should use this time to encourage lasting healthy dietary changes.**

CHAPTER 3. BREASTFEEDING

3.1 Breastfeeding Definitions

The use of standardised breastfeeding definitions is essential to facilitate 'like-with-like' comparisons between different data sources, to evaluate best practice targets, and to assess the effectiveness of interventions to support, promote and protect breastfeeding over time.

The following standardised breastfeeding definitions are used throughout this report:

Exclusive breastfeeding: Requires that the infant receives only breast milk (including expressed breast milk) and no other liquids or solids, with the exception of oral rehydration salt solution, drops or syrups consisting of vitamins or mineral supplements, or medications (WHO, 1991)

Predominant breastfeeding: Requires that the infant receives breast milk (including expressed breast milk) as the predominant source of nourishment. However, the infant may also have received water and water-based drinks (sweetened and flavoured waters, teas, infusions etc.), fruit juices, oral rehydration salt solutions, drops and syrup forms of vitamin and mineral supplements, medicines, and ritual fluids (in limited quantities). With the exception of fruit juice and sugar water, no food-based fluid is allowed under this definition (WHO, 1991)

Partial breastfeeding: Breastfeeding in combination with formula and/or other non-human milk feeds or fluids, and/ or solid foods

Any breastfeeding: Refers to all infants who received any breast milk, or a combination of breast milk and other non-human milk feeds, and/ or solid foods

3.2 Breast Milk is the Normal Source of Nutrition for Infants

Breastfeeding supports optimum growth, development and health, and also ensures better future health for infants and their mothers. Breastfeeding exclusively provides complete nutrition for around the first 6 months of life for the vast majority of infants. After this, complementary foods are needed along with breast milk to meet the infant's growing nutritional needs. Breastfeeding continues to provide significant nutritional and health benefits up to 2 years of age or older.

As recommended by the Department of Health and Children, *"infants should be exclusively breastfed for the first 6 months of life, and thereafter continue to be breastfed in combination with suitably nutritious complementary foods for up to two years of age or beyond. This practice is the safest and best way of ensuring that babies achieve optimal growth, health, and development"* (Department of Health and Children, 2005). Breastfeeding is suitable for the vast majority of infants. Breast milk contains bioactive components which are involved in antimicrobial activities, as well as nutrient absorption enhancement, and is uniquely adapted to be digested by the immature gastrointestinal, renal, and metabolic systems of the infant. The nutritional profile of breast milk changes with the stage of lactation, presumably to meet the changing nutritional requirements of the individual infant during this time period (Rautava & Walker, 2009), and so can provide complete nutrition for the first 6 months (26 weeks) of life for most infants (WHO/UNICEF, 2003). While the recommendation to exclusively breastfeed for 6 months is suitable for the vast majority of infants, some infants may benefit from the slightly earlier introduction of complementary foods (see Chapter 5 for further details). Should parents wish to introduce complementary foods earlier than 6 months, they should be actively discouraged from doing so before 4 months (17 weeks) of age. After 6 months of age, babies require complementary foods as well as breast milk, to meet their growing nutritional needs.

Breast milk is produced by the mammary glands within breast tissue. The development of milk producing tissue begins in the foetus and continues as the female develops. With the fall in placental progesterone influence following birth, women begin to lactate. The two primary hormones that are involved in lactation are prolactin and oxytocin. Prolactin stimulates milk biosynthesis within the alveolar cells of the breast, and oxytocin stimulates contraction of the myoepithelial cells that surround the alveoli, causing the milk to be ejected into the ducts leading to the nipple when stimulated by the baby suckling. Effective baby-led feeding maintains milk supply. The supply of breast milk is also dependent on other factors including the availability of thyroid hormone, insulin and insulin-like growth factors, cortisol, and the intake of nutrients and fluids. The supply of milk is dependent on several factors, of which the most critical is the removal of milk, as this controls the production of more milk. When milk is not removed from the breast, the milk supply reduces and will eventually cease.

3.3 Breastfeeding Protects the Health of Mothers and their Infants

Breast milk offers unique immunological, nutritional and psychological advantages and protects the health of mothers and their children in both the short and long-term.

Breastfeeding is the normal method of infant feeding and has many health protective and health enhancing advantages. Human breast milk is available on demand at the right temperature, with no preparation required. As well as the risks associated with the loss of the health protective properties of breast milk, infant formulae carry the additional risk of bacterial contamination due to the manner in which it is manufactured and handled. Other risks associated with infant formulae include the potential for incorrect reconstitution of powdered products. By breastfeeding an infant, the mother is avoiding these risks. Breastfeeding is also an inexpensive form of nutrition with no need to purchase infant formulae, teats and bottles and the sterilising and cleaning products required for bottle feeding. Research shows that breastfeeding decreases the incidence of infections and many chronic diseases which reduce infant morbidity and mortality. It has been calculated that "*improved breastfeeding practices and reduction of artificial feeding could save an estimated 1.5 million children a year*"(UNICEF, State of the World's Children, 2001). In all settings, breastfeeding is undeniably beneficial, contributing significantly to the optimal lifelong health of the infant and the better future health of the mother (Table 3.1). Considering the risks associated with not breastfeeding, the American Academy of Paediatrics (AAP) suggest that the breastfed infant should be the reference against which all alternative feeding methods must be measured with regard to growth, health and other developmental outcomes (AAP, 2005).

Table 3.1 Health protective and health enhancing advantages of breastfeeding

Breastfeeding protects the health of the infant in the short-term:	Breastfeeding protects the health of the mother in the short-term:
• Decrease in post-neonatal deaths from all causes other than congenital anomalies and malignancies (Chen and Rogan, 2004) • Reduced hospitalisation from infections during the first year of life (Talayero *et al*, 2006) • Helps protect against otitis media (McNeil *et al*, 2010) • May reduce the risk of gastroenteritis (Plenge-Bönig *et al*, 2010) • Associated with reduction in Sudden Infant Death Syndrome (SIDS) (Stuebe *et al*, 2009) • Associated with decreased risk of necrotising enterocolitis (Arslanoglu *et al*, 2010; ESPGHAN, 2009)	• Positive effect on post-partum weight (Kac *et al*, 2004; Rooney *et al*, 2002, 2003; Hatsu *et al*, 2008) • Promotes a sense of well being and relaxation • Contributes to the development of the mother-baby bond • Contraceptive effect (King, 2007) • Decreased post-partum bleeding and more rapid uterine involution (King, 2007) • Economic benefits and time saving benefits
Breastfeeding protects the health of the infant in the long-term:	**Breastfeeding protects the health of the mother in the long-term:**
• May reduce the risk of Crohn's disease and ulcerative colitis (Akobeng *et al*, 2006) • May reduce the risk of obesity and being overweight in later life (Horta *et al*, 2006; Cope and Allison, 2009; Owen *et al*, 2005) • Associated with reduced blood pressure (Horta *et al*, 2006), and cholesterol in later life (Horta *et al*, 2006; Owen *et al*, 2008) • May be linked with increased cognitive development in childhood and increased educational attainment in young adulthood (Horta *et al*, 2006) • May reduce the risk of asthma and atopic sensitisation (Oddy *et al*, 2004) • May be linked with decreased risk of both type 1 (James *et al*, 2009), and type 2 (Owen *et al*, 2006) diabetes in later life	• May be protective against breast cancer (Zheng *et al*, 2000a, Zheng *et al* 2001; Tryggvadóttir *et al*, 2001; Collaborative Group on Hormonal Factors in Breast Cancer, 2002) • May reduce the risk of developing ovarian cancer (Tung *et al*, 2005) • May reduce the risk of rheumatoid arthritis in later life (Pikwer *et al*, 2009)

Breastfeeding and contraception

Breastfeeding has *some* contraceptive effect **but is not always a reliable form of contraception**.

Elevated levels of prolactin common during lactation can interfere with oestrogen secretion and ovulation (King, 2007). However, the effectiveness of lactation, as a form of contraception, depends largely on the frequency and intensity of infant suckling. Lactation is only deemed as a reliable form of contraception (98% efficacy) if the mother is breastfeeding at regular intervals (no greater than 4 hours between feeds during the day, and a maximal 6 hours interval at night), and breastfeeding is exclusively providing 90-95% of the infant's dietary requirements (King, 2007; HSE, 2008). Additionally, as expressing milk by hand or with a pump is deemed not to be as vigorous as suckling, this may reduce the maternal neuro-endocrine response and increase the risk of ovulation, thereby reducing the contraceptive effect (Labbok *et al*, 1997). **Women who are not planning to have another child immediately, who are not breastfeeding as described above, or whose menses have returned, should be advised to use an alternative form of contraception compatible with the continuation of breastfeeding (King, 2007; HSE, 2008)**. Non-hormonal methods of contraception such as barrier methods or the copper intrauterine device (IUD), or the progesterone-only contraceptive pill are the preferred choices, as these do not interfere with lactation. Additionally, the transfer of hormones into milk poses a theoretical risk to the infant (Truitt *et al*, 2003; HSE, 2008).

3.4 Very Rare Situations in which Breastfeeding may not be Advisable

Breastfeeding is the ideal form of nutrition for the vast majority of infants; however, infrequent situations do occur where breastfeeding may not be advisable, and where an alternative form of nutrition may be more appropriate.

3.4.1 Infant-led situations in which breastfeeding is not appropriate

An infant with galactosaemia should not be breastfed (AAP, 2005; HSE, 2008; WHO, 2009) as the lactose in breast milk will cause galactose to accumulate; causing harm to the infant. As normal infant formulas are based on cows' milk which also contains lactose, infants with galactosaemia should be fed a lactose-free, soy-based formula (see Chapter 4 on formula milks). Infants with phenylketonuria should not be exclusively breastfed. A specific phenylalanine-free infant formula should be used. Although some breastfeeding is possible and should be actively encouraged considering the benefits to both the mother and the infant, careful monitoring by a specialised team is required (WHO, 2009). For further information on infants with inborn errors of metabolism, see Chapter 9.

3.4.2 Maternal-led situations in which breastfeeding is not appropriate

Several maternal medical conditions make breastfeeding inadvisable. Human Immunodeficiency Virus (HIV) may be transmitted during pregnancy, birth, and in colostrum and breast milk during lactation. Although the exact mode of transmission remains unclear, nipple cracking and bleeding have been suggested as a possible source of transmission associated with breastfeeding (FSAI, 1999). This risk of transmission to the infant varies with the stage of maternal HIV infection, increasing during the viraemia of primary HIV infection and with the progression to acquired immunodeficiency syndrome (AIDS) (FSAI, 1999). Although in the developing world, the risk of not breastfeeding may outweigh the risk of HIV transmission, this is not the case in the developed world. Ireland, in agreement with other developed countries, advises HIV positive mothers against breastfeeding their infants (HSE, 2008; FSAI, 1999). Even if the infant is already infected at birth, breastfeeding should be avoided (FSAI, 1999; American Academy of Paediatrics, 2005; HSE, 2008). Where the HIV status of the mother is unknown, but it is recognised that she is at particular risk of being sero-positive (injective drug users, sexual partners of known HIV positive persons, or active drug users), the mother should be counselled not to breastfeed her baby (FSAI, 1999).

Other incidences in which breastfeeding is inadvisable includes cases in which the mother has untreated tuberculosis, T-cell lymphotrophic virus type I, or type II (HSE, 2008), or has a condition in which the immune system is compromised (AAP, 2005). Additionally, if the mother has herpes simplex lesions on a breast, this breast should not be offered to the infant, although the other breast (if free from lesions) may be offered (HSE, 2008).

Situations in which breastfeeding is not advisable

Mother	**Infant**
HIV	Galactosaemia
Untreated TB	Other metabolic disorders, e.g. phenylketonuria (PKU) (limited breastfeeding under the supervision of the specialist team only is advised)
T-cell lymphotrophic virus type I or II	
Herpes simplex lesion on breast	
Immune system is compromised	

These situations are rare and in all other circumstances, breastfeeding is the best source of nutrition for infants.

3.5 Promotion of Breastfeeding among all Members of Irish Society

Breastfeeding is the natural and normal source of nutrition for infants. Although breastfeeding initiation rates are increasing, duration rates remain low. Further public health interventions are required to increase breastfeeding rates in Ireland.

As discussed in Chapter 1, breastfeeding initiation rates are increasing modestly and as a result of an increase in public awareness, driven by Government policy and health promotion campaigns. However, both initiation and duration rates remain below current policy recommendations (Department of Health and Children, 2005), and Ireland lags behind many European and international counterparts. There is a clear need for a further increase in public awareness and facilitation of breastfeeding within Irish society.

3.5.1 Barriers to breastfeeding among Irish women

Many mothers find it difficult to exclusively breast feed for 6 months, and a supportive structure which facilitates this must be established in Irish society. The WHO recognises that 'the rates of exclusive breastfeeding decline substantially after 4 months. It is important to identify biological and social constraints to exclusive breastfeeding to 6 months in different geographical and cultural settings, and develop appropriate and effective interventions to deal with these barriers and their consequences" (WHO/UNICEF, 2003). Recent research (Tarrant *et al*, 2010a; Begley *et al*, 2008) has identified several barriers to breastfeeding which are summarised in Table 3.2. It is vital that healthcare professionals working in clinical, community and health promotion settings are aware that these barriers may exist and discuss these, in addition to developing ways to overcome these barriers to breastfeeding, with individual women. Nationally representative data has revealed that women who had ceased to breastfeed by 3 to 4 months; 81% would have liked to have breastfed for longer (Begley *et al*, 2008). It is important to promote the message that breastfeeding does not cause breast ptosis (breast sagging) and that pregnancy is the main cause of this occurring (Rinker *et al*, 2010).

Table 3.2 Attitudes influencing the decision to breast or bottle feed identified by recent Irish research (Tarrant *et al*, 2010a; Begley *et al*, 2008)

Reasons for Breastfeeding:	Reasons for Bottle Feeding:
• Best for baby • Breastfed before • Easier and more convenient • Mother-baby bonding • Benefits for mother (weight loss, reduced cancer risk, bonding, economic) • Natural form of feeding • Flexible • Family members had breastfed • Enjoyable • Wanted to try it • Just knew	• Bottle fed before • Not comfortable breastfeeding in public • Husband can help • Other children in the family • Other family members had bottle fed • Easier to make bottles • Working and had no time • Can see how much baby is taking • Lack of positive breastfeeding role models • Personal choice, always planned to • Medical reasons

From these reports, the influence of family is clear; the maternal grandmother (mother's mother) is seen to be particularly influential with regards to infant feeding decisions. However, wanting to involve the partner, as well as having other children also influenced the decision not to breastfeed, highlighting the need for widespread education and promotion of breastfeeding.

3.5.2 Promoting research on breastfeeding

Promoting research in the area of breastfeeding, and encouraging funding bodies to target breastfeeding as an important topic to research, as is the allocation of training grants to promote and support breastfeeding at the local level, and to develop woman-to-woman networks (James *et al*, 2009). Beneficial research on breastfeeding in Ireland has been completed in recent years; however, further work may be required in the area of creative solutions to poor breastfeeding rates in Ireland, as well as evaluating the long-term effectiveness of these strategies.

3.5.3 Implementing policy to promote breastfeeding

The full implementation of the 5 year strategic action plan for breastfeeding (Department of Health and Children, 2005) should be fully supported. This action plan lays out strategies to target promotion, support to communities with low breastfeeding rates and to broaden the promotion of breastfeeding on a whole population and societal level. This latter point is important, and classroom education on infant feeding has been shown to increase knowledge and improve attitudes of adolescents towards breastfeeding, resulting in a greater intention to breastfeed their children in the future (Walsh *et al*, 2008).

The Baby Friendly Hospital Initiative (BFHI) has been in place in Ireland since 1989 and has a high participation rate among maternity and paediatric units and hospitals. Both in Ireland and globally, implementing practices of the BFHI have been shown to improve breastfeeding initiation and health of infants, as well as cost savings to the health services. The implementation of the WHO/UNICEF Baby Friendly Initiative at hospital and community levels nationally as proposed by the Breastfeeding Action Plan (Department of Health and Children, 2005) is important. Hospital practices are influential in the initiation and duration and success of breastfeeding, and provide an important link between the mother and health promotion messages. The Promotion of Breastfeeding Intervention Trial (PROBIT) in Belarus reported that breastfeeding duration and exclusivity was higher in mothers who had given birth in Baby Friendly Hospital Initiative compliant centres (Kramer *et al*, 2001).

3.5.4 Communicating positive messages to the public and controlling messages about formula feeding

In Ireland, breastfeeding women are more aware of the health benefits to the mother than those women who are formula feeding (Begley *et al*, 2008), highlighting the importance of continued broad-spectrum education and promotion of these benefits. The 'Scientific Recommendations for Healthy Eating Guidelines in Ireland' (FSAI, 2011) has included breastfeeding as the optimal food for infants, and aims to increase awareness of the importance of breastfeeding on a population level (FSAI, 2010). Data from the National Infant Feeding Survey have revealed that although 93% of mothers have reported seeing an advertisement for infant formula, less than two thirds of these (59%) reported seeing an advertisement for breastfeeding (Begley *et al*, 2008). Although advertisement or promotion of infant formula is not permitted within the EU (Directive 2006/141/EC), the advertisement of follow-on formula is permitted. The use of younger looking infants can send confusing messages to parents who may feel that these milks are suitable for children under 6 months. Furthermore, health claims relating to child health and development are permitted on these milks, provided that a dossier of scientific evidence is submitted to the European Food Safety Authority (EFSA), who must approve the claim. It is important that food business operators comply with the law on advertising of follow-on formula and restrictions of advertising of infant formula, in addition to the composition of this formula and health and nutrition claims, which are made on the labelling of these products.

Advertisement of infant formulae and follow-on formulae bearing health claims may send a message indicating that these milks are in some way superior to breast milk. Parents should be advised that breast milk remains the optimal source of nutrition for infants.

3.6 Facilitating Successful Breastfeeding among Mothers in Ireland

Mothers need to be facilitated in order to breastfeed in line with best practice recommendations. The experience of breastfeeding has been lost in many Irish families and there is anxiety around breastfeeding, particularly among first time mothers. It is vital that healthcare professionals advise mothers on the correct feeding technique as well as equipping them with the confidence and knowledge to know that breastfeeding is going well. Helping to provide solutions to potential barriers to breastfeeding, offering support and referring mothers on to community based breastfeeding support groups is also essential.

3.6.1 A good feeding technique ensures effective breastfeeding

Whilst breastfeeding is an integral part of the reproductive process, the skill of breastfeeding needs to be learned, especially in Ireland where the experience of breastfeeding has been lost in many families. Mothers, therefore, need to:

- Learn how to correctly position and attach their infants at the breast to ensure effective feeding
- Know that newborn babies have very small stomachs so need to feed frequently, especially in the early weeks. They need to know that breast milk is also very easy to digest and, therefore, passes quickly through the gut
- Know that baby-led or demand feeding is normal and ensures a good milk supply
- Know that ready access to the breast is important not just for food, but also for comfort and reassurance of infants
- Know that infants go through normal growth spurts about every 3 weeks. These growth spurts are associated with more frequent demand for feeds, and mother's supply will increase accordingly to meet the growing needs of her baby. These growth spurts usually last approximately 48 hours, after which the feeding routine returns to a more normal pattern
- Not doubt the adequacy of their milk supply once breastfeeding has been established, or give supplements during growth spurts (or at any time) as these will interfere with the demand-supply basis of milk production and may jeopardise the success of breastfeeding
- Know that if there is a doubt about milk adequacy, the feeding technique should be checked and corrected as a first resort

A good feeding technique is important to ensure effective breastfeeding which will support all the nutritional needs of the infant. The experience of breastfeeding has been lost in many families in Ireland, and there may be an understandable anxiety which can arise around the adequacy of breastfeeding, particularly among new mothers. Recent research has shown that a perceived lack of milk and a perceived lack of ability to breastfeed was a barrier to breastfeeding (Tarrant *et al*, 2010a; Begley *et al*, 2008). Considering this, it is vital that standard feeding assessments be built into the community care of all new mothers and their infants.

3.6.2 Ensuring breastfeeding is going well

Healthcare professionals in the maternity unit should show mothers how to correctly position and attach their baby at the breast, and how to maintain lactation even if they should be separated from their baby. Staff in the maternity unit should also assess feeding during the hospital stay and prior to discharge, and if the mother is transferred home under the early transfer home team, midwives should assess length and weight; the public health nurse should assess feeding, height and weight thereafter. Before leaving the maternity unit, all breastfeeding women should be provided with information on breastfeeding, as well as a checklist to monitor if breastfeeding is going well. It is vital that information on support services are given to mothers before leaving the maternity unit. Staff at the maternity hospital will provide feeding support in the early weeks post discharge. The public health nurse should see the mother and their baby for an office or a home visit between 3 to 5 days of age to check on breastfeeding and the baby's weight. Community support services including the public health nurse, the GP, the practice nurse, breastfeeding support groups and community based lactation consultants, are also important sources of support.

The following checklist can be used to assess how well breastfeeding is going.

If the mother can answer YES to each of these questions when the baby is one week old then you know that breastfeeding is going well. If the mother answers no to any of these questions further help may be required. Getting help early can prevent problems and lead to a good breastfeeding experience.

Question	Yes	No
Do you feel breastfeeding is going well for you so far?		
Has your milk come in yet (i.e. did your breasts get firm and full between the 2nd and 4th day post delivery)?		
Is the baby having **4 to 6 bowel movements in 24 hours** that are mustard, or golden yellow with curds in them?		
Is the baby having at least 4 good size (i.e. more than a stain on the nappy) bowel movements (dirty nappies) each day?		
Is the baby **wetting his/her nappy at least 6 times each day?**		
Are the breasts free from any **sore, tender, or red and firm areas?**		
If the mother had initial **nipple soreness**, is this **resolved**?		
Do **breasts feel full before feeding** and **softer after feeding**?		
Is the baby **feeding at least 8 times in 24 hours**?		
Do you **see and hear swallowing** when the baby is breastfeeding, and is the **baby's suck strong, slow and steady**?		
Is the baby able to sustain rhythmic sucking for at least 10 minutes per total feeding?		
Does the baby demand to feed? And feed at least 8 times in each 24 hours? (tick no if the baby is sleepy and needs to be frequently awakened for most feeds)		
Does the baby usually feed at both breasts at each feeding?		
Does the baby feed approximately every 2 to 3 hours with no more than one longer interval of up to 5 hours at night (i.e. 8 breastfeeds at least each 24 hours)?		
Does the baby seem **satisfied after a feeding (happy or sleepy)**, and does the baby **come off the breast looking relaxed and content**?		
Are there any **sore, tender, or red and firm areas** in either breast, and are your breasts and nipples now comfortable?		
Has the baby started **gaining 15 to 30 grams per day**?		
Is the baby **sleeping between feeds**?		
Are the baby's **eyes bright and alert** and their mouth moist?		
Does the baby have a **strong cry** and **move actively**?		
If the mother has answered NO to any of these questions, there may be some problems with breastfeeding.		

Monitoring of growth and development of all infants is important, and acts as a marker of nutritional intake in the healthy infant.

Effective monitoring of growth and development is essential for all infants and early intervention if required, as well as parental support, should be offered if any problems arise (for further information see Chapter 7).

As with all infants, breastfed infants should be supplemented with 5µg/day (200 I.U.) vitamin D_3 daily, throughout the first year of life (see Chapter 1).

3.6.3 Maternal support

Mothers should be supported to exclusively breastfeed for the first 6 months of their infant's life, and to continue breastfeeding thereafter together with offering complementary foods (see Chapter 5 for more information) for as long as possible, or as long as they wish. A large proportion of women who ceased breastfeeding during the first 6 months of their infant's life reported that they would like to have continued to breastfeed. However, they stopped for various reasons including; 'wanting to wean baby from the breast', 'issues concerning the perceived milk supply/hungry baby', 'busy lifestyle/older children', 'night feeds', 'to get the baby accustomed to taking a bottle' (Begley *et al*, 2008). Women need to be actively supported when breastfeeding. As the mother's own experience was cited as the most influential factor in helping to continue to breastfeed (Begley *et al*, 2008), it is vital that each woman who breastfeeds views her experience as positive.

There are many types of support which can be offered to breastfeeding women including verbal and emotional support, actual how-to-breastfeed assistance and practical supports such as maternity leave and home help. All types of support are needed. Health care professionals should try to ensure that breastfed women have the support that they need and help breastfeeding women arrange additional support. Community based information and support groups should be widely promoted.

Expectant and new mothers and their families should have access to information and support for breastfeeding as necessary.

A supportive environment is key to prolonging breastfeeding duration and improving initiation rates. The expansion of the national maternity leave under the Maternity Protection (Amendment) Act 1994 has increased the time a mother can be with her infant, with mothers now entitled to 26 weeks paid maternity leave and 16 weeks unpaid maternity leave, under this Act. As 2 weeks of this time must be taken before the due date, this equates to 40 weeks in total, which will cover the period of exclusive breastfeeding. However, as it is ideal that infants should be breastfed up to 2 years of life (Dept of Health and Children), it is important that the mother is still facilitated to breastfeed whilst back at work. Employers should be encouraged to facilitate this by providing expressing facilities and permitting breaks during the working day in line with the Maternity Protection (Protection of Mothers who are Breastfeeding) Regulations, 2004 (S.I. No. 654 of 2004). All women should be provided with the equipment and skills required to express breast milk, and educated on the correct and safe storage procedure for expressed breast milk (see section 3.7).

Support should also be given to the mother to allow her to maintain a healthy post-pregnancy weight. Breastfeeding helps mothers return to their pre-pregnancy weight more quickly.

3.7 Expressed Breast Milk

Expressing breast milk may represent a method of providing breast milk whilst the mother is away from her baby. All women should receive information on how to express and store breast milk effectively and safely.

Expressing breast milk may represent a method of providing breast milk whilst the mother is away from her baby. Expressing milk can also help to reduce the volume of milk in the breast, increasing comfort for the mother and helping the infant to attach to the breast. Breast milk can be expressed by hand or with the use of an electric or foot powered pump. A recent Cochrane review revealed that greater volumes of milk were obtained by using an electric or foot powered pump, compared with hand expression, and that providing mothers with a relaxing tape also increased the volume of milk obtained in a single session (Becker *et al*, 2008). Simultaneous (expressing from both breasts simultaneously) rather than sequential (expressing from each breast separately) pumping is possible and takes less time than sequential pumping to obtain the same volume of milk (Becker *et al*, 2008). Feeding and pumping simultaneously may also help save time for the mother. The HSE has issued guidelines on the safe and correct storage of expressed breast milk summarised in Table 3.3.

Table 3.3 Expressed breast milk storage guidelines (HSE, 2008)

Freshly Expressed Breast Milk		
Room temperature (26°C or below)	6-8 hours	Refrigerate where possible.
Refrigerator (4°C or below)	3-5 days	Store at the back of the main body of the fridge where the temperature is coldest. Do not store in the door of the fridge as the temperature is most variable here.
Freezer (-18°C or below)	2 weeks	Freezer compartment of the fridge
	3 months	Freezer section of a fridge with separate main door
	6 months	Separate chest freezer
Previously Frozen Breast Milk, Thawed in Refrigerator and Not Warmed		
Room temperature (26°C or below)	Up to 4 hours	Refrigerate where possible
Refrigerator (4°C or below)	Up to 24 hours	Store at the back of the main body of the fridge where the temperature is coldest. Do not store in the door of the fridge as the temperature is most variable here.
~~Freezer (-18°C or below)~~	Never refreeze	
Breast Milk Thawed Outside the Refrigerator in Warm Water		
Room temperature (26°C or below)	~1 hour	Refrigerate where possible.
Refrigerator (4°C or below)	Up to 4 hours	Store at the back of the main body of the fridge where the temperature is coldest. Do not store in the door of the fridge as the temperature is most variable here.
~~Freezer (-18°C or below)~~	Never refreeze	
Infant has Begun Feeding		
~~Room temperature (26°C or below)~~	Duration of the feed	
~~Refrigerator (4°C or below)~~	Do not store. Remaining milk must be discarded after feeding.	
~~Freezer (-18°C or below)~~	Do not store. Remaining milk must be discarded after feeding.	

Checklist for Expressing, Storing and Using Breast Milk

- ☐ Ensure hands are clean before starting to express milk.
- ☐ Express breast milk in a relaxed atmosphere.
- ☐ Use hard plastic or glass containers which have been sterilised to store expressed milk. Plastic bags are not recommended for storing breast milk as there is a greater risk of spillage, leakage and contamination. Additionally, components of breast milk may adhere to the sides of the soft plastic containers, e.g. soluble IgA (sIgA).
- ☐ Store expressed breast milk in small amounts to minimise waste.
- ☐ Keep milk from different days separate from each other.
- ☐ Several expressed breast milk yields may be added together in order to store the desired volume. If adding milk to milk expressed previously on the same day, chill the milk in the fridge for 1 hour before combining. Only combine breast milk expressed on the same day.
- ☐ Do not completely fill containers as breast milk will expand when freezing.
- ☐ Label all breast milk containers using a water-proof marker with the day, date and if necessary, e.g. if leaving expressed breast milk at a child-care facility, with the child's name, and always use the oldest breast milk first.
- ☐ Ideally thaw expressed breast milk in the fridge for up to 24 hours. Breast milk can also be thawed in warm water. Ensure that the water never reaches above the neck of the bottle.
- ☐ **DO NOT MICROWAVE**. Heat spots can scald the infant's mouth, and high temperatures can destroy nutrients in the milk.
- ☐ To heat the expressed breast milk, warm to temperature using a bottle warmer or by standing the feed in a container of warm feed. Never leave a feed warming for more than 15 minutes. Swirl the milk to distribute the heat evenly.
- ☐ **Take care to avoid scalding**. Always test to the temperature of the milk before offering to the infant. Ensure the milk is not too hot by shaking the bottle and placing a drop of liquid on the inside of the wrist; **breast milk should feel lukewarm**.
- ☐ **Use fresh breast milk before using up stores of refrigerated breast milk**. If fresh breast milk is not available, always use stores of refrigerated breast milk if available, before thawing and using frozen breast milk.

3.8 Health Promotion Among Breastfeeding Mothers

Although a specific diet and lifestyle are not essential for successful breastfeeding, promoting a balanced lifestyle and a diet rich in essential nutrients helps to protect the good health of the mother.

3.8.1 A healthy, balanced maternal diet and lifestyle

A special dietary intake is not required for successful breastfeeding, and breast milk from a mother with a less than excellent diet is still preferable to formula milks. A healthy balanced diet is important for all parents (both breastfeeding and formula feeding) as it promotes good health needed when caring for their infants. The positive influence of a varied maternal diet has been highlighted by research which suggests that the variation in the taste and odour of breast milk exposes the infant to a greater variety of gustory stimuli, which encourages the selection of a wider variety of foods in later life (Arenz *et al*, 2004). In addition to consuming a varied diet, certain nutrients in particular, are important during the lactation period.

Long chain omega-3 polyunsaturated fatty acids (PUFAs)

Long chain omega-3 PUFA such as DHA are important to protect the health of the mother and may be involved in the brain and eye development of infants. Mothers should eat 1 to 2 portions of oily fish weekly whilst breastfeeding.

Fats in human milk are of critical importance during infancy, and are a major energy source present in breast milk, helping to support the rapid growth and development which is occurring at this time. In recent years, the importance of long chain polyunsaturated fatty acids (PUFA), particularly DHA, has been increasingly recognised. DHA is involved in visual and cognitive development in infants. DHA is naturally present in breast milk, and can be increased if the mother includes sources of omega-3 fatty acids in her weekly diet. It has been recommended that breastfeeding women should aim to consume ~200mg DHA per day (~1400mg DHA per week) (Koletzko *et al*, 2007). This is supported by the Scientific Recommendations for Healthy Eating Guidelines in Ireland (FSAI, 2011), which recommended that to achieve this, breastfeeding women should eat 2 portions of fish weekly, with 1 to 2 of these servings to be oily fish.

Docosahexaenoic acid (DHA) is a long-chain, omega-3 polyunsaturated fatty acid. Long chain omega-3 fatty acids such as DHA have many functions in the body, including reducing the risk of cardiovascular disease. DHA specifically is also the most abundant fatty acid found in the brain and retina and is essential for optimal neuronal functioning (learning ability, mental development) and visual acuity. To ensure an optimal amount of DHA in the diet, DHA rich foods should be consumed often. The best source of dietary DHA is oily fish (Table 3.2).

Table 3.4 LC Omega-3 PUFA and methylmercury content of 150g (average portion) of three commonly consumed fish

Fatty Acids/150g Fish	Salmon	Fresh Tuna	Mackerel
Total omega-3 fatty acids (mg)	2,376	2,836	1,892
Sum LC omega-3 (mg)	1,989	2,474	1,541
C20:4 omega-6 (mg)	126	166	137
C20:5 omega-3 (mg) EPA	495	921	517
C22:5 omega-3 (mg)	252	176	107
C22:6 omega-3 (mg) DHA	1,233	1,377	926
Contaminants/150g fish	**Salmon**	**Fresh Tuna**	**Mackerel**
MeHg (µg)	6	74	6

Long chain (LC), polyunsaturated fatty acids (PUFA), eicosapentaenoic acid (EPA), docosahexaenoic acid (DHA), methyl mercury (MeHg) Data adapted from EFSA, 2005

Fish can be a source of environmental contaminants such as methylmercury (See section 2.3.1). Breastfeeding women should avoid consuming swordfish, marlin and shark, and to limit consumption of tuna to 1 fresh tuna steak, or 2 8oz (2 x 240g) cans of tuna per week (FSAI, 2004).

The level of fish intake recommended for breastfeeding women should not exceed the tolerable intake of environmental contaminants (EFSA, 2005). Based on the Joint FAO/WHO Expert Committee on Food Additives (JECFA) (WHO, 2004) Provisional Tolerable Weekly Intake (PTWI) of 1.6µg MeHg/kg body weight/ week, an average woman of 60kg (9 stone 6 lbs) should consume no greater than 96µg MeHg (60kg x 1.6µg) per week (see Table 3.2).

Iron

Iron is important for growth of the infant, as well as the health and well-being of the mother. Breastfeeding mothers should consume iron rich foods in their daily diet.

Iron is also important for the health and well-being of the breastfeeding mother. Although the lack of menses which often occurs during breastfeeding will slightly reduce the requirement for iron slightly, breastfeeding women should be counselled to include iron rich foods daily in the diet. Haem sources of iron are more readily absorbed by the body than non-haem sources. Haem sources of iron include red meats, e.g. beef, lamb, pork, and smaller amounts are found in poultry and fish. Lactating women should follow the 'Scientific Recommendations for Healthy Eating Guidelines in Ireland' (FSAI, 2011) when choosing daily portions of these foods. Non-haem sources, which are not as easily absorbed by the body, include fortified cereals and other foods, wholegrains, and iron in leafy green vegetables such as spinach. Consuming a dietary source of vitamin C, e.g. citrus fruits, will increase the absorption of non-haem sources of iron.

Calcium

Breastfeeding women should follow the *'Scientific Recommendations for Healthy Eating Guidelines in Ireland'* (FSAI, 2011) and consume three portions of calcium-rich foods such as milk and milk products daily.

Calcium is a vital component of breast milk and is also important for maternal bone health. Although the calcium requirement does not rise particularly during lactation and is similar to the requirement of the general population of women, data collected from Survey of Lifestyle, Attitudes and Nutrition (SLÁN) suggest that women may not achieve the recommended calcium intake (Morgan *et al*, 2008). Furthermore, it is important that the diet contains sufficient calcium to protect against the risk of osteoporosis later in life. *'Scientific Recommendations for Healthy Eating Guidelines in Ireland'* (FSAI, 2011) recommend that women should consume three servings of milk and milk products in their daily diet in order to meet their requirement for calcium (FSAI, 2010). Milk and milk products such as yoghurt and cheese are good sources of dietary calcium. Fish with soft bones such as sardines and tinned salmon are also good sources of calcium, as well as being rich in vitamin D, and important omega-3 fatty acids such as DHA.

Although energy requirements may increase while a woman is breastfeeding, women should be counselled on returning to their pre-pregnancy weight, or a healthy post-partum weight where appropriate, and choosing low-fat milk and milk products may help with this. The calcium content of full-fat and low-fat milk products are very similar, so low-fat milk and milk products are good sources of calcium as well as being lower in fat and energy.

Women who are lactose intolerant should be counselled on the inclusion of non-milk sources of calcium in the diet, and should be advised to take a calcium supplement if required.

The bioavailability of calcium depends on the size of the dose, the form, and the presence or absence of a meal, with the former improving absorption. Tablet disintegration of supplements is crucial, and the efficiency of calcium absorption from supplements is greatest when calcium is taken in doses of 500mg or less (Institute of Medicine, 2006).

Vitamin D

Breastfeeding women should follow *'Scientific Recommendations for Healthy Eating Guidelines in Ireland'* (FSAI, 2011) and should be advised to include vitamin D rich foods in their diet.

Adequate vitamin D is required for the effective absorption of dietary calcium, and so is an essential nutrient involved in bone health and protection against osteoporosis later in life. Low vitamin D intakes have also been implicated in the development of non-communicable chronic diseases such as cardiovascular disease and certain cancers (FSAI, 2007). Data collected as part of the Survey of Lifestyle, Attitudes and Nutrition (Morgan *et al*, 2008) suggest that vitamin D intakes among women in Ireland are below the recommended daily intake. Vitamin D rich foods include oily fish, some fish-liver oils, fortified margarines and milk, and certain fortified cereals (Institute of Medicine, 2006). A recent report 'Scientific Recommendations for Healthy Eating Guidelines in Ireland' (FSAI, 2011) suggested that a working group should be convened to examine the issue of vitamin D supplementation among all population groups in Ireland. This will include setting a specific recommendation for women during the lactation period. As an interim measure, women who are breastfeeding should take 5µg of vitamin D_3 daily. Breastfeeding mothers should remember that even if they are taking a vitamin D_3 supplement, their infant will still require daily supplementation of vitamin D_3 throughout the first year of life.

3.8.2 Other diet and lifestyle factors to consider for the breastfeeding mother

Allergenic foods

There is currently insufficient evidence to recommend avoidance of potentially allergenic foods during breastfeeding. Furthermore, food avoidance increases the risk of nutrient deficiency.

For mothers of infants at risk of developing atopic disease (infants with at least 1 first-degree relative (parent or sibling) with an allergy), it has previously been suggested that potentially allergenic foods (eggs, fish, cows' milk, peanuts and tree-nuts) be avoided during the nursing period. While some studies have found a protective effect (Businco *et al*, 1983; Lovegrove *et al*, 1994), others have reported no effect of dietary restrictions while breastfeeding (Sigurs *et al*, 1992; Hattevig *et al*, 1999; Lack *et al*, 2003). This lack of effect was also observed with longer follow-up periods of over 4 years (Muraro *et al*, 2004). Several reviews in this area including a review led by the section on allergy and immunology of the American Academy of Paediatrics (Greer *et al*, 2008), as well as a Cochrane systematic review (Kramer & Kakuma, 2006) have concluded that there is insufficient evidence to advocate the avoidance of potentially allergenic foods during lactation, although it has been acknowledged that further research is required in this area (Kramer & Kakuma, 2006). Indeed, recent research has indicated that maternal exposure to certain antigens can prevent the subsequent sensitisation in the offspring through 'breast milk-mediated antigen tolerance' (for review see Rautavar & Walker, 2009).

Dietary restriction may also increase the risk of nutrient deficiency. Avoiding foods such as cows' milk, fish, eggs and nuts during lactation may increase the risk of consuming inadequate amounts of certain key nutrients such as calcium, vitamin D, DHA and other polyunsaturated fatty acids, as well as iron. Additionally, as a varied diet should be promoted to expose the infant to flavours and odours (Arenz *et al*, 2004), unnecessary dietary restrictions are not ideal during this period. While presently there appears to be insufficient evidence to avoid potentially allergenic foods during pregnancy, care should be taken to ensure that the mother does not consume foods which she is allergic to.

An exception to this is where an infant has been diagnosed with a protein food allergy, e.g. cows' milk protein allergy. In this case, the mother may be advised to eliminate the allergen from her diet. It is important that the mother receives dietary advice to ensure that her diet remains balanced. In the case of a cows' milk protein allergy, the mother may be advised to eliminate cows' milk protein from the diet, as small amounts of beta-lactoglobulin may be expressed in breast milk, leading to symptoms in the infant. As milk and milk products are important sources of nutrients such as calcium and protein, it is important that the breastfeeding mother receives advice on foods or supplements necessary to maintain a healthy balanced diet during this stage (see section 9.3).

Caffeine

Caffeine can be transferred to the infant in breast milk and can cause poor sleep and irritability. Breastfeeding mothers should limit their consumption of caffeine to ~200 to 300mg/day.

Caffeine does not enter freely into breast milk however, small amounts of caffeine can be transferred from the mother to the infant via breast milk (Tyrala *et al*, 1979), and breastfeeding women should reduce their overall intake of caffeinated foods and beverages. The enzymes required to break down caffeine are not present in the infant liver until approximately 3 months of age (Tyrala *et al*, 1979). Therefore, caffeine present in the breast milk may have a negative effect, causing poor sleep and irritability (AAP, 2001). Two to three cups of caffeinated beverages, corresponding to ~200 to 300mg/caffeine per day is generally considered safe for breastfeeding mothers (AAP, 2001) (see Appendix B for caffeine content of commonly consumed foods).

Alcohol

Small amounts of alcohol may be transferred to the infant through breast milk, and have been linked with poor sleeping patterns as well as potentially decreased motor development. It is therefore advisable that breastfeeding women do not consume alcohol at least 2 to 3 hours before breastfeeding. Breastfeeding women should follow healthy eating guidelines for alcohol intake and should not consume more than 1 to 2 standard drinks per day.

Although consumption of alcohol is not a contraindication to breastfeeding, it is best to consume only small amount of alcohol while breastfeeding (HSE, 2008). Alcohol is not stored in breast milk but will be present in small amounts which parallel those in the mother's blood. It is therefore recommended that alcohol should be avoided for approximately 2 to 3 hours before breastfeeding to allow the maternal blood alcohol level to drop (HSE, 2008). Drinking alcohol during lactation can result in reduced milk production and may negatively impact an infant's sleeping patterns (Mennella, 2001). Considering the rapid brain development which occurs during early infancy, and the possible vulnerability to toxic exposures throughout this period, it may be prudent to restrict alcohol intake to not more than 1 to 2 standard drinks/ day, and to avoid alcohol intake during the first month post-partum until breastfeeding is well established. It may also be advisable that mothers express breast milk in advance if they anticipate that they will be consuming alcohol.

Smoking

Chemicals from cigarette smoke may be transferred to the infant via breast milk. Breastfeeding women should be encouraged not to smoke whilst breastfeeding and not to smoke in the home.

Cigarette smoke contains chemicals which may potentially be transferred to an infant in breast milk with adverse effects. Additionally, smoking during breastfeeding may result in decreased milk production (Einarson & Riordan, 2009). However, tobacco exposure is not a contraindication to breastfeeding, and breastfeeding is still the best and preferred method of feeding, as it offers many health related benefits for both the infant and mother (AAP, 2005). Women who smoke should be encouraged not to smoke while breastfeeding and not to smoke in the home (HSE, 2008). It is important to keep the infant free from environmental tobacco smoke, due to the increased risk of Sudden Infant Death Syndrome (SIDS) which this poses (Reviewed in Hunt and Hauck, 2006).

Medications

All breastfeeding women should consult her primary care team regarding the use of medications and supplements whilst breastfeeding.

Some medications and medical treatments are contraindications to breastfeeding such as if the mother is receiving diagnostic or therapeutic radioactive isotopes, has had exposure to radioactive materials, is receiving anti-metabolites or other chemotherapeutic agents, or is abusing drugs (HSE, 2008). All breastfeeding women should consult her primary care team regarding the use of medications or herbal remedies whilst breastfeeding (AAP, 2005). Stopping breastfeeding is rarely the right decision, and most mothers could, and should, continue to breastfeed while taking medication, without risk to their baby. Whereas certain drugs, e.g. cytotoxic drugs, are an absolute contraindication to breastfeeding, small amounts of other medications are rarely a contraindication to breastfeeding, and drugs which may have a safety concern usually have a safe alternative. The HSE has published a factsheet for prescribing medications to breastfeeding mothers (Appendix A) (HSE, 2008). This factsheet includes further details of medications which may or may not be used, in addition to links to additional sources of information.

Summary

- Breastfeeding is the biologically normal method of infant and young child feeding, offering significant health and economic advantages to the infant and mother in both the short and long-term.
- All infants (with very rare exceptions) should be breastfed exclusively for the first 4 to 6 months of life, after which nutritionally suitable complementary foods should be introduced to meet the growing nutritional needs of the infant. Breastfeeding in conjunction with nutritious solids should continue until the infant is 2 years or over.
- Good maternal health and nutrition along with a supportive breastfeeding environment help in the achievement of this best practice recommendation.
- All infants, including breastfed infants, should be fed on demand and should receive 5µg (200 I.U.) of vitamin D_3 as a supplement daily throughout the first year of life.
- **The implementation of the five year strategic action plan for breastfeeding (Department of Health and Children, 2005) should be fully supported:**
  - **Supportive health service, community and workplace structures must be put in place**
  - **The significant benefits of breastfeeding and the risks of a decision not to breastfeed must be communicated and promoted at a whole population level**
- **Rigorous controls over the marketing and promotion of artificial infant formulae and allied products must continue and be strengthened.**
- **Mothers should be provided with information on what diet and lifestyle practices help support lactation.**
- **Evidence based interventions to tackle Ireland's very low breastfeeding rates, in addition to the promotion of positive breastfeeding role models should be funded, as should the evaluation of the short, medium and long-term effectiveness of these interventions. Specific interventions to address the breastfeeding promotional and support needs of communities where breastfeeding is least likely should be developed in conjunction with members of these communities and the statutory and voluntary providers of breastfeeding services.**

CHAPTER 4. FORMULA FEEDING

4.1 Definitions of Formula Milks

Standard infant formula

- Infant formulae are foodstuffs intended for particular nutritional use by infants during the first months of life, and should satisfy by themselves, the full nutritional requirements of infants until the introduction of appropriate complementary feeding (Directive 2006/141/EC). For the purposes of this report, the term 'standard infant formula' will refer to those formulae based on a modified cows' milk protein, unless otherwise specified.

Follow-on formula

- Follow-on infant formulae are foodstuffs intended for particular nutritional use by infants when appropriate complementary feeding is introduced, and constituting the principal liquid element of a progressively diversified diet of such infants (Directive 2006/141/EC). Follow-on formulae is suitable for infants over 6 months of age, and should only be used in conjunction with nutritious complementary foods. For the purposes of this report, the term 'follow-on formula' will refer to those formulae based on a modified cows' milk protein, unless otherwise specified.

Unmodified cows' milk

- The term whole cows' milk refers to pasteurised full-fat cows' milk. Pasteurised whole cows' milk should not be given as the main milk drink until the infant is over 12 months of age; however, small amounts can be used when preparing complementary foods. Unpasteurised cows' milk should never to be given to infants.

4.2 The Role of Formula Milk in Infant Feeding

While breastfeeding is the biologically normal source of nutrition for infants, there are certain rare circumstances where breastfeeding is not advisable. More commonly in Ireland today, a large proportion of mothers make an informed decision not to breastfeed or may cease breastfeeding during the first year of their infant's life. In these situations, an infant formula is required.

It is well established that breastfeeding is the safest and best way of ensuring that infants achieve optimal growth, health and development (Department of Health and Children, 2005). However, there may be rare situations in which breastfeeding is not advisable due to a medical condition of either the mother or the infant. Additionally, a large proportion of mothers in Ireland make an informed decision not to initiate breastfeeding, or to introduce formula milks at some stage during their infant's life. Therefore, in those instances in which the mother is unable to, or does not wish to breastfeed, a suitable infant formula is required. The role of infant formulae in these situations is to offer a suitable source of complete nutrition which meets the full nutritional requirements of the infant.

Whereas breastfeeding is considered the gold standard for infant nutrition, there are certain situations in which this may not be advisable. If an infant has been diagnosed with galactosaemia or primary lactase deficiency, breastfeeding is not recommended. Infants with phenylketonuria (PKU) should not be exclusively breastfed; however, with careful monitoring some breastfeeding is beneficial for both the infant and mother. Additionally, the following maternal medical conditions are considered as contraindications to breastfeeding: human immunodeficiency virus (HIV), untreated tuberculosis (TB), T-cell lymphotrophic virus type I or type II, or herpes simplex lesions on the breast (Health Service Executive, 2008). In all other situations, breastfeeding should be considered the normal method of infant feeding, offering significant advantages for both mother and infant. Breastfeeding should be encouraged, and the mother actively supported to ensure that she may breastfeed for the recommended time (see Chapter 3).

4.3 Infant Formula Milk is based on Cows' Milk Protein which has been Modified to be more Suitable for Infants. However, Breast Milk Remains the Superior Form of Nutrition for Infants

The composition, marketing and promotion of infant formula and follow-on formula are strictly legislated. Infant formula is based on cows' milk protein which has been modified to be more suitable for infants. A small number of health claims are permitted on infant formula; these bring the composition of infant formula somewhat closer to that of breast milk. However, breast milk remains the far superior form of nutrition for infants.

4.3.1 Important differences exist in the nutritional composition of breast milk and formula milk

Breast milk substitutes must fulfil the same conditions as human milk, namely that alone they can satisfy the complete nutritional requirements of an infant up to the introduction of appropriate complementary feeding (Commission Directive 2006/141/EC). All infant and follow-on formulae are fortified with a range of vitamins, minerals and trace elements, and strict legislation (Directive 2006/141/EC) governs their composition. Infant formulae are based on cows' milk protein, and have been modified to be closer to the composition of breast milk. However, fundamental differences in the source of fatty acids, carbohydrate, and protein remain (Table 4.1). Indeed, the greater amounts of protein contained in infant formula has been recently implicated in the variation in growth rates observed between breastfed and formula fed infants during the first year of life (Koletzko *et al*, 2009; Ong *et al*, 2009).

Table 4.1 Differences in composition between 100mls of mature human breast milk, infant formulae and follow-on formulae and pasteurised cows' milk

	Human Breast Milk#	Infant Formula*	Follow-on Formula*	Pasteurised Cows' Milk#
Macronutrients				
Protein (g)	1.3	2.1	2.4	**3.4**
Casein:whey	32:68	-	-	**77:23**
Fat (g)	4.1	4.2	4.2	**3.9**
Carbohydrate (g)	7.2	9.8	9.8	**4.6**
Lactose (g)	7.2	3.1	3.1	
Energy (kcal)	69	70	70	**67**
Minerals				
Sodium (mg)	15	42	42	**52**
Potassium (mg)	58	112	112	155
Chloride (mg)	43	112	112	98
Calcium (mg)	34	97.9	97.9	124
Magnesium (mg)	3.4	10.5	10.5	12
Phosphorus (mg)	15	62.9	62.9	98

Data adapted from McCance and Widowson Composition of Foods, 6th Edition, * Data adapted from Directive 141/2006/EC using the maximum permitted amounts of nutrients

The amounts of certain vitamins and minerals can also differ between breast and formula milks. However, nutrients which are present in breast milk are present in a form which is absorbed more easily by the infant. Unlike formula milk, breast milk also contains hormones and other bio-active molecules which provide many benefits to the infant. Formula milks do not provide the immunological and developmental properties of human milk and breastfeeding. Finally, while the nutritional profile of formula milk remains static, the composition of breast milk changes with the stage of lactation, presumably to meet the changing nutritional requirements of the individual infant during this time period (Rautava & Walker, 2009).

4.4 Types of Formula Recommended for the Healthy, Full-term Infant

If an infant is not breastfed, a standard infant formula based on cows' milk protein, which has been significantly modified to increase the suitability for infants, should be used throughout the first year of life. Provided the weaning diet is nutritionally dense, specific follow-on milks are not necessary. Pasteurised whole cows' milk should not be offered as the main milk drink before 12 months of age. Unpasteurised milk should never be given to infants.

Breastfeeding is the gold standard for infant milk feeding. Where breastfeeding is not possible, a standard infant formula based on modified cows' milk protein should be used to meet the infant's nutritional and developmental needs. A standard infant formula can be used as a substitute if necessary for breast milk until complementary feeding is started, and is suitable for infant feeding in addition to complementary foods until 1 year of age. The cows' milk protein-based infant formulae which are available are whey or casein protein predominant. Although the nutritional quality of bovine casein and whey proteins differ minimally, whey predominant formulae approximate, the proteins in breast milk (reviewed in Heird, 2007). However, it is important to realise that the casein and whey fractions of human milk proteins differ considerably to both modified and unmodified cows' milk protein (Heird, 2007).

A standard infant formula should continue to be used after the first 6 months of life where an infant is not breastfed. As the infant's diet becomes more diverse, their dependence on milk (breast or formula) as the sole source of nutrition diminishes. Changes to the amounts of infant formula and additional foods given should be largely driven by the individual infant's developmental and physiological requirements.

Specific follow-on milks should not be necessary (World Health Assembly Resolution 39.28, 1986; FSAI, 1999), but can be used, if desired, from 6 months of age onwards. However, follow-on formulae should not be given without complementary foods, and are intended for use during the weaning process only. Follow-on milks should never be given to infants under 6 months of age. Provided that the weaning diet is nutritious and energy dense, and is sufficient to meet the requirements for growth and development, breast milk, or where this is not possible, a standard cows' milk protein-based infant formula milk should be continued throughout the first 12 months of life. After 12 months, it is appropriate to use pasteurised whole cows' milk as the main drink (Table 4.2). Unpasteurised cows' milk is not suitable for infants and should not be given.

Table 4.2 Types of milks suitable as the main milk drink for healthy, full-term infants

	Breast Milk	Infant Formula	Follow-on Formula	Pasteurised Cows' Milk#
0-6 months	√	§	x	**x**
7-12 months	√	§	§	**x**
12 months+	√	x	§	§

√=most suitable §=also suitable x=not suitable

The infant formulae described previously are suitable for healthy infants who are born at term. An additional range of products is available for infants with specific needs who are not breastfed, and these will be discussed in the following sections.

4.5 Infant Formulae for Infants with Special Medical Needs

Specialised infant formulae are used in the treatment of certain medical disorders where an infant cannot, or should not, be breastfed. These include products with altered nutrient profiles suitable for feeding infants with specific medical conditions. All such products should be used under close medical supervision, as the careful monitoring of these conditions and the infant's nutrient intake is required.

4.5.1 Soy-based formula

Soy protein-based formula should only be used with infants with galactosaemia or primary lactase deficiency.

Soy-based formulae are made with soy protein isolate, and are free from cows' milk protein and lactose. Soy-based formulae have been shown to meet the nutritional requirements of the term infant, and meet the standards set by current legislation on acceptable protein sources in infant formulae and follow-on formulae (Commission Directive 2006/141/EC). Soy-based formulae are fortified with additional amino acids, vitamins and minerals, carbohydrate, and fatty acids. They are generally fortified with greater amounts of minerals such as iron, calcium, and zinc, due to the greater amounts of phytates present in soy-based formulae compared with cows' milk-based formulae (Donovan *et al*, 2009).

The key difference between soy protein-based formulae and cows' milk protein-based formulae are the presence of phytochemicals, including isoflavones. It is this component of soy-based formulae, and the potential oestrogenic effects and possible impact on growth factor signalling cascades, which has led to the greatest concern in the use of soy-based formulae in infants (Donovan *et al*, 2009). According to the Scientific Advisory Committee on Nutrition (UK) *"in view of some remaining uncertainties on the short- and the long-term effects of a high isoflavone (found in soy) intake in infants, and on the potential to influence allergic and autoimmune disease, the committee is of the opinion that soy-based formula should be reserved for specific situations only, and that cows' milk based formula should be the standard"* (Scientific Advisory Committee on Nutrition, 2003). Although a more recent statement from the American Academy of Paediatrics has concluded that there is currently insufficient convincing evidence from animal, human adult, or infant populations, demonstrating that dietary soy isoflavones may adversely affect human development, reproduction or endocrine function (Bhatia *et al*, 2008), the clinical indications for soy protein-based formulae are few.

Soy-based formulae should be limited in infants with diagnosed galactosaemia or primary lactase deficiency, or in situations in which a vegan diet is preferred and the mother is not breastfeeding (Bhatia *et al*, 2008). There appears to be insufficient evidence upon which to base a recommendation for the use of soy protein-based formulae in infants at high risk of, or with diagnosed allergy (Osborn & Sinn, 2006b; Greer *et al*, 2008). In these situations, breastfeeding is the optimal source of nutrition. In situations where this is not appropriate, extensively hydrolysed formulations should be used (Greer *et al*, 2008) (see section 9.2).

Soy-based infant formulae are not generally recommended for infants under 6 months of age, unless required due to a medical diagnosis, e.g. galactosaemia.

Soy protein-based formulae are not recommended for pre-term infants unless the pre-term infant has been diagnosed as having galactosaemia or primary lactase deficiency. For pre-term infants the mother's breast milk, or where this is not available, cows' milk protein-based formulae which are specifically designed for use in non-galactosaemic pre-term infants are superior (Bhatia *et al*, 2008). Evidence in support of soy protein-based formulae in the treatment of acute diarrhoea, secondary lactase deficiency, colic, or formula intolerance is lacking (Bhatia *et al*, 2008; Lucassen *et al*, 1998).

4.5.2 Hydrolysed formula and amino acid-based formulae

Hydrolysed or amino acid-based formulae may be used in infants with, or at risk of allergy. Breast milk is the ideal form of nutrition for infants with, or at risk of allergy.

Although breastfeeding is considered the optimal form of nutrition for infants who are at increased risk of allergy, the use of partially or extensively hydrolysed formula for infants at risk of developing allergy has been the focus of much attention over the past 2 decades. According to a recent statement from the American Academy of Paediatrics (AAP), for those infants who are not breastfed exclusively for 4 to 6 months and are formula fed, there is modest evidence that atopic dermatitis may be delayed or prevented by the use of extensively hydrolysed formulae compared with a standard cows' milk protein based infant formula (American Academy of Paediatrics, 2005).

Several hydrolysed and amino acid-based formulae are available currently on the Irish market. Partially hydrolysed (PH) formulae contain reduced oligopeptides that have a molecular weight of generally less than 5000d. Extensively hydrolysed (EH) formulae contain only peptides that have a molecular weight of less than 300d. Free amino acid-based formulae and peptide-free formulae contain mixtures of essential and nonessential amino acids (Greer *et al*, 2008).

Extensively hydrolyzed formulae may be more effective than partially hydrolysed formulae in the prevention of atopic disease (Greer *et al*, 2008, von Berg *et al*, 2008). The use of amino acid-based formulae in individuals with cows' milk allergy has been the focus of a recent systematic review which revealed that these formulae appeared equally effective in relieving symptoms of cows' milk allergy compared with extensively hydrolysed formulae. However, in a subgroup of infants in which tolerance to extensively hydrolysed formulae was low, amino acid-based formulae may be more suitable (Hill *et al*, 2007). Cost should be considered with the use of hydrolysed formulations (Fine & Sehgal, 2008), and every effort should be made to support parents in the provision of these infant feeds. Hydrolysed infant formulae are considered superior to soy-based infant formula for infants with cows' milk allergy (ESPGHAN, 2006). There is no evidence to suggest that feeding with hydrolysed formulae is superior to breastfeeding for the prevention of allergy (Osborn & Sinn, 2006a). For specific information on feeding with allergy, please see Chapter 8 (section 8.6).

4.5.3 Pre-term infant formulae

Pre-term infants have special nutritional requirements and should be offered human breast milk, where possible. If this is not available, infant formulae specifically designed for this group should be used.

Pre-term infants have special requirements for protein, energy, fatty acids, vitamins, minerals, and trace elements (ESPGHAN, 2010). The mother's own pre-term breast milk is the best source of nutrition for pre-term infants and offers unique immunological and developmental advantages (AAP, 2005). However, in situations where sufficient breast milk is not available, or the mother does not wish to provide breast milk, an alternative source of nutrition is required. A recent Cochrane systematic review has revealed that donor breast milk use has been associated with a reduced incidence of necrotising enterocolitis (NEC) in pre-term infants, and so may be superior to formula milk if the infant is thought to be at risk of developing this severe gut disorder (Quigley *et al*, 2007).

Pre-term formulae contain greater amounts of nutrients compared with standard formulae, and continue to evolve in line with the latest scientific knowledge. In the event that a ready-to-feed formulae is not being used, powdered infant formula should be prepared carefully, and in accordance with the guidelines for the safe preparation of powdered infant formula to prevent illness through the contamination with bacteria such as *Chronobacter spp*. (formerly *Enterobacter Sakazakii*) or *Salmonella Enterica*, which are linked with illness and death in infants (FSAI, 2007). These risks of bacterial contamination are not associated with breast milk, further promoting breast milk as the optimal form of nutrition for the pre-term infant. The specific care of pre-term infants will be discussed in Chapter 9 (section 9.1).

Table 4.3 Different milks are suitable for varying stages and conditions during infancy

	Breast Milk	Formula Milk	Follow-on Formula	Soy-based Formula	Hydrolysed or AA-based Formula	Pre-term Enriched Formula
Term infant	√	§	x	x		
0-6 months	√	§	x	x	x	x
6-12 months	√	x	§	x	x	x
Galactosaemia	x	x	x	§	x	x
Vegan (strict)	√	x	x	§	x	x
Allergy	√	x	x	x	§	x
Pre-term	√ (with fortification)	x	x	x	x	§

√ Most suitable § Also suitable x Not suitable x may be suitable

4.6 Certain Milks are not Suitable for Infants under 12 Months

4.6.1 Cows' milk

Whole pasteurised cows' milk is not suitable as the main milk drink for infants under 1 year of age, and should not be introduced to the diet as the main milk drink before the age of 12 months. Small amounts of pasteurised whole cows' milk can be given in small amounts when preparing complementary foods. Unpasteurised cows' milk is not suitable for infants and should not be given to infants under any circumstances.

Cows' milk is a poor iron source and some data also suggest that consumption of cows' milk can provoke microscopic intestinal bleeding in infants (ESPGHAN, 2008). The principal reason for delaying the introduction of cows' milk to the infant's diet, is to prevent iron deficiency anaemia. Small amounts of pasteurised whole cows' milk can be used in small amounts when preparing complementary foods however cows' milk should not be given as the main milk drink until after 12 months of age. Interestingly, *'Growing Up in Ireland- National Longitudinal Study of Infants'* highlighted that 41% of infants had been introduced to cows' milk by 9 months of age (Williams *et al*, 2010), possible highlighting the importance of increased, continued education of parents regarding the introduction of cows' milk into their infant's diet. Unpasteurised cows' milk is not suitable for infants and should not be given to infants under any circumstances.

4.6.2 Goats' milk

An infant formula based on goats' milk protein is not suitable as a source of nutrition for infants under 12 months of age. Pasteurised or unpasteurised goats' milk is not suitable for infants and should not be given under any circumstances.

Assessments carried out by EFSA concluded that there is insufficient evidence to establish goats' milk protein as a suitable source of protein in infant formula (EFSA, 2004). Goats' milk is not listed as a suitable source of protein for infant formulae or follow-on formulae (Directive 96/4/EC), and so products based on goats' milk are not permitted to be marketed for use as a sole source of nutrition for infants.

There is currently no convincing evidence to support the belief that the risk of allergic reactions is lower when feeding goats' milk based formulae, compared with cows' milk based formulae. Goats' milk protein is a potential allergen and is therefore not suitable for infants at risk of allergy. Furthermore, the potential for cross-reactivity with cows' milk protein means that goats' milk is not suitable as an alternative for infants with cows' milk allergy (EFSA, 2004). In these situations, breast milk, or where this is not possible, a hydrolysed infant formula, are the most appropriate feeding choice (Greer *et al*, 2008; Osborn & Sinn, 2006a) (see section 8.6).

Because of similar levels of lactose to cows' milk, goats' milk based formulae are not suitable for infants with galactosaemia or lactose intolerance (Bhatia *et al*, 2008).

Healthcare professionals should make parents aware that infant milks based on goats' milk are not suitable, and should provide individualised advice on the most appropriate method of infant feeding.

4.7 Feeding Support for Formula Feeding Parents

A large proportion of mothers in Ireland make an informed decision not to breastfeed. Therefore, it is essential that parents in Ireland receive timely and practical information on the safe preparation of powdered infant formula, as well as constructive information on feeding their baby. Community based support groups and contact with healthcare professionals in the community is important for parents who are formula feeding their infant.

Best practice guidelines for feeding infants who are not breastfed include exclusive feeding using a formula that is modified to be as close as possible in composition to that of human breast milk. In addition to the type of formula recommended for use, the manner of formula feeding should mimic that of the breastfed infant:

- Formula fed infants should be fed on demand and not according to a schedule. The intakes will vary on a day-to-day basis, as infants will have hungrier days than others due to growth spurts
- Frequent feeding best meets physiological requirements in early life

- As the infant matures, an increased feed volume may be required in order to meet the nutrient and energy demands for growth and development
- No other foods such as rusks or baby rice should be added to the infant's bottle, due to the risk of choking and over-concentration of feeds. Additionally, this may pose a food safety risk

The infant should always be supervised when feeding. It is important also to assess feeding of the formula fed infant. If the mother has made an informed decision not to breastfeed, staff at the maternity unit should provide information on the practical aspects of formula fed infants. This should include:

- Information on the correct preparation of powdered infant formula
- Information on how to correctly wash and sterilise all the equipment needed to formula feed an infant
- The different milks available on the Irish market and which types are suitable for infants
- The practical aspects of how to feed a baby
- Transport and storage of formula feeds
- The average number of feeds which a baby will need
- Vitamin D supplementation of infants as all infants should be given a vitamin D only supplement providing 5µg (200 IU) of vitamin D daily for the first 12 months of life
- Type of water advised to make up powdered infant formula

The public health nurse should make contact with the parents in the 2 to 3 days post discharge from the maternity unit to assess how feeding is going. This assessment should determine:

- The number of feeds the infant is taking daily
- The average length of time between feeds
- The type of formula offered to the infant
- The facilities available to the parents to safely and correctly prepare a powdered infant formula, and wash and sterilise the equipment needed

This information is important to give to all parents. In line with breastfeeding promotion, it is important to recognise that a large proportion of Irish mothers make an informed decision not to breastfeed and to offer formula milks from birth (see Chapter 1 for further details). Additionally, the proportion of infants receiving formula milk rises throughout the first 6 months of life as breastfeeding rates decline. Worryingly, despite the large numbers of mothers offering formula milks from birth, less formula feeding mothers were provided with information on where to get support regarding infant feeding in the community, compared with breastfeeding mothers on discharge from the maternity unit, and the majority of parents were not shown how to correctly prepare a formula feed by a healthcare professional (Begley *et al*, 2008). Furthermore, recent research has highlighted that 5% of mothers add solids such as baby rice and rusks to the infant's bottles. Reasons cited for this practice include 'sleep promotion', 'to keep baby fuller longer' or 'to entice baby to take bottle' (Tarrant *et al*, 2010b). These are inappropriate feeding practices associated with an increased risk of choking and over concentration of feed. A healthy balanced diet should be promoted among all parents. This is important for parents when they are caring for their infants in order to promote good health at this time, as well as being a positive role model for healthy diet and lifestyle choices.

4.8 The Safe Preparation of a Powdered Infant Formula Feed

4.8.1 Risks associated with powdered infant formula

Significant risks are associated with incorrect preparation of powdered infant formula. In order to minimise these risks, all care-givers should be educated on the correct way to prepare an infant feed.

Powdered infant formula is not a sterile food product. Harmful bacteria such as *Enterobacter sakazakii* (renamed *Cronobacter spp*.) and *Salmonella enterica* have been associated with powdered infant formula, and can cause illness in infants (FSAI, 2007). As infants under 12 months of age are considered a vulnerable group, and all infants less than 2 months of age are considered the most vulnerable group for foodborne illnesses (FAO/WHO, 2006), it is vital that infant formula be prepared correctly to minimise the risk of bacterial contamination (FSAI, 2007).

A systematic review assessing the prevalence of inappropriate infant feeding practices identified several errors in the preparation of infant feeds. All five studies included in the review identified errors. Overall, the investigators revealed a tendency to over-concentrate feeds, although under-concentration was also observed (Renfrew *et al*, 2003).

Many infant formulae, including powdered infant formula and liquid concentrate feeds, require the correct dilution with clean water before they are suitable for consumption by an infant. In a recent study examining infant formula handling and preparation practices in a group of women in the USA, it was reported that, similar to the situation in Ireland, the majority of women did not receive guidance from a healthcare professional on how best to prepare an infant feed. Thirty percent of women included in the study reported not reading the safe-use directions on the formula package label, and 38% were unaware that powdered infant formula was not a sterile food product. Fifty-five percent of women did not wash their hands properly before preparing feeds, 32% did not adequately wash the bottle nipple, 35% heated formula in the microwave, and 6% did not always discard formula left standing for greater than 2 hours (Labiner-Wolfe *et al*, 2008). Although specific data on infant feed preparation practices are not available in Ireland, data obtained from the National Infant Feeding Survey indicate that, similar to that reported in the above study, the level of education regarding formula feed preparation in Ireland is low, and 62% of women do not receive guidance on the correct method of preparing powdered infant formula. Additionally, 29% of those who did receive guidance were shown by a family member (Begley *et al*, 2008), who may not have been aware of the more recent recommendations (FSAI, 2007).

Risks Associated with Incorrect Preparation of Powdered Infant Formula

Over-concentration
- Hypernatraemic dehydration
- Diarrhoea
- Excessive intake of calories leading to a greater risk of obesity

Under-concentration
- Failure-to-thrive

Contamination with bacteria
- Illness and potentially death in infants

4.8.2 Correct method of preparing a powdered infant formula feed

All healthcare professionals, as well as parents and other care-givers, should be aware of the correct method of preparing a powdered infant feed. Clinical, as well as child care settings, should have a protocol prepared, as well as a designated feed preparation area.

In recent years, the emergence of disease associated with a bacterium *Enterobacter sakazakii* (renamed *Cronobacter spp*.) in powdered infant formula has necessitated a new risk assessment. In 2007, new guidance was issued on the correct preparation of an infant feed. These guidelines were designed to minimise the risk associated with bacterial contamination of powdered infant formula (FSAI, 2007). It is essential to recognise the large proportion of women who are currently formula feeding due to either choice, or medical contraindications. It is also important to also recognise the potential risks associated with powdered infant formula and to ensure that formula feeding is a safe form of

nutrition. Support and education should be made available to all parents who are formula feeding or who may formula feed their infant. It is essential that education materials informed by best practice guidelines be made available to parents, and funding should be made available for this (FSAI, 2007). Additionally, specific guidance materials should be developed for use in the medical care setting/child care setting (FSAI, 2007).

Recommended Procedures for the Safe Preparation of Infant Feeding Equipment

- Wash hands thoroughly before cleaning feeding equipment. Hands are a source of dirt and bacteria which can be transferred to the feeding equipment.
- Feed residues are a source of food for bacteria, and so it is necessary to wash feeding and preparation equipment well in hot soapy water before sterilisation, paying particular attention to hard to reach areas of the equipment. Scrub the insides and outsides of teats and bottles with a teat brush to remove all remaining traces of feed.
- Dishwashers can be used to clean feeding and preparation equipment, but only if the equipment is dishwasher proof and stacked correctly following machine instructions. The suitability of feeding and preparation equipment for dishwasher use should be checked with the manufacturer of the equipment prior to washing. **Dishwashers will not sterilise feeding and preparation equipment**.
- Clean feeding and preparation equipment should be sterilised prior to use and is necessary to kill bacteria which may be present on equipment surfaces. Trapped air bubbles should be removed as they prevent the liquid being used to sterilise coming into contact with all surfaces of the equipment. Several methods of sterilisation are available:
  - Steam is the best method of sterilisation. Commercially available home electrical units or units that work in the microwave oven are available. Always follow manufacturer's instructions
  - Sterilisation is also possible by immersion in boiling water; fill a large pan with tap water and completely submerge all feeding and preparation equipment ensuring there are no trapped air bubbles. Cover the pan, bring to the boil and boil for at least 3 minutes, making sure the pan does not boil dry
  - Sterilisation is also possible using chemical sterilant added to the water. Make up a batch of sterilant following the manufacturer's instructions. Ensure all equipment is completely immersed in the liquid and that there are no trapped air bubbles. Leave the equipment submerged for the length of time specified by the manufacturer and follow all other manufacturer's instructions
- Wash hands and surfaces before handling and assembling sterile feeding equipment. Assemble bottles tightly and correctly as soon as possible after sterilisation. This will keep the inside of the bottle sterile for up to 24 hours. After 24 hours have passed, re-sterilise the bottle, even if it has not been used.
- Bottles or other feeding equipment should be assembled immediately after sterilisation. Care should be taken to avoid touching the teats and the insides of the bottles, sealing discs, bottle caps and collars. Even washed hands harbour bacteria so avoid touching the parts of the bottle which come into contact with the feed (inside teats, bottle, sealing disc and collar) as well as those parts which will be in contact with the infant's mouth (outside of teat). To avoid this, the use of sterile tongs is recommended. Sterile tongs may be used to fix teats into collars. Once assembled correctly, bottles will remain sterile for 24 hours providing that they remain unopened.
- It is important to use hot water (~70°C) as this temperature will kill *E. sakazakii* and any other bacteria such as *S. Enterica* which may be in the powdered infant formula. Water should never be used below 70°C. If hot water cannot be accessed, use sterile bottles of water. Once opened, it is important to discard any remaining water after 24 hours, as it is possible that the water will no longer be sterile. Alternatively, ready-to-use liquid formula can be used when travelling.
- Cool the feed quickly by running or immersing in cold water as bacteria can grow quickly between 30°C and 43°C, and cooling quickly prevents this growth from occurring on too great a scale.
- Scalding is a concern and care should be taken to avoid this. It is important to test the temperature of the feed before use.
- **DO NOT USE A MICROWAVE TO HEAT FEEDS**.

Recommendations for the Safe Feeding of Powdered Infant Formula in the Domestic Setting	Recommendations for the Safe Feeding of Powdered Infant Formula in the Medical Setting
Step 1 – Boil fresh tap water in kettle or suitably covered vessel. **Step 2** – When boiled, leave to cool in kettle of covered vessel for 30 minutes (but not longer) (no less than 70°C). **Step 3** – Clean the feed preparation area thoroughly and wash hands with soap and hot water, and dry. **Step 4** – To make feed, pour the hot water into a sterile bottle **taking care to avoid scalding**. Make each feed in a sterile bottle by adding the exact amount of powdered infant formula, as instructed by the manufacturer, using the clean scoop provided. Re-assemble the bottle tightly, and shake well to mix contents, **taking care to avoid scalding**. **Step 5** – Cool quickly to feed temperature by running under cold tap water or standing in a large volume of cold water. Ensure cold water does not reach the neck of the bottle. **Step 6** – To feed: **Immediately:** Ensure feed is not too hot by shaking the bottle and placing a drop of liquid on the inside of the wrist – **it should feel luke-warm not hot**. **Later:** Wipe the bottles dry with a clean cloth and place in back of fridge (operating at max 5°C), not in the door and use within 24 hours. To feed, remove bottle just before it is needed and warm to feeding temperature by using a bottle warmer or by standing the feed in a container of warm feed. Never leave a feed warming for more than 15 minutes. Ensure the feed is not too hot by shaking the bottle and placing a crop of liquid on the inside of the wrist – **it should feel luke-warm**. **Step 7** – Discard any feed that has not been consumed within 2 hours of preparations. For slow feeding babies, use a fresh feed after 2 hours.	**Step 1** – Boil fresh tap water in kettle or suitably covered vessel. **Step 2** – When boiled, leave to cool in kettle of covered vessel. Use a clean thermometer to ensure the water is between 70°C-75°C before use. **Step 3** – Clean the feed preparation area thoroughly and wash hands with soap and hot water, and dry. **Step 4** – To make feed: **The preferred method**; Pour the amount of hot water into a sterile bottle, **taking care to avoid scalding**. Make each feed in a sterile bottle by adding the exact amount of powdered infant formula as instructed by the manufacturer, using the clean scoop provided. Re-assemble the bottle tightly, and shake well to mix contents, **taking care to avoid scalding**. **The batch method**: Use a clean and sterile jug with a pouring spout of no greater capacity than 1 litre. Pour the amount of hot water required into the jug, taking care to avoid scalding. Add the exact amount of powdered infant formula for volume of water being used as instructed on the label using the clean scoop provided. Mix thoroughly using a clean sterile spoon. Decant the feed into sterile bottles, taking care to avoid scalding. Re-assemble the bottle tightly and carefully. **Step 5** – Cool quickly to feed temperature by running under cold tap water or standing in a large volume of cold water. Ensure cold water does not reach the neck of the bottle. **Step 6** – To feed: **Immediately**: Ensure feed is not too hot by shaking the bottle and placing a drop of liquid on the inside of the wrist – **it should feel luke-warm not hot**. **Later:** Wipe the bottles dry with a clean cloth and place in back of fridge (operating at max 5°C), not in the door and use within 24 hours. To feed, remove bottle just before it is needed, and warm to feeding temperature by using a bottle warmer or by standing the feed in a container of warm feed. Never leave a feed warming for more than 15 minutes. Ensure the feed is not too hot by shaking the bottle and placing a drop of liquid on the inside of the wrist – **it should feel luke-warm**. **Step 7** – Discard any feed that has not been consumed within two hours of preparations. For slow feeding babies, use a fresh feed after two hours.

4.8.3 Water used in the preparation of powdered infant formula

Boiled tap water should be used to prepare powdered infant formula. If this is not available, boiled bottled water[1] should be used.

Tap water which has been boiled on only one occasion is recommended for preparation of powdered infant formula feeds (FSAI, 2007). Using fluoridated tap water to prepare powdered infant formula is safe, and tap water should be used to prepare powdered infant formula (Forum on Fluoridation, 2002), unless specific advice not to use tap water has been given. In the event that tap water is not available, or when it has been advised that tap water should not be used, boiled bottled water should be used. Bottled water is not sterile, and should be brought to the boil prior to use in preparing powdered infant formula feeds. If boiling water on the hob, water should be brought to a rolling boil for at least one minute before being used (WHO, 2005).

The concentration of several minerals in bottled water, particularly sodium, has been an issue of some concern. Infants and children, the elderly, and people with compromised renal systems are more susceptible than healthy adults to the harmful effects of high sodium intakes.

Based on the EU legislation on infant formula, it has been recommended that all infant formula should contain a maximum of 60mg sodium/100kcal as reconstituted (Directive 2006/141/EC) which is equivalent to about 400mg sodium/l. The highest labelled sodium concentration in infant formula on the Irish market is 270mg/l as reconstituted (see Annex 1). Assuming this only takes account of sodium in formula powder (and not water used for preparing the formula) this allows for up to 130mg sodium/l in water used for preparing the formula. The sodium concentration of practically all public drinking water supplies in Ireland is less than 130mg/l (see Annex 1) while the sodium concentration of bottled waters available in Ireland does not exceed 40mg/l (see Annex 1). Thus, boiled tap water or boiled bottled water may be safely used to prepare powdered infant formula. It is best not to use bottled water labelled as 'Natural Mineral Water' as it can have higher levels of sodium and other minerals. It can be used if no other water is available, for as short a time as possible, as it is important to keep babies hydrated.

[1] It is best not to use bottled water labelled as 'Natural Mineral Water' as it can have higher levels of sodium and other minerals. It can be used if no other water is available, for as short a time as possible, as it is important to keep babies hydrated.

Summary

- In circumstances in which breastfeeding is not possible, a suitable infant formula is required in order to meet the nutritional and developmental needs of the infant.
- An infant formula based on a modified cows' milk protein is suitable up to 12 months of age. Specific follow-on milks, suitable for use from 6 months of age, are not strictly necessary provided the weaning diet is suitably nutritious. Whole cows' milk is not suitable as the main milk drink for infants under 1 year of age.
- Several different infant formulae exist, and can be used in specific circumstances where an infant is not breastfed, and where a standard cows' milk protein based formulae is less suitable. The composition and marketing of all infant formulae and follow-on formulae are strictly governed, however, due to the large range of products on the Irish marker, the potential for these products to bear health claims, as well as the imagery and language used throughout these advertisements may leave parents confused. This area needs to be tightly and continuously monitored. Powdered infant formula is not a sterile food product and must be prepared correctly to minimise the risk of over or under concentrations and bacterial contamination. Recent research has indicated that the majority of parents do not receive appropriate advice, and this needs to be rectified to minimise risks associated with formula feeding.
- All infants in Ireland should be fed on demand and receive 5ug (200 I.U.) of vitamin D_3 daily throughout the first year of life.
- **Powdered infant formula is not a sterile food product, and it is important to provide parents with information regarding the safe preparation of powdered infant formula.**
- **It is essential that the development of education materials informed by best practice guidelines is funded, and that these are made available to parents and care-givers if formula feeding is to be used as a method of infant feeding.**
- **All medical or childcare settings in which infant feeds are prepared should have an up-to-date, evidence based protocol used by all staff members for the preparation of infant feeds.**
- **National policy advocating vitamin D in all infants in Ireland for the 1st year of life should be promoted.**

CHAPTER 5. INTRODUCTION OF COMPLEMENTARY FOODS

5.1 Definitions

Weaning

Weaning refers to the time period of gradual reduction in frequency and volume of breastfeeding (or infant formula feeding) which starts with the first introduction of complementary foods. The progression through the weaning process should result in a dietary pattern which is customary in the infant's family during the second year of life (EFSA, 2009).

Complementary foods

Complementary foods refer to all liquids, semi-solid and solid foods other than breast milk, and infant formulae which are fed to infants during the weaning process.

The WHO has described complementary foods as 'any nutrient containing food or liquid other than human breast milk given to young children during the period of complementary feeding'. However, considering infant formula milk to be a complementary food may be unhelpful and even confusing (ESPGHAN, 2008), as recent data indicate that a large proportion of Irish infants are frequently fed infant formulae from birth (Begley *et al*, 2008; Tarrant *et al*, 2010a). Therefore, for the purpose of this report, the term 'complementary foods' refers to all liquids, semi-solid, and solid foods other than human breast milk and infant formulae which are fed to infants during the weaning process.

5.2 Weaning is Necessary for Growth and Development

Infancy is a period of very rapid growth and development and during the latter half of infancy, the introduction of complementary foods is necessary to ensure a sufficient nutritional intake to support growth.

Relative to their size, infants have high energy requirements to support growth. At 6 months they have doubled, and at 1 year have tripled their birth weight and doubled their surface area (FSAI, 1999). By 6 months, an infant's store of nutrients such as iron, zinc and some fat soluble vitamins (A and D) are decreasing. However, as requirements continue to increase, either human breast milk or infant formula milk intake alone may not be sufficient to fulfil nutritional requirements at this stage. Therefore, to support the continuation of rapid growth throughout infancy, in addition to facilitating various developmental milestones, the timely introduction of complementary foods to the diet is necessary.

5.3 Timing of First Introduction of Complementary Foods – not too early, not too late

Every infant will have unique physiological and nutritional requirements and flexibility in weaning recommendations is important to ensure that timing the first introduction of complementary foods should be tailored to the individual infant. The introduction of complementary foods should not be before 17 weeks (4 months) but should not be delayed beyond 26 weeks.

The WHO recommends that the introduction of weaning foods be delayed until the infant is 6 months of age (WHO/UNICEF, 2003). This policy has been adopted by many countries, including the Department of Health in Ireland (Department of Health and Children, 2005). While it is important that infants are not introduced to complementary foods later than 6 months, for reasons which will be discussed further (see section 5.5), due to the natural variation in the physiological requirements of individual infants, research has shown that some infants may require complementary foods before the age of 6 months to support optimal growth and development (for review see Lanigan *et al*, 2001; Fewtrell *et al*, 2011).

The age at which complementary feeding will be appropriate is multi-factorial and depends greatly on an individual infant's developmental readiness, the development of the infants fine, gross and oral motor skills (Wright *et al*, 2004), as well as the ability of exclusive breastfeeding or infant formula feeding to support growth and development (EFSA, 2009). There is a 5 week gestational age range with respect to term infants (born between 37 and 42 weeks gestation), and infants grow and develop at different rates. This means some infants will be ready to begin weaning at an earlier post-natal age than others. It is important to recognise this individuality, and stress that flexibility is required to meet the needs of the individual infant.

Signs to Look for When an Infant is Ready to Start Weaning

- Doesn't seem satisfied after a milk feed, or starts to demand feeds more frequently over a time period of more than 1 week. May start to wake in the night to be fed, having previously slept through
- Seems hungry between milk feeds
- Shows an interest in food, perhaps reaching out for food
- Watching others with interest when they are eating
- Shows an increased need to chew, and dribbles more frequently
- Starts to put toys or other things, e.g. fists into his or her mouth to explore the taste and texture
- Should be able to sit up with some support to begin with

These developmental signs are generally seen between 4 and 6 months and this seems to be the best time to start solids because from this age, infants learn to accept new tastes and textures (BDA, 2010; INDI, 2010).

A health-care professional who can make a clinical assessment of an individual infant's requirements is the person best placed to give advice on the most appropriate age of complementary food introduction. Should parents wish to introduce complementary foods earlier than the 6 months recommended by the Department of Health, they should be actively encouraged not to do so before 4 months (17 weeks) of age. Parents should also be encouraged not to delay weaning past 6 months (26 weeks) of age. Parents should be provided with education and support to allow them to optimise the infant's nutritional intake.

5.3.1 Complementary foods should not be introduced too early

Infants should be introduced to complementary foods close to 6 months of age. Some infants may require the introduction of complementary foods slightly before 6 months of age to support optimal growth and development. No infant should be introduced to complementary foods before 4 months (17 weeks) of age, unless otherwise specified by a healthcare professional.

Renal and gastrointestinal maturation is required for an infant to metabolise non-milk foods. Whilst the renal concentrating capacity is limited during the neonatal period (Joppich, 1977), data suggest that after 4 months, renal function has matured, and can handle foods with a higher solute load (Ziegler *et al*, 1971; ESPGHAN, 2008; EFSA, 2009). Secondly, from 4 months, the gastrointestinal maturation required to switch from a relatively high-fat milk diet to a higher carbohydrate diet during the weaning process has occurred in the majority of infants (ESPGHAN, 2008).

Additionally, from 4 to 6 months, neurodevelopmental changes such as increased tongue flexibility and a decline in the extrusion reflex occurs, aiding the development of chewing and swallowing skills. Both of these skills are necessary for the safe and effective progression to a mixed diet. Also from this age, minor motor skills and hand-to-mouth coordination improves, allowing the infant to begin to self-feed.

Much work has been done to determine if the age of introducing complementary foods has a long-term effect on body composition (Cohen *et al*, 1994; Dewey *et al*, 2000; Mehta *et al*, 1998). However, there is currently little evidence to suggest that the timing of weaning onto solid food has a negative effect on body weight in childhood. This is difficult to assess, however, as the age of weaning is highly related to the size of the infant. Careful monitoring is important to ensure that sudden changes in infant weight are not occurring and that the individual infant is continuing to follow a centile channel without large or erratic variations during the first year of life (see Chapter 7 on growth).

Four months (17 weeks) should be viewed as the earliest age at which complementary foods should be introduced and the disadvantages of earlier weaning should be discussed with parents. Parents should receive guidance and support from healthcare professionals allowing them to begin weaning their infant onto solid foods, in accordance with best practice recommendations.

5.3.2 Complementary foods should not be introduced too late

Beginning to wean infants onto solid foods should not be delayed past 6 months (26 weeks) of age. Delayed weaning is associated with impaired oro-motor or speech impediments, as well as increasing the risk of nutrient deficiency. No infant should be introduced to complementary foods later than 6 months of age, unless otherwise specified by a healthcare professional.

Stores of important nutrients necessary for growth such as iron and zinc decline from 4 to 6 months of age, and so the timely introduction of complementary foods is important to ensure that the infant consumes adequate amounts of these essential nutrients in their daily diet. Furthermore, the energy intakes required to support rapid growth are high and increase further during the second half of infancy, due to an increased surface area. As the volumes of milk needed to meet these energy requirements is more than would be manageable for either mother or infant, nutritionally dense complementary foods must be introduced to ensure that continued growth and development occurs. A timely progression through the weaning process is also important, and parents who wean infants at 6 months should be therefore encouraged to move more quickly through the weaning process.

Data which have emerged from the *'Avon Longitudinal Study of Parents and Children'* have indicated that the introduction of lumpy solids later than 10 months increases the risk of feeding difficulties later in life. Those children, for whom lumpy solids were introduced at a later age, ate a less varied diet and consumed less fruit and vegetables at age 7 years (Coulthard *et al*, 2009). Delayed progression to foods of a less smooth consistency may result in oro-motor or speech development impediments, and may increase the risk of nutrient deficiencies, particularly in exclusively breastfed infants (Coulthard *et al*, 2009). Parents should be advised not to delay beginning the weaning process beyond 6 months of age. The disadvantages of delayed weaning should be discussed with the parents, and parents should receive support and guidance from healthcare professionals to allow them to wean their infants onto solid foods in accordance with best practice recommendations.

5.3.3 Guidelines for breast and formula-fed infants should be the same

The overall recommendations for the age of weaning should be the same for both breastfed and formula-fed infants. Generally, infants should not be introduced to complementary food before 4 months (17 weeks) and or after 6 months (26 weeks) of age with the exact timing driven by the unique needs of the individual infant.

There are well established differences in growth velocities between breastfed and formula-fed infants throughout the first year of life (see Chapter 7 for further information). Therefore, it is likely that these 2 populations will be entering into the weaning period, with differing anthropometric and potentially differing neurodevelopmental, renal and gastrointestinal maturation (ESPGHAN, 2008). However, there is currently insufficient evidence to support separate requirements for breastfed and formula fed infants, and these may be confusing for parents. The recommendation therefore, stands that all infants independent of the type of milk feeding should be first introduced to complementary foods close to 6 months. Whereas this recommendation is suitable for the vast majority of infants, some flexibility may be required to best meet the individual infant's unique requirements. The introduction of complementary foods should not be before 4 months (17 weeks), but should not be delayed beyond 6 months (26 weeks) of age (ESPGHAN, 2008).

5.4 Early Feeding Patterns can Influence Food Choice and Health in Later Life

Feeding patterns during infancy are important factors in laying the foundations for food choice and good health in later life. Parents need guidance and support from healthcare professionals to offer their infant a diet rich in texture and flavours during the first year of life.

Growth patterns and body weight during the first 12 months of life can have far reaching and persistent consequences throughout adulthood, and can influence the later development of chronic disease (Eriksson *et al*, 2003; Fall *et al*, 2008). The first hint of the importance of this early period came from animal studies conducted in the 1960s in which it was observed that under-nutrition during the early weeks post-natally had permanent effects on body weight, whereas under-nutrition during the later weeks had a transient effect only (Widdowson and McCance, 1963). This first year of feeding, particularly the sensitive transition from milk to solid foods is important in establishing life-long feeding patterns (Cooke, 2007). An increase in texture complexity and variety of flavours facilitates subsequent acceptance of new foods. Recent work on the dietary patterns of Irish infants at 6 months suggests that, worryingly, infants are consuming a diet of suboptimal variation, with a greater weekly frequency of inappropriate sugar and salt rich foods compared with fruit and vegetables (Tarrant *et al*, 2010b). This is of concern from a public health perspective as high-fat, high-salt foods in infancy may result in excessive weight gain, obesity and higher blood pressure in the short-term, and promote the choice of unhealthy food patterns in later years. Given the potential to prevent and modulate ill health in later life, and the relative ease with which infant feeding can be controlled during this stage, it is important to promote an optimal diet for this age group. It is vital that healthcare professionals understand the components of an optimal diet for infants during the first year of life, and communicate these to parents and carers, helping them to make the best possible choices for their infant.

5.5 Progression through the Weaning Process

Weaning is a process during which foods of an increasing texture and flavour diversity are offered to the infant, alongside a gradual decrease in milk consumption. Progression through the weaning process should be influenced primarily by the individual infant's unique physiological and developmental requirements.

Weaning is a process and leads gradually through varying textures of solid foods to the consumption of family foods during the second year of life. Many new skills are developed throughout this process and help the infant to deal with the new food textures introduced (Table 5.1).

Table 5.1 Many skills are learned during weaning and help the infant to progress through varying food textures to the eventual consumption of family foods

New Food Textures to Introduce	Skills to Learn
Smooth purées Mashed foods (Close to 6 months but not before 4 months (17 weeks))	✓ Taking food from a spoon ✓ Moving food from the front to the back of the mouth for swallowing
Mashed food with soft lumps Soft finger foods Liquids in a lidded beaker or cup (From 6-9 months)	✓ Managing thicker purées and mashed foods ✓ Moving lumps around the mouth ✓ Chewing lumps ✓ Self-feeding using hands and fingers
Hard finger foods Minced and chopped family foods (From 9 to 12 months)	✓ Sipping from a cup ✓ Chewing minced and chopped foods ✓ Self feeding attempts with a spoon

Adapted from BDA, 2010

The weaning process (see Figure 5.1)

- **First introduction of complementary foods**. The initial introduction of complementary foods should occur close to 6 months of age. First foods should be of smooth puréed or semi-solid consistency, and taken from a spoon 1 to 2 times daily (COMA, 1994). Suitable first foods include vegetables purées, fruit purées and baby rice (see Figure 5.1). Breast milk or formula milk can be used to adjust the consistency if necessary (INDI, 2010). To begin, one to two spoonfuls should be offered once daily, and gradually built up. Once the infant is taking 6 spoonfuls at a time, it may be best to introduce another meal time. Once the infant is more established on spoon feeds, their milk and spoonfeed can be spread out over the course of the day (INDI, 2010). As the infant moves through the weaning process, the variety of foods eaten should be increased. In addition to vegetable and fruit purée, and baby rice, iron rich foods such as red meats should be introduced early in the weaning process (see Figure 5.1, page 81).
- **Introducing foods of a lumpier consistency (mashed/minced/soft pieces/soft finger foods)**. The timing of introducing lumpier foods will be dependent on the developmental readiness of the individual infant. As a general rule, the closer the infant is to 6 months (26 weeks), when the weaning process is first started, the more quickly they should be introduced to thicker purées and finger foods. By 8-9 months of age, infants should be ready to move to lumpier foods and most should be having lumpy foods by 10 months of age (INDI, 2010). It is important to note that foods of a mixed texture may be more difficult for the infant to manage during this stage, and that foods of a generally smooth texture with several larger lumps mixed throughout should be limited. As the infant develops the ability to pick up objects with their thumb and fore-finger, this should be encouraged by giving small pieces of soft finger foods and encouraging self-feeding. Important nutrients at this stage include protein, energy and certain fats, as well as essential vitamins and minerals such as iron, zinc, vitamin D, calcium, and antioxidants. These can be included in the diet by encouraging a wide range of foods (see Figure 5.1, page 81).
- **Introduction of harder finger foods, and minced or chopped family foods**. This final stage may occur between 9 to 12 months, and is again dependant on the developmental readiness of the infant. During this stage, 3 modified meals interspersed with 2 to 3 smaller servings of foods of varying textures and tastes, should be offered (COMA, 1994). At this age, most infants have the manual skills required to drink from a standard cup with both hands and to feed themselves, and this should be actively encouraged. At this stage also, infants can eat foods prepared for the rest of the family with minor modifications such as cutting into bite-sized pieces (ESPGHAN, 2008).
- Parents should be encouraged to introduce 1 new single ingredient food at a time, with the introduction of each new food separated by 1 day (see Figure 5.1, page 81). This allows the caregiver to assess tolerance to, and potentially adverse effects of, a new food.
- As small amounts of foods are needed for each mealtime, suitable complementary foods can be prepared, separated into individual portions using an ice-cube tray and frozen for convenience (INDI, 2010).
- Parents should not add anything to an infant's bottle, including rusks, cereals or baby rice, as this impairs the development associated with feeding, as well as increasing the risk of choking, dental caries and hypernatraemia (COMA, 1994; FSAI, 1999).
- During weaning, teaching children to recognise hunger and satiety cues is important. Parents can do this by feeding an infant only when they are hungry, by not forcing an infant to eat, and stopping when the infant indicates that he/she has had enough (Briefel *et al*, 2004).
- Parents should not judge baby foods as bland and should not feel they need to add sauces, gravies or additional sugar or butter.
- Parents should not limit their infant's diet by offering foods based on their own likes and dislikes and should instead offer a wide variety of foods, exposing their infant to a range of flavours, and therefore allow the infant to develop their own individual tastes.
- Parents should not adopt a negative attitude towards certain foods as the infant will be heavily influenced by this and this may negatively impact on food acceptance.

5.6 The Weaning Diet – Nutrients to Consider

5.6.1 Fluids during the weaning stage

Breastfeeding should continue throughout the weaning period. If a mother cannot or does not wish to breastfeed, a suitable infant formula should be used. A standard infant formula is suitable throughout the first year of life.

Continued breastfeeding is recommended along with the introduction of complementary feeding and remains the optimal form of milk feeding during the weaning period. If a mother cannot or does not wish to breastfeed, a standard infant formula should be used (for further information see Chapter 4). However, it is inappropriate to rely solely on breast milk or formula milk past 6 months (26 weeks). Provided that the weaning diet offered is nutritionally dense, specific follow-on milks should not be necessary and breast milk or a standard infant formula, in addition to nutrient rich complementary foods should provide all the nutrients required during the latter half of infancy. If the caregiver wishes to use specific follow-on milks, they should be advised that these are suitable from the age of 6 months only, and must be offered in conjunction with nutritious complementary foods.

Pasteurised cows' milk should not be offered as the main milk drink before 12 months of age. However, small amounts can be used in the preparation of weaning foods. Unpasteurised cows' milk is not suitable for infants and should not be given under any circumstances to infants and young children. Juices are not necessary for infants and increase the risk of developing dental caries. If a parent wishes to introduce juices, they should be encouraged to offer well diluted juices, not to give these in a bottle and not to offer between meal times (for further information see Chapter 6 on dental care). Excessive water and juice intakes are not necessary and may displace more nutritious milk based drinks.

5.6.2 Energy density

Infants have high nutrient requirements but the capacity to consume small amounts of food. Therefore, energy and nutrient dense complementary foods are vital during the weaning period to ensure nutritional requirements are met.

Complementary foods are introduced to ensure optimal growth; hence, ensuring sufficient nutrition to support growth is one of the main factors to be considered when designing a diet for infants at this stage. Infants have the capacity to consume relatively small amounts of food, yet have high nutritional requirements due to the rapid growth experienced during this time. Therefore, the inclusion of energy dense foods which provide energy without making the diet bulky is of prime importance. Priority should be given to energy dense foods which also provide essential micronutrients required for health such as iron, zinc and calcium, as well as essential fatty acids such as docosahexaenoic acid (DHA). Such foods include meats, poultry and fish. Milk and plain yoghurts are important sources of energy and are also rich in important nutrients such as calcium. Cereal products are also suitable during this stage, although some care should be taken when introducing those containing gluten (see section 5.10.2). Although lower in energy density, fruits and vegetables provide many essential micronutrients and should also form part of the daily diet during this stage. High energy foods which are not suitable for infants include high-sugar, high-salt foods such as chocolate, crisps and other confectionary products.

5.6.3 Total fat

Low-fat diets which are recommended for adults are not suitable for infants because a certain amount of fat is needed to provide the energy essential for growth. Breast milk or formula milk is the major source of fat in an infant's diet. Generally, extra fats such as butter or cream which can be added to foods and which provide little additional nutrition should not be added to the infant's diet.

Of all the macro (energy giving) nutrients, fat provides the highest amount of energy per gram and is therefore important in providing the sufficient energy needed in a small amount of food. The low-fat diets which are not recommended for the adult population are not suitable for infants and should be avoided. It is recommended that fat should not fall below 25% of total energy intake, and should be higher if an infant is feeding poorly, and or has recurrent infections (ESPGHAN, 2008). Conversely, it is not recommended that fat should be actively reduced before the age of 3 years, and reduced fat milk (1.5-2.0%) is not suitable for children under 2 to 3 years of age unless otherwise directed by a healthcare professional (ESPGHAN, 2008).

Breast milk and formula milk are relatively high in fat, and so will contribute greatly to the fat content of the infant's diet. Plain yoghurts and small amounts of cheese are also important sources of fat in the diet, as well as being rich in other essential nutrients such as calcium and protein.

Breast or formula milks will provide an appreciable amount of fat. However, these are unlikely to provide sufficient to meet the infant's energy requirements for growth and development. Full-fat dairy products such as full-fat plain yoghurts and fromage frais, as well as small amounts of pasteurised cheese are also important sources of fat and energy during the weaning stages, as well as being important sources of calcium (a micronutrient essential for the healthy development of bones and teeth).

Cheeses made with unpasteurised milk are not suitable for infants under 1 year of age as they are more likely to be contaminated with *Listeria monocytogenes*, a form of bacteria that can cause fatal foodborne illness especially in infants. Infants should only be offered cheeses which are clearly marked as pasteurised.

Despite the importance of energy dense foods in the weaning diet, a fine balance exists and it is important to not consume nutritionally poor (poor micronutrient content) sources of fat such as dessert foods, or to add unnecessary additional sources of fat to the diet such as butter. Excessive weight increases during the first months of life may have important repercussions for metabolic health down-stream, and high-fat, high-sugar confectionary foods may also negatively impact food patterns in later life, further adding to the risk of obesity.

5.6.4 Omega-3 polyunsaturated fatty acids (PUFAs) and docosahexaenoic acid (DHA) rich foods

Omega-3 PUFA such as DHA is important for infant development. Breast milk is a source of DHA, with slightly lesser amounts of this important fatty acid present in formula milk. From 7 months of age, additional sources of DHA (the richest of which is oily fish) should be added to the diet.

In recent years, emphasis has been given to the long chain omega-3 polyunsaturated fatty acids, particularly docosahexaenoic acid (DHA). DHA is involved in brain and cognitive development, and higher long chain omega-3 fatty acid consumption in infancy may be associated with a decreased risk of developing type 1 diabetes in later life (Norris *et al*, 2007; Stene *et al*, 2003). During infancy, DHA levels can drop during weaning due to the higher levels of DHA in breast milk or infant formula, relative to the lower levels of DHA commonly found in the weaning diet. EFSA has recently recommended that infants between the ages of 7 to 12 months should consume 100mg/day DHA (700mg/week DHA) (EFSA, 2010). Breast milk is a naturally rich source of DHA, and the DHA content of breast milk can be further increased by DHA in the maternal diet (Brenna *et al*, 2007) (see section 3.8.1). Although the addition of DHA is permitted to formula milks, the amounts permitted are static and strictly governed (Directive 2006/141/EC) and a review of formula milks on the Irish market currently suggests that formula milks contain DHA, although at quantities slightly below that of breast milk (see Table 5.1).

Table 5.2 DHA content (mg) in formula milk and breast milk

	Formula Milk*	Breast Milk†
200mls	14	18
400mls	28	36
600mls	42	53
800mls	56	71
1000mls	70	89

*Calculated from a range of standard infant formulae on the Irish market; †Calculated using average DHA content of breast milk in a sample of UK women (Yuhas *et al*, 2006)

Oily fish is one of the richest food sources of DHA (Table 5.3), as well as being an important source of high biological value protein and other essential nutrients including iodine, selenium, vitamins A, D and B12. Depending on the amount of breast milk or formula milk consumed, the inclusion of 30-60g (1-2 oz) of oily fish in the weekly diet of infants from 7 months should help to ensure that infants meet the optimal intake requirement.

Table 5.3 DHA content (mg) of a 30g (1oz) portion of commonly consumed oily fish

	DHA (mg)
Salmon	621
Tuna (fresh)	687
Mackerel	377
Rainbow trout	160
Herring	226

Data adapted from EFSA, 2005

Oily fish can be a source of environmental contaminants. Several of these contaminants such as methylmercury (MeHg) are harmful to the developing brain. Whereas *in utero* exposure is believed to be the most sensitive period for target organ development, the duration of increased susceptibility may extend into post-natal development (EFSA, 2004). It is therefore of prime importance that excessive contaminants are not present in the diet at this stage.

Table 5.4 Methylmercury (MeHg) content (µg) of a 30g (1oz) portion of commonly consumed oily fish

	MeHg (µg)
Salmon	1.3
Tuna (fresh)	16.3
Mackerel	1.3
Rainbow trout	1.3
Herring	1.0

Data adapted from EFSA, 2005

Based on the Joint FAO/WHO Expert Committee of Food Additives (JECFA) (WHO, 2004) Provisional Tolerable Weekly Intake (PTWI) of 1.6µg MeHg/kg body weight/week, as well as the average weight of a 7 to 12 month old of 9kg (Institute of Medicine, 2006), infants during the latter half of infancy should consume not greater than 9.6µg MeHg per week (1.6µg MeHg x 9kg). Consumption of small amounts of most oily fish should not exceed the recommended intake of MeHg, and it is important to realise the importance of oily fish in the diet of infants. Due to the high levels of MeHg found in older fish, and those higher up in the food chain (marlin, ray, shark, tuna) it may be advisable for infants to avoid the consumption of these fish, and to include oily and white fish with a lesser amount of MeHg and other contaminants, such as those lower down the food chain (FSAI, 2004) (see **Table 5.4**).

5.6.5 Protein

Protein is essential for optimal growth during infancy. Foods such as meat, poultry, fish, eggs, breast or formula milk, milk products such as plain yoghurts and pasteurised cheese, as well as pulses and legumes, are suitable sources of protein and other nutrients such as zinc, required for growth.

Protein is essential for growth and repair, and due to the high requirements for growth during infancy, infants require more protein per kilogram body weight than adults. Both breast milk and formula milk are important sources of protein in the diet throughout the first year of life. However, it is important that the diet also contains high protein foods, particularly in the latter half of infancy, when protein in milk alone will not be sufficient to meet optimal requirements. High protein foods such as meat, poultry, fish, eggs, and dairy products should be included in the diet at this stage. These foods are considered to contain proteins of high biological value, and are also a source of dietary zinc, a crucial nutrient important for growth and development. Additional sources of protein include pulses and legumes. These foods are considered to contain protein of lower biological value and may also be included in an infant's diet. As high protein diets have been associated with a more rapid growth velocity (Koletzko *et al*, 2009; Ong *et al*, 2009), which may have adverse health effects in later life, very high protein diets are inadvisable in the first year of life.

5.6.6 Sugar

High-sugar foods are not recommended for infants during the weaning period and under normal circumstances, infants should follow a no-added sugar diet.

Although a certain amount of taste preference is innate and has a strong genetic basis, flavours encountered both in the prenatal and post-natal period play a pivotal role in food choice and taste preferences in later years (Beauchamp & Mennella, 2009). Studies have shown that the preference for sweet foods can be influenced by the infant's dietary experiences over the preceding 6 months (Beauchamp & Moran, 1982); highlighting the importance of a non added-sugar diet.

Taste perceptions are different during infancy, and adults should never judge baby foods as bland. Sugar is also cariogenic, and high sugar diets have a potentially negative impact on healthy dental development and oral hygiene. The addition of extra sugar to infant foods is not recommended unless specifically recommended by a healthcare professional. High-sugar diets are associated with an increased risk of inappropriate or excessive weight gain; may negatively influence food patterns in later life; and have a high cariogenic potential. Therefore, infants should follow a no-added sugar diet throughout the first year of life.

5.6.7 Fibre

High-fibre diets are not suitable for infants as they tend to be bulky and low in energy density.

Due to their small stomach size, in addition to the high energy requirements relative to their body mass, high-fibre diets are not suitable for infants, and fibre intakes should be substantially lower than those of adults. Eating fibre-rich foods is recommended in later life, so introducing some fibre-rich foods in infancy may help establish healthy food preferences in later life. Fibre-rich foods are also often a rich source of several B vitamins, and can help prevent constipation. However, care should be taken that the inclusion of high-fibre foods does not result in an inadequate energy intake because fibre-rich foods add bulk to the diet, and may be lower in energy. Infant diets should include some fruits, vegetables and pulses, together with small amounts of brown bread (COMA, 1994). Small amounts of some wholegrain cereals may also be included. High-fibre diets (including unprocessed bran, fibre enriched cereals and high- fibre seeded or granary breads) are not recommended for infants.

5.6.8 Salt

High salt intakes are not suitable for infants, and infants should not consume greater than 1g salt daily.

High-salt foods and the addition of extra salt to the infant's diet during the first 12 months of life should be avoided. It has been suggested that infancy represents a significantly more salt sensitive period than later ages (Dahl *et al*, 1963), and early salt intake may have persistent long-term effects on blood pressure independent of salt intakes in later life. A Dutch study which randomised infants to lower or higher sodium diets for the first 6 months of life reported that those in the lower sodium group had systolic blood pressure which was significantly below those who had received the higher sodium diet, at 15 years follow up. Importantly, this was independent of current sodium intakes (Geleijnse *et al*, 1997). Due to differences in body weight, salt intake in infants and children needs to be proportionally lower than in adults. It has been recommended that infants up to 12 months of age should not consume greater than 1g salt daily (FSAI, 2005).

5.6.9 Iron rich foods

Iron stores decline from 4 to 6 months of age and high-iron foods such as red meat should be introduced at this time, to ensure the presence of adequate iron in the daily diet.

During periods of rapid growth such as infancy, the need for iron is high. The largest portion of the body's iron is present in red blood cells which are used in the transport of oxygen to developing tissues. At birth, an infant is endowed with stores of iron which are highly related to maternal iron stores, as well as intakes of iron during pregnancy. During early infancy, birth weight, rate of growth and gender, as well as nutritional factors, will determine the rate at which these iron stores will become depleted. However, all infants will begin to experience a reduction in iron stores from 4 to 6 months of age. Additionally, requirements continue to increase due to continuing growth and an increase

in body mass. Although the bioavailability of iron in breast milk is high and formula milks are fortified with iron, milk intake alone will not be sufficient to ensure optimal iron intakes in the latter half of the first year of life. Therefore, during the weaning process, iron rich foods should be offered to all infants from an early stage to ensure that ideal iron intakes and stores are maintained. Iron-rich foods such as red meat, e.g. beef, pork, lamb, should be introduced early in the weaning diet (from around 6 months of age), and their introduction should not be delayed past this age to ensure that sufficient iron is present in the daily diet. Iron-fortified commercially prepared baby foods can also be used as a source of dietary iron.

Iron is present in foods as haem and non-haem iron. Haem iron is easily absorbed by the body and sources include red meats such as beef, pork and lamb. In addition, poultry and fish contain slightly smaller amounts of haem-iron when compared to red meat. Liver is also a good food source of haem iron. However, some concerns have been raised about the potential toxicity of liver because of hormones, toxic substances or other substances present (Krebs, 2007). Specific safety data are not available at present, so it is difficult to make an exact recommendation at this point. However, the inclusion of liver in the diet represents a strong risk of the infant exceeding the tolerable upper level of vitamin A intake. Therefore, liver is not recommended for infants during the first year of life. Non-haem iron is less readily absorbed by the body, and is found in beans, eggs, leafy green vegetables, wholegrains, as well as iron-enriched foods. Non-haem iron absorption can be increased by including a source of vitamin C such as fruit and vegetables, with citrus fruits such as oranges being particularly rich sources of vitamin C. Fruit consumption should be encouraged in the form of actual fruits rather than in juice form. All foods offered should be prepared to a consistency which is appropriate for the weaning stage.

5.6.10 Vitamin D rich foods

All infants should be given a vitamin D only supplement providing 5µg (200I.U) vitamin D_3 daily throughout the first year of life and should be offered vitamin D rich foods.

The fat soluble vitamin D is essential for good bone health and may also play a role in the prevention of serious chronic diseases including cardiovascular disease and diabetes, as well as certain cancers (FSAI, 2007). All infants are at risk of becoming vitamin D deficient due to Ireland's northerly latitude, the limited number of foods high in vitamin D, the low vitamin D content of breast milk and the small amounts provided by fortified formula milks (FSAI, 2007, HSE, 2010). Additionally, poor maternal status during pregnancy is an issue as this may result in suboptimal transfer of vitamin D to the infant at birth. Due to the emergence of rickets amongst infants and young children in several Dublin hospitals, as well as the recognition that infants in Ireland are at risk of severe vitamin D deficiency, it is now national policy in Ireland that all infants between the ages of 0 to 12 months are given a vitamin D only supplement providing 5µg (200 I.U.) of vitamin D_3 daily (FSAI, 2007). Foods which contain vitamin D such as oily fish and eggs should also be included in the weaning diet.

Figure 5.1 Progression through the weaning diet is a gradual process leading to the consumption of family foods in the second year of life

Start with 1-2 spoonfuls of food and increase gradually. When the infant is taking 6 spoons at one sitting, consider adding another meal time.

Separate new foods by one day to assess tolerance and the possibility of adverse reactions.

It is important to increase the texture and variety of the infant's diet.

High-fibre, high-sugar or high-salt diets are not suitable for infants.

Infants should move from one stage to the next depending on developmental readiness.

The aim is to safely introduce infants to complementary foods.

4-6 months

Foods should be of a smooth, puréed or semi-solid consistency and the consistency increased gradually.

Commercially prepared gluten-free baby rice

Fruit, vegetable and legume purées

Puréed banana, apple (no skin), pear (no skin), carrot, broccoli, cauliflower, peas

Meat, poultry and fish purées

Potato

Red meat such as lamb and beef are particularly important as they are rich sources of iron.

Very small amounts of home prepared gluten-containing foods may be given close to 6 months. Ideally, gluten-containing foods should be introduced whilst the mother is still breastfeeding.

The texture of the diet is increased – becomes more solid and the frequency and amounts of foods increases.

6-9 months

- Consistency should be thicker and mashed, minced and lumpier foods.
- Soft finger foods should be encouraged.
- Puréed foods with some lumps are difficult for the infant and should be avoided. Although texture is very important, it is best that the texture of the food is more consistent throughout.

Gluten-containing baby foods:

Meats

Fish

Poultry

Potatoes

Eggs

Fruits

Vegetables

Legumes

Gluten should be introduced to the diet in small quantities and introduced slowly, preferably whilst breastfeeding.

Red meat such as lamb and beef are particularly important as they are rich sources of iron.

Oily fish should be included in the diet from 7 months to ensure adequate DHA is present in the diet.

The texture of the diet changes and only small baby-friendly modifications are necessary close to 12 months.

9-12 months

Foods should be minced or chopped family foods. Harder pieces of finger foods should be encouraged.

Breads (not wholegrain)

Meats

Fish

Poultry

Fruits, vegetables and legumes

Gluten-containing cereals

High-fibre diets are not suitable for infants.

Avoid high-salt, high-fat processed meats.

5.7 The Introduction of Certain Foods

5.7.1 Introduction of pasteurised cows' milk

Infants should not consume pasteurised cows' milk as the main milk drink before the age of 12 months although small amounts can be used in the preparation of weaning foods. Unpasteurised cows' milk is not suitable for infants and should not be given.

Cows' milk is a poor iron source and some data also suggest that consumption of cows' milk can provoke microscopic intestinal bleeding, although this has not been demonstrated after the age of 9 months (ESPGHAN, 2008). The principal reason therefore, for delaying the introduction of cows' milk to the infant's diet is to prevent iron deficiency anaemia. Pasteurised cows' milk should not be introduced as the main milk drink before the age of 12 months. However, small amounts can be used to prepare weaning foods. Unpasteurised cows' milk is not suitable for infants and should not be given.

5.7.2 Introduction of gluten-containing foods

Very small amounts of gluten should be introduced slowly to the infant's diet close to 6 months of age. The introduction of gluten should not be delayed past 6 to 7 months. Under no circumstances should an infant be introduced to gluten before 4 months (17 weeks). Where possible, gluten should be introduced while the mother is still breastfeeding and women should be counselled on the benefits of continuing breastfeeding until the infant is close to 6 months of age. Gluten-containing foods should be introduced in very small quantities, and increased slowly over time.

Why is the timing of first introduction to gluten important?

The food antigen gluten is an immunological trigger, and the first introduction of gluten-containing foods may be linked with the development of chronic diseases such as coeliac disease and type 1 diabetes. In recent years, accumulating evidence has led to renewed interest and discussion on the appropriate timing of gluten-containing foods to the infant's diet. Studies examining the particular impact of timing of gluten introduction on coeliac disease and type 1 diabetes risk are summarised in Table 5.5. Several issues have emerged from these data, with the age of first introduction to gluten appearing to be of particular importance. It appears that there may be a critical window of opportunity for the introduction of gluten-containing foods, with early introduction (less than 3 months) as well as late introduction (after 6-7 months) both adversely impacting health outcomes. This has been highlighted on a population level in Sweden, where a sharp rise in the incidence of coeliac disease was observed after the guideline to delay gluten introduction to 6 months or over, was introduced. This incidence declined again when the guideline of gluten introduction from 4 to 6 months was reinstated (Cavell *et al*, 1992).

Although the reasons for this are not entirely clear, it is possible that immaturity of the gut and immunological systems may be a contraindication for early introduction. Larger portion sizes, which would typically be given to an older infant, and which would result in an increased antigenic load, may be responsible for the negative effects seen when gluten is introduced at a slightly later stage. Ivarsson and co-workers reported that introducing gluten in a larger portion size, as may be typically given to an older infant (relating to >16g flour/day) was associated with a greater risk of developing coeliac disease than when introducing gluten in a smaller portion size (<7g flour/day) (Ivarsson *et al*, 2002). This work supports an earlier study which reported an association between the larger amounts of gliadin in the diet of Swedish infants, compared with their Danish counterparts, and the higher prevalence of coeliac disease in Sweden than in Denmark (Wiele *et al*, 2005). Additionally, introducing gluten whilst the infant is receiving breast milk has consistently emerged as having a protective effect on later development of coeliac disease and type 1 diabetes (Akobeng *et al*, 2006; Ivarsson *et al*, 2000; Peters *et al*, 2001).

Table 5.5 Studies examining gluten introduction and adverse health outcomes

Authors	Country	Strength of Evidence	Study Design	Main Outcomes
Kelly *et al*, 1989	England	2-	*n*=192 children with CD retrospective observational study	Later introduction (4 months compared with 2 months) to gluten correlated with a later age of presentation with coeliac disease.
Cavell *et al*, 1992	Sweden	2+	Retrospective population survey of the incidence of CD in 34 paediatric units between 1978 and 1987 representing 7.18 million	The incidence of CD doubled after 1982. The authors postulate that the increased incidence observed in children born after 1982 may relate to the recommendation to postpone gluten introduction from 4-6 months to 6 months of age.
Weile *et al*, 2005	Sweden and Denmark	2+	*n*=381 Swedish children, *n*=390 Danish children Observational study	Greater prevalence of CD in Sweden compared to Denmark despite comparable levels of breastfeeding and a similar genetic background. Swedish children had higher levels of gliadin in the diet at both 8 and 12 months of age.
Fälth-Magnusson *et al*, 1996	Sweden	2-	*n*=72 CD cases, *n*=288 controls; retrospective questionnaire study	Cases less likely to be breastfed upon introduction to gluten. Cases more likely to be first introduced to gluten through gluten-containing follow-on formula compared with controls, which were more likely to be introduced to gluten through gluten-containing porridge.
Challacombe *et al*, 1997	England	2-	*n*=26 CD cases and *n*=62 controls; retrospective study	Decreased incidence of CD may relate to the increase in age of first gluten introduction from 3.3 months during the 1970s to 5 months in the 1980s as well as to the increase in rates of breastfeeding initiation.
Ascher *et al*, 1997	Sweden	2-	*n*=8 CD, *n*=73 controls; case-control design	No significant difference between time of gluten introduction and duration of breastfeeding between cases and controls.
Peters *et al*, 2001	Germany	2-	*n*=143 CD cases and *n*=137 controls; case-control study	The duration of breastfeeding (>2 months) was associated with a decreased risk of CD but the age of first gluten introduction was not significant.
Ivarsson *et al*, 2002	Sweden	2-	*n*=627 CD cases, *n*=1254 controls; case-control study	Risk of developing CD reduced if breastfeeding when gluten introduced and lower again if breastfeeding was continued for 2-3 months following introduction. Introducing larger amounts of gluten into the diet first increased the CD risk.
Ivarsson *et al*, 2000	Sweden	2+	Analysis of population-based prospective incidence register of CD from 1991-1997 in addition to retrospective data from 1973-1991 *n*=2151 cases of coeliac disease	From 1985-1987, the annual incidence of coeliac disease in children rose sharply. This was followed by a decline in incidence post 1995. These changes may be related to an interplay between amount of gluten given on first introduction, the age of gluten introduction and whether or not breastfeeding was ongoing at time of gluten introduction.
Norris *et al*, 2005	USA	2+	Prospective observational cohort study. DAISY trial including *n*=1560 children followed from birth to 2-3 years of age at risk of developing CD based on HLA typing	Children exposed to gluten in first 3 months of life had a 5 times greater risk of developing CD autoimmunity than those first introduced to gluten between the ages of 4-6 months. Children exposed to gluten after 7 months had a marginally higher risk of developing CD autoimmunity than those exposed to gluten at 4-6 months at a mean follow up of 4.8 years.

Table 5.5 Studies examining gluten introduction and adverse health outcomes cont'd

Authors	Country	Strength of Evidence	Study Design	Main Outcomes
Akobeng *et al*, 2006	Sweden	2++	Systematic review and meta-analysis of observational studies	Pooled Odds Ratio 0.48, 95% CI 0.40-0.59. Risk of CD was significantly reduced in infants who were breastfed at time of gluten introduction, compared with non-breastfed infants.
Ziegler *et al*, 2003	USA	2+	Prospective cohort study; (BABYDIAB) *n*=1610 children	Early (<3 months) introduction of gluten-containing foods increased the risk of developing pancreatic islet auto antibodies. However, it did not increase the risk of developing CD auto antibodies. Exposure after 6 months did not have adverse effects on these disease development risks at 8 year follow up.
Norris *et al*, 2003	USA	2+	Prospective observational cohort study DAISY trial including *n*=1183 children at risk of developing type 1 diabetes	Children exposed to gluten initially between 0-3 months or after 7 months were at greater risk of developing pancreatic islet autoimmunity at a mean follow up of 4 years, compared with those children who had been exposed to gluten between 4-6 months.
Wahlberg *et al*, 2006	Sweden	2+	Prospective, population-based follow-up study of *n*=7208 infants from the All Babies in Southeast Sweden cohort; mean follow up time 2.5 years	A late introduction of gluten (>7 months) associated with induction of beta-cell auto antibodies in 2 ½ year old children.

CD, coeliac disease; Strength of evidence determined as indicated by the Scottish Intercollegiate Guideline Network (SIGN, 2005), a modified GRADE approach to grading evidence and recommendations (See Appendix C).

Assessing the evidence base and designing a recommendation for the first introduction of gluten for Ireland

A review of the evidence for first introduction of gluten suggests 4 key areas which need to be considered: the risk associated with late introduction of gluten, the risks associated with early introduction of gluten, the size of the portion of gluten first introduced, and the presence or absence of breastfeeding when gluten is first introduced. The strength of the evidence for each of these factors is presented in Table 5.6. Several limitations of the literature regarding the first introduction of gluten exist. The majority of studies in this area is of a case-control design and includes relatively small numbers of individuals. Furthermore, there is a distinct lack of randomised control trials in this area. Prospective cohort studies assessing the effects of gluten introduction examine surrogate end points such as the risk of autoimmunity rather than harder disease endpoints; further decreasing the overall strength of evidence. Nevertheless, there exists good overall consistency between the various evidence sources.

Table 5.6 Strength of evidence for introduction of gluten guidelines

Breastfeeding has a protective effect; therefore, gluten should ideally be introduced whilst the mother is breastfeeding	**B**
References: (Falth-Magnusson *et al*, 1996; Peters *et al*, 2001; Ivarsson *et al*, 2000; Akobeng *et al*, 2006; Ivarsson *et al*, 2000; Akobeng *et al*, 2006)	
First introduction of gluten over 6 months may be associated with an increased risk of developing CD or DM1 risk; therefore, the delayed introduction of gluten should be avoided	**C**
References: (Kelly *et al*, 1989; Cavell *et al*, 1992; Ascher *et al*, 1997; Peters *et al*, 2001; Norris *et al*, 2005; Ziegler *et al*, 2003; Wahlberg *et al*, 2006; Norris *et al*, 2003)	
First introduction of gluten under 3 months may be associated with an increased risk of developing CD or DM1 risk; therefore, gluten should not be introduced earlier than 4 months (17 weeks)	**C**
References: (Challacombe *et al*, 1997; Ascher *et al*, 1997; Norris *et al*, 2005; Ziegler *et al*, 2003; Norris *et al*, 2003)	
Size of gluten-containing food portion may be linked with adverse health consequences; therefore, gluten should be first introduced in very small quantities and the amount of gluten in the diet increased gradually	**C**
References: (Weile *et al*, 1995; Ivarsson *et al*, 2002)	

For key to evidence statements and grades of recommendation, see Appendix C.

When designing a guideline which would be appropriate for Ireland, a number of additional factors should be acknowledged:

- Complementary foods should not be introduced before 4 months (17 weeks), or after 6 months (26 weeks) of age, so introducing gluten between 4 to 6 months falls within the 'window of opportunity' discussed above. In Ireland however, a large proportion of infants in Ireland are prematurely weaned, and at 6 months, many infants consume a diet which is more advanced than expected for infants of that age (Tarrant *et al*, 2010b). Although it has recently been proposed that there is no need to delay the introduction of gluten past 17 weeks (ESPGHAN, 2008), a potential fear of relaxing this guideline is that gluten-containing foods may be used as first foods for infants who are weaned at an inappropriately early age (under 4 months), thus, potentially putting these infants at risk
- Breastfeeding rates in Ireland are generally poor, and the majority of women are no longer breastfeeding at 4 to 6 months (Tarrant *et al*, 2010a; Begley *et al*, 2008), and so many infants would not receive the protective effects of breastfeeding at the time of first introduction of gluten
- Commercially available gluten-containing baby foods are available in Ireland for infants aged 4 to 6 months of age, although the presence of gluten for this age group must be clearly labelled (Commission Directive 2006/125/EC and S.I. No. 209 of 2009

Recommendation for the first introduction of gluten

Considering all of the above, parents should aim to introduce very small amounts of gluten close to 6 months of age, and should ideally introduce gluten while still breastfeeding. Under no circumstances should an infant be introduced to gluten before 4 months (17 weeks). However, the first introduction of gluten should not be delayed past 7 months. Small amounts of gluten-containing foods should be introduced to their infant's diet, and increased slowly over time.

5.7.3 Introduction of honey

Honey, even pasteurised honey, is not suitable for infants under 12 months of age.

The consumption of honey has consistently been associated with infant botulism due to the presence of spores of *Clostridium botulinum*. *Clostridium botulinum* bacteria can produce botulinum toxin, a nerve poison which can cause paralysis. No honey (not even pasteurised honey) should be fed to infants younger than 12 months of age.

5.8 Restricted Diets during the Weaning Stage

Vegan diets are not suitable for infants or young children. Well-planned vegetarian diets are appropriate; however, the input of a dietitian is important to ensure this diet provides the nutrients required by the infant.

Restricted diets in infants, children and adolescents can increase the risk of nutrient deficiencies. Restricted diets may be parent, or child selected, whereas others are unavoidable, e.g. if a child suffers from a specific food allergy (Kirby & Danner 2009). The safety of extreme diets such as fruitarian, raw food or macrobiotic diets has not been studied in infants; however, as these will be low in energy, protein, and some vitamins and minerals, they cannot be recommended for infants. Vegan diets are also deemed to not be appropriate for infants or young children, due to the difficulty in obtaining sufficient energy, protein and nutrients such as iron, zinc and calcium.

If appropriately planned, vegetarian diets may be healthy and nutritionally adequate in infancy (Craig *et al*, 2009). However, careful planning and often intensive education and follow-up for parents is necessary to ensure that non-vegetarian foods are replaced with those of a high nutritional density, and that the diet is suitably rich in nutrition to support growth and development.

Key nutrients which may be low in vegetarian diets include protein, omega-3 fatty acids, iron, zinc, iodine, calcium and vitamin D, and vitamin B_{12}.

For an infant being weaned onto a vegetarian diet, from 4 to 6 months, meat may be replaced with mashed and strained tofu, legumes (peas, beans and lentils), soy or dairy plain yoghurt, well cooked egg-yolk, and cottage cheese. Meat substitutes such as textured vegetable protein (TVP) mince can be prepared to a suitable consistency, depending on the weaning stage. Later, from 7-10 months, foods such as cubed tofu and pasteurised cheese may be introduced. Foods such as tofu or legume spread, e.g. hummus, may also be used (Craig *et al*, 2009). It is vital that the energy density of the diet be monitored, alongside assessment of growth, and supplements and fortified foods offered, if required. A factsheet on weaning for vegetarian infants is currently being developed by the Irish Nutrition and Dietetics Institute. For more information, see www.indi.ie.

5.9 The Need for Weaning Education in Ireland Today

Weaning and the transition to solid foods is an important stage in an infant's life. It is essential that all healthcare professionals are up-to-date with recent best practice recommendations around weaning and promote these widely among all parents and so help them to make the best possible choices for their infants.

As discussed in Chapter 1, weaning practices in Ireland have improved over the past decade, particularly the age of first introduction of complementary foods which has decreased. Recent research however, has indicated that in comparison to the current ideal laid out, there remains room for improvement in weaning practices in Ireland; highlighting the need for further education and promotional efforts.

Research examining the factors contributing to the timing of weaning onto solid foods identified maternal age, education level, marital status and social class as indicators of inappropriate weaning (Tarrant *et al*, 2010a). Other influencing factors include family, with the maternal grandmother exerting the greatest influence (Tarrant *et al*, 2010a). This type of research helps to identify those individuals requiring greatest intervention

Introduction of complementary foods is a sensitive transition in the life of an infant. The aim of this period is not only to provide additional sources of nutrients, allowing the high requirements for infant growth to be met, but to also promote dietary patterns which will promote good health in later life. In order to promote effective nutritional practices and to promote appropriate weaning practices on a wide level, intensive education and support may be required in certain population subgroups, e.g. amongst the Traveller population, or women from a lower socioeconomic group in particular, to promote optimal infant health.

An ante-natal intervention to promote positive weaning behaviours has recently been shown to increase adherence to weaning guidelines relating to the timing of first introduction of complementary foods, in addition to the suitability of first foods (Dunleavy, 2010). The importance of appropriate weaning practices should be discussed with mothers from the ante-natal stage in order to best promote optimal weaning practices. All women should be facilitated and actively encouraged to attend ante-natal education.

Education on a broad societal level is required in order to promote best practice in infant feeding. Engagement with community support and education from attendance at ante-natal clinics and public health nurse contact positively impacted the introduction of complementary foods;

highlighting the need for increased provision of community support. It is vital that all staff providing training should be up-to-date with the most recent best practice recommendations. The positive impact of the public health nurse was observed in the recently completed 'First Foods Project' which was conducted by community dietitians in the midlands (Loane *et al*, 2008, unpublished results). Data emerging from this work also highlighted the confusion arising from conflicting messages from family and healthcare professionals, again reinforcing that broad-spectrum education on appropriate infant feeding practices may be necessary in order to facilitate evidence-based weaning/complementary feeding practices.

Healthcare professionals need to make parents aware of weaning guidelines so that they can make the best choices for their infants during the weaning period. As infants are heavily influenced by their parents and their home environment, the promotion of healthy eating guidelines is essential to ensure that parents set the best example possible in terms of diet and lifestyle habits for their infants and don't judge using their own likes and dislikes.

Summary

- From 4 to 6 months of age, the stores of several essential nutrients such as iron and zinc are decreasing. As growth during this stage remains rapid, requirements continue to be high and it is not possible for an infant to receive sufficient quantities of nutrients from milk alone. Complementary foods are introduced to the diet to ensure all nutritional requirements are met as the infant continues to grow and develop.
- The weaning diet should be rich in energy and protein, and should contain adequate amounts of certain important nutrients such as iron and vitamin D, as well as certain fatty acids to support optimal growth and development.
- Complementary foods should be introduced close to 6 months of age with the exact timing of weaning dependent on the individual infant's unique nutritional requirements. Weaning before or after the recommended time-frame is associated with both short and long-term health and developmental consequences, and so no infant should be weaned onto complementary foods before 4 months (17 weeks) or after 6 months (26 weeks) unless under the specific advice and guidance of a healthcare professional.
- Care should be taken with the introduction of certain foods including cows' milk, honey and gluten containing foods, and these should not be introduced before the recommended age.
- Inappropriate weaning practices which exist within Ireland today such as early weaning, or the presence of high-salt, high-sugar foods in the weaning diet, are detrimental. As eating patterns in infancy have been linked with those of later years, it is important to promote an optimal diet for infants which will lay the foundations for a healthy eating pattern later in life.
- **Education on a wide societal level on appropriate first foods and progression through weaning is essential to ensure conflicting messages are minimised.**
- **The development of educational resources which outline appropriate foods for the weaning stages should be funded. All parents should receive up-to-date, accurate information on weaning from the ante-natal stage, in order to meet the growth and developmental requirements of their infant.**
- **All child-care facilities should have access to these resources, and any foods provided should be nutritious and should be appropriate and suitable for the age and developmental stage of the infant.**

CHAPTER 6. DENTAL HEALTH

6.1 Healthy Teeth are Important for Early Development

Healthy teeth are important for eating, speech, smile and confidence and must be taken care of to avoid the development of dental caries.

Teeth begin to develop before birth, and the infant's first milk teeth (of which there are approximately 20 in total), begin to appear at around 6 months of age. Milk teeth are important for eating, speech, smile and confidence, as well as for the development of permanent teeth. Good oral health is an important aspect of infant health and development and should be promoted.

Early childhood caries are rampant. Caries of the primary dentition of infants and toddlers can lead to pain and infection, as well as being costly to treat on a population level (Forum on Fluoridation, 2002). Due to interference with comfort nutrition, concentration and school participation, dental decay can cause problems with growth and cognitive development. Dental decay in early childhood is also predictive of future dental problems (Gussy *et al*, 2006).

6.2 Modifiable Behaviours which Influence Dental Health and Development

Three main modifiable behaviours can greatly impact infant dental health and these include:
1. Feeding practices
2. Dietary habits
3. Dental hygiene

6.2.1 Feeding practices

Inappropriate infant feeding practices can lead to a typical nursing decay pattern.

- Going to bed with a bottle has been linked with dental caries (Feldens *et al*, 2007), and so it is important to avoid giving an infant a bottle before going to sleep.
- The transition from bottle to cup should be encouraged from 6 months of age, and this transition should be completed by 12 months of age. Delayed weaning from a bottle (after 2 years) is associated with dental decay (Parnell *et al*, 2002).
- For infants who are breastfed, it is important that a cup is offered from 6 months of age and can contain cool boiled water.

Nursing bottle caries

Nursing bottle caries is the name given to the dental caries which results from the constant exposure of teeth to drinks from a bottle. Exposure of the teeth is significantly increased if the infant sucks the bottle for prolonged periods. Even milk and breast milk, if in constant contact with an infant's teeth can cause decay; try to feed at regular or defined intervals (FSAI, 1999).

Sweetened liquids pool around the tooth surfaces and combined with bacteria present in the mouth, leads to the formation of an acid by-product. This by-product then causes demineralisation and breakdown of the enamel surface of the tooth. Over a period of time, this can result in tooth decay and dental erosion (FSAI, 1999).

- Never dip a soother in sugar, honey or anything sweet, before giving to an infant.
- Do not give sweetened liquids in a bottle or 'sippy cup' frequently, or between meals.

6.2.2 Dietary practices

Dietary practices can affect dental health and the amount and frequency of sugar consumption is particularly important. Infants less than 12 months of age should follow a no-added sugar diet and keep sugar-rich foods to a minimum.

As the time of first introduction of complementary foods to the infant's diet coincides with the time when the first teeth being to appear, every effort should be made to ensure that the weaning diet promotes healthy dental development, and does not negatively impact dental health.

Cariogenic Foods and Liquids

Cariogenic foods and liquids are those which, when in contact with oral micro-organisms (bacteria), can cause the pH in the mouth to drop below 5.5. Below pH 5.5 is the level at which tooth decay begins. Cariogenic foods include added sugar, sugary foods, juices and sweetened drinks. Other foods such as fruit (fresh or canned) contain a certain amount of natural sugars. However, these are an important part of the infant diet and should not be avoided.

- Sugar intake is a major factor influencing the development of dental caries. Both the amount and frequency of sugar consumption is important and high-frequency consumption is detrimental to dental health. High-sugar foods should not be consumed between meals, and should be kept to meal times only (Irish Oral Health Services Guidelines Initiative, 2009).
- As glucose, maltose and sucrose are cariogenic, it is important to check labels for the presence of these on the ingredients list. Parents should be informed that food packaging claiming 'low-sugar' or 'no added sugar' does not mean that the food or drink is sugar-free, and so may have the potential to negatively impact dental health. Many sweeteners are also cariogenic and should be avoided. These cariogenic sweeteners include corn syrup, dextrose, fructose and sucrose. Artificial sweeteners have been designed to be non-cariogenic and are often used in some chewing gums, soft drinks and include acesulfame K, aspartame and saccharin. However, these foods and drinks are not suitable for infants or young children and should not be consumed.
- Frequent consumption of juice or other sugar-containing drinks in bottles or beakers should be avoided (Parnell *et al*, 2002). Juices are not necessary for infants and if extra fluids are needed, cool boiled water is the most suitable.
- Healthy snack options include fresh fruit, vegetables, plain yoghurt, cheese and bread. Milk and cooled boiled water are the most tooth friendly drinks. Large volumes of water are not necessary for infants and may lead to displacement of more nutritious milk in the diet.
- Sugar-free medicines should be used where possible (Irish Oral Health Services Guidelines Initiative, 2009).

6.2.3 Dental hygiene

Parents should be encouraged to brush their infant's teeth as soon as the first tooth appears using a small, soft toothbrush and tap water only.

Establishing appropriate dental hygiene practices in infancy helps to ensure optimal dental development during this stage and guards against dental caries. A good dental routine from the beginning may also positively impact dental hygiene practices in later life.

Guidelines for good dental hygiene practices have been developed for children aged 0 to 2 years (Irish Oral Health Services Guideline Initiative, 2009).

- Parents and carers should start brushing the infant's teeth as soon as the first tooth appears.
- A soft toothbrush with a small head and tap water only should be used.
- Fluoride toothpaste is not suitable for infants and young children under 2 years of age and should not be used unless otherwise advised by the dental team.

6.3 Fluoride and Dental Health

Water fluoridation programmes in Ireland deliver a low amount of fluoride which helps prevent against dental caries without adverse effects. Fluoridated water in Ireland is safe for infants less than 12 months of age and should be used in the preparation of powdered infant formula.

Excessive consumption of fluoride can lead to fluorosis, and so, due to the risk of swallowing, the topical application of fluoride toothpaste is not suitable for infants under 2 years of age. Fluoride supplements are also not generally suitable for infants. Fluoride toothpaste or fluoride supplements should only be used if specifically recommended by a healthcare professional.

Water fluoridation programmes help protect against dental caries (WHO, 1994). The water fluoridation programme which began in Ireland in 1964 has made a significant impact to dental health in Ireland, particularly amongst children (Forum on Fluoridation, 2002). The best available and most reliable scientific evidence indicates, that at the maximum permitted level of fluoride in drinking water (at 1.5 part per million (ppm)), human health is not adversely affected. The target fluoride level for fluoridated drinking water supplies in Ireland is below this at 0.6-0.8ppm (Forum on Fluoridation, 2002). If fluoridated water is not available, parents should seek advice from a dental healthcare provider.

Using fluoridated tap water to prepare powdered infant formula is safe, and tap water should be used to prepare powdered infant formula (Forum on Fluoridation, 2002), unless specific advice not to use tap water has been given.

Fluoride toothpaste is not recommended for infants and young children under the age of 2 years in Ireland, as it has been associated with an increased risk of fluorosis (Mascarenhas, 2000; Franzman *et al*, 2006). Infants deemed to be at high risk of dental caries following assessment may be specifically recommended by a healthcare professional to use fluoridated toothpaste. However, fluoridated toothpastes should not be used for infants and young children in Ireland between 0 to 2 years unless specifically advised by a healthcare professional (Irish Oral Health Services Guideline Initiative, 2009).

Fluoride supplements are not recommended for infants or young children in Ireland due to the risk of fluorosis. Although other countries may recommend fluoride supplements for infants, as water in Ireland is fluoridated, additional fluoride supplementation of any children in Ireland is not recommended unless specifically advised by a healthcare professional.

Fluorosis is a disturbance in the enamel formation (leading to discolouration of the tooth enamel) which occurs when excess fluoride is ingested during tooth development (Oral Health Services Guidelines Initiative, 2009)

6.4 Dental Health Recommendations in Ireland

- The Irish Oral Health Service Guideline Initiative (2009) has compiled a report on dental health in Ireland, which includes recommendations on the provisions of oral health education and dietary advice, the building of a formal caries risk assessment using the Caries Risk Assessment Checklist into each infants health assessment, the formation of a nationally co-ordinated, central data system into which information on dental health should be entered to identify problem areas for targeted health promotional activities as required (Irish Oral Health Service Guideline Initiative, 2009). These recommendations should be supported on a national level.
- Oral health messages should be included into relevant general health promotion interventions, such as general weaning, breastfeeding and formula feeding promotional literature (Irish Oral Health Services Guideline Initiative, 2009).

Summary

- Healthy teeth are important for eating, speech, the smile and confidence, and must be taken care of to avoid the development of dental caries.
- Nursing bottle caries is caused by inappropriate feeding practices and should be avoided. High-sugar foods are linked with dental caries and care should be taken to reduce the amount and frequency of high-sugar foods and drinks in the infant's diet.
- Good dental hygiene practices should be developed as soon as the first tooth appears. Parents should brush their infant's teeth with a small, soft toothbrush and tap water only, and no toothpaste. Fluoridated toothpastes are not suitable for infants < 2 years old.
- **Good oral health is an important aspect of infant health and development, and the recommendations arising from the Irish Oral Health Service Guideline Initiative Report (2009) should be supported.**
- **As there is an appreciable overlap between elements of dental health and nutrition, oral health messages should be included in relevant health promotion interventions and educational resources, such as general weaning, breastfeeding and formula feeding promotional literature.**

CHAPTER 7. GROWTH MONITORING

7.1 Monitoring Growth in Infancy and Childhood is Essential

Growth during the first year of life can have an important impact on development and health in later life. Effective monitoring in conjunction with a holistic clinical assessment which allows early and effective intervention in the event of a problem is vital.

Growth monitoring is a critical part of an infant health assessment and provides crucial information on the overall health and nutritional status of the infant. As growth throughout the first year of life can influence health and development in later years, accurate growth assessment with early intervention if required is essential during this time. It should be stressed that the accuracy of growth measurements is of paramount importance and all staff should be trained in how and when to assess growth, as well as in the use of the equipment which must be regularly calibrated, and in the metric system.

7.1.2 Consequences of slow weight gain or growth in infancy

The relationship between low birth weight and metabolic health in adulthood is well established (Ravelli *et al*, 1976; Barker *et al*, 1990; Huxley *et al*, 2000). Evidence also suggests that, in addition to birth weight, an infant's growth pattern during the first year is strongly related to health in later life. A study of 4630 men conducted in Helsinki demonstrated that low weight gain during the first year of life is associated with an increased risk of coronary heart disease, independent of birth weight (Eriksson *et al*, 2001).

'Failure-to-thrive' has been defined as *"a failure of expected growth (usually weight) and well being"*. Infants with failure-to-thrive at 14 months were shown to have a relatively delayed progression to solid foods, poorer appetites, and ate a narrower range of foods (Wright and Birks, 2000); all of which has implications for growth and health in later childhood. Common causes of 'failure-to-thrive' include organic disease, abuse and neglect, deprivation and under-nutrition (Wright, 2000), and so a full assessment should be carried out for all infants in which 'failure-to-thrive' is suspected.

7.1.3 Consequences of excessive weight gain or growth in infancy

Excessive weight gain in early infancy is also problematic. The first 12 months of life are considered a critical period of development, and evidence suggests that conditions during this time have far reaching effects on adult health. Four systematic reviews have concluded that high early weight gain results in an increased risk of obesity in school age and adulthood (Baird *et al*, 2005; Monteiro *et al*, 2005; Ong *et al*, 2006; Monasta *et al*, 2010). This is associated with an increased risk of: hypertension, insulin resistance, heart disease, diabetes and asthma, leading to the development of the 'grow now, pay later' theory of excessive weight gain in childhood (Metcalfe *et al*, 2001).

7.2 Monitoring Infant Growth during the First Year of Life

The use of correct age and gender appropriate growth charts allows the monitoring of growth and nutritional status of an infant. Measurements of length-for-age, weight-for-age, length-for-weight, and head-circumference-for age provides important information on the growth and nutritional status of the infant. Serial measurements are important, as a single measurement does not provide sufficient information on which to base a clinical decision.

7.2.1 A growth chart is used to assess growth in clinical practice

Monitoring growth in clinical practice is an important part of the health assessment of the infant; increasing the chances of an early diagnosis of illness or inappropriate feeding patterns, in addition to helping to monitor progress during treatment or interventions. During the routine assessment of an infant, healthcare professionals should assess physical growth using a growth chart to assess and record the infant's weight, stature, length, and head circumference.

Correct use of an age and gender appropriate record allows the monitoring of the growth and nutritional status of an infant, as well as helping with the early detection of medical disorders; thus allowing prompt action. Information from growth charts can be used as a valuable tool in parent education, offering reassurance or explanation for a particular intervention. Growth charts and growth monitoring are also tools for healthcare professionals, and can provide information which will add to the overall impression of an individual infant's health. However, growth charts are not a sole diagnostic tool and should always be used within the context of the individual child, in conjunction with other

medical assessments and information such as gestational age and weight, and family history. Data obtained from growth charts can also contribute to the monitoring and surveillance of the health of the nation's children; helping to guide focused public health initiatives and education campaigns, as well as future research.

The Characteristics of an Ideal Growth Chart

Considering the diverse uses and functions of growth charts, the overall chart design is essential. Flow, simplicity, and ease of use are of paramount importance, allowing trends and changes to be noted and observed effectively and simply. As growth monitoring is often used in research studies, data obtained from one growth chart should be comparable with all other growth charts, allowing comparison between different populations. The ideal growth chart would be based on data collected longitudinally, and should be representative of children whose feeding and care comply with recommended health practices. Finally, reference charts measure growth in a reference population giving information on how infants and children are actually growing. However, this raises issues due to the rising obesity rates in infants and children. The alternative is a growth standard based only on the growth of healthy children under optimal conditions. This describes how children should grow rather than how they actually grow, and are the preferred growth charts (Wright, 2005).

7.2.2 What should a growth chart measure?

Several measurements can be made and these form part of a clinical impression of the individual infant's growth and development. These measurements include:

- **Length-for-age:** Indicates whether the infant is an appropriate length for their age
- **Weight-for-age:** Indicates whether the infant is gaining an appropriate amount of weight for their age
- **Head circumference-for-age:** Provides information on brain development
- **Weight-for-length:** Provides information which indicates whether the weight and length of the infant are in proportion

7.2.3 How often should growth be assessed during the first year of life?

Infants show variability in growth during the first weeks of life and fluctuations in weight are common at this stage (Wright, 2000). Changing weight during the first two weeks of life may relate to feeding problems, and it is vital that parents are fully supported at this time to establish an appropriate feeding routine. Too frequent weighing is often considered counterproductive, and may lead to unnecessary worry among parents. If weights are recorded at intervals too close together, natural variability and measurement error will be greater than potential weight gain in that period and can therefore be misleading. Parents should be aware of the importance of assessing growth during infancy and information given from the ante-natal period may be helpful in educating parents on the importance of this.

Individual measurements at a single point in time are not sufficient to monitor growth, and considering the variability in infant growth, two or more measurements over a period of time are required to detect a change in growth rate, irrespective of the starting point (Hall, 2000). Measuring growth at specific time points, e.g. those corresponding with vaccinations, may be helpful to ensure that the timing of growth measurements is more standardised, and ensure that an infant's growth is regularly measured.

In most children, height and weight follow consistently along a 'channel' (i.e. between or on the same centile(s)). Despite perception, the 50th percentile is not the goal for each child and the direction of serial measurements is more important than the actual percentile. When a child's growth deviates from a given centile channel or curve, an abnormality in growth may be suspected. However, some shifts in growth are normal (Mei *et al*, 2004). Normal children often shift 1 to 2 major centiles (i.e. 5th, 10th, 25th, 50th, 75th, 90th, 95th) for both length and weight, especially in the first 6 months of life (Dietitians of Canada and Canadian Paediatric Society Joint Statement, 2010). However, serial measurements showing unexpected movement away from more established rates of growth may be problematic.

DEFINITION: Percentile: Percentiles are the most commonly used clinical indicator to assess the size and growth patterns of an individual child. Percentiles rank the position of an individual by indicating what percentage of the reference population the individual would equal or exceed.

The Programme for Action for Children (PAC) has devised recommendations for assessing growth during the first year of life. It recommends a reduced number of mandatory growth monitoring assessments:

- Birth
- Six to eight week check
- School entry

Children should be weighed and measured at opportunistic times which may include birth, at immunisations, and/or during child health surveillance checks.

Accuracy of measurements, documentation and interpretation of findings is central to effective growth monitoring. It is essential that all individuals involved in growth assessment of infants and children are adequately trained and use equipment that is regularly calibrated.

The following equipment is needed:

- Electronic self zeroing scales
- Supine length measure (infantometer or babymat)
- Lasso-o-tape or other non-stretchable tape measure
- Leicester height measure (self calibrating)
- Centile charts

Referral criteria:

- Below 0.4th centile for weight, length and height
- Seek advice if head circumference below 0.4th or above 99.6th centile
- Parental or professional concern (National Core Child Health Programme Review Group, 2005)

7.2.4 Who measures the growth of the infant in the clinical setting?

The growth of an infant is measured by several different people involved in the care of the infant including the public health nurse, the practice nurse, the GP, the paediatrician, and the dietitian. Therefore, there is a need to standardise the growth chart used, the method used, as well as the data collection point. Serial measurements are vital, and it is possible that several different healthcare professionals may be measuring and making decisions on the health of the infant during the first year of life. Considering this, the use of a child health record, as well as the collation of these data centrally for all healthcare professionals to view, would be helpful and provide a tracking record of the infant's growth and a fuller picture on the growth and development of the infant.

7.3 Different Growth Patterns of Breastfed and Formula Fed Infants

There is a well established difference between the growth rates of breast fed and formula fed infants during the first year of life, with the growth rate of the breastfed considered the gold standard. It is important that healthcare professionals take this into consideration when monitoring the growth of an infant.

The difference in growth patterns between breast and formula fed infants during the first year of life has been much discussed (Dewey *et al*, 1998; Kramer *et al*, 2004), and this has recently been linked with differing protein contents of breast and formula milks (Koletzko *et al*, 2009; Ong *et al*, 2009). Breastfed infants have higher weight gain during early infancy, with a gradual decline during the remaining 6 months of the first year of life. A similar, though less pronounced, pattern is seen with length and children in late infancy who are breastfed tend to be leaner. This slower growth velocity observed in breastfed infants is considered healthier in light of the negative impact of rapid weight gain on non-communicable chronic metabolic diseases in later life (Ong & Loos, 2006; Ekelund *et al*, 2006; Leunissen *et al*, 2009). The well established difference between breastfed and formula-fed infants should be anticipated when assessing growth in order to avoid unnecessary investigations or counselling (Dietitians of Canada and Canadian Paediatric Society Joint Statement, 2010), and it is important that the growth of breastfed infants in Ireland should be assessed using a growth chart developed with data from breastfed infants.

7.4 Interventions for Slow or Excessive Weight Gain in Infants

Both slow and excessive weight gain is problematic during infancy and can influence development and long term health. In the event of a problem, early support and advice which is within the means of the family is essential.

Treatment and management of both slow and excessive weight gain in infancy should be multidisciplinary and family based. Consideration should be given to environmental factors and family resources, and parents should receive early support, as well as access to evidence based information (Dietitians of Canada and Canadian Paediatric Society Joint Statement, 2010). Except for children who are sick, or those with continuing weight loss, as opposed to low or static weight gain, it has been suggested that first line management should remain in the primary care system (Wright, 2000), and small changes which are within the means of many families are likely to be effective in reversing a negative trend. It has been suggested that referral is necessary if the child is below the 0.4th centile for weight, length, height or head circumference, or if there is parental or professional concern (National Core Child Health Programme Review Group, 2005).

Growth faltering or restriction during infancy has been linked with adverse health outcomes so it is important that slowing in growth is corrected early to reduce these health risks. If an infant is experiencing growth faltering, it is important to assess the adequacy of infant feeding. The frequency and volumes of milk feeding should be assessed and the possibility of feed under concentration should also be identified. Complementary foods may be introduced from 4 to 6 months, depending on the developmental stage of the infant, and their individual requirements. No infant should be weaned before 4 months (17 weeks of age). The presence of an organic cause for a slowing of growth should be ruled out, and an infant with slow growth may need to be referred to the paediatrician or dietitian if growth does not improve.

If an infant is gaining weight too rapidly, and large variations or increases are observed, it is important to assess the frequency, amounts and types of complementary foods offered for suitability, as well as ruling out the possibility of formula feed over-concentration. The infant may need to be referred to the paediatrician or dietitian if the problem persists, and referral to these services from the community is advisable if head circumference is >99.6th percentile, or if there is parental or professional concern (National Core Child Health Programme Review Group, 2005).

7.5 Growth Charts for Specific Medical Conditions

Certain growth charts are available which have been designed for groups of infants with specific medical conditions.

Specific growth charts exist for certain particular conditions. The main growth charts used in Ireland today are as follows:

- For pre-term infants, the adapted WHO/RCPCH charts from the UK are recommended
- For infants with Down Syndrome, charts available from the Child Growth Foundation are commonly used. However, as these charts are growth references and not growth standards, they should be used with some caution
- Growth charts are also available for children (aged 2 to 20 years) with cerebral palsy (Day *et al*, 2007; Day, 2010). These are also based on growth references and are not growth standards so should be used with some caution

Growth Charts in Ireland Today

No growth charts based on Irish data are available for use with Irish children aged 0 to 12 months. Several growth charts are currently used in Ireland at present; Hoey, Tanner Cox (1987) growth standard for 2 to 18 years, UK 1990 (Freeman *et al*, 1995; Preece *et al*, 1996), CDC charts (CDC, 2000), and the most recent WHO growth standards (WHO, 2006) are available and used currently with centre-specific differences in usage occurring. This variability in growth chart use is of concern and may negatively affect continuity of care of an individual infant, as well as having implications for the implementation of widespread training programmes.

Summary

- Growth monitoring is essential in childhood, as slow or excessive weight gain can be problematic for both short and long-term health. Growth monitoring is also important on a population level in order to identify trends and direct interventions to address issues and promote good health.
- Anthropometric measures such as length-for-age, weight-for-age, head circumference-for-age, and weight-for-length should be measured on an age and sex appropriate chart by trained staff. Individual measurements at a single time point are not sufficient and so serial measurements are required to effectively monitor growth. Measuring the healthy infant too frequently may be counter-productive as some natural variation in weight will occur, particularly in younger infants. That an infant is following a channel and not making large or erratic variations is key during the first year of life.
- Growth velocities differ between breast and formula fed infants and this should be considered when monitoring growth so that unnecessary investigations or counselling is avoided. In the event of a problem, full support should be given to parents to reverse this potentially negative trend. Measuring breastfed infants on a chart for formula fed infants may be detrimental as it may lead to excessive weight gain promoted despite the breastfed infant displaying the more ideal growth pattern.
- Interventions for problematic growth should be community based initially, with changes within the means of the family promoted. The infant should be referred for specialist attention if the problem persists.
- **A growth chart Implementation Group led by the Department of Health has recommended that the UK adapted WHO growth charts be used in Ireland for infants and young children from 0 to 4 years of age.**
- **Accuracy of measurements is key and healthcare staff that have been suitably trained and who are using regularly calibrated equipment only should measure growth. A nationwide training programme is vital once the decision on which charts to use has been finalised.**
- **Growth monitoring information should be entered into a central monitoring system, allowing effective and efficient surveillance of growth patterns of infants across the country. Due to fiscal realities within Ireland today, this centralisation of growth information would identify areas in which specific public health initiatives are particularly needed, thus improving the effectiveness of same.**

CHAPTER 8. COMMON TRANSIENT CONDITIONS WHICH MAY ARISE DURING INFANCY

8.1 Constipation

Constipation in children can be a cause of distress for both infants and parents and requires active management as well as parental support and reassurance. From a nutritional perspective, ensuring an adequate age appropriate intake of fluid and fibre is essential. Constipation should ideally be dealt with by the primary care team which should include dietetic input.

Constipation can be defined as hard scybalous, pebble-like stools for most stools or firm stools 2 or fewer times per week (NASPGHAN, 2006). Breastfed infants tend to have a greater number of bowel movements in comparison with their formula fed counterparts (Table 8.1), and constipation is unusual in breastfed infants. However, due to differences in fat digestion and absorption, as well as carbohydrate and protein composition, constipation is more common in formula-fed infants. A reduced bowel motion frequency or change in consistency in the breastfed infant is likely due to a suboptimal breast milk intake, and a feeding assessment is important to identify any issues with the feeding technique (see Chapter 3). Constipation in infancy may be due to over-concentration of feeds, or an inadequate fibre or fluid intake, particularly as the diet becomes more varied. Symptoms of constipation in infants and young children include infrequent bowel activities; foul smelling wind and stools; excessive flatulence; irregular stool texture; passing occasional large stools or frequent small pellets; withholding or straining to stop passage of stools; soiling or overflow; abdominal pain; distension or discomfort; poor appetite; lack of energy unhappy angry or irritable mood, and general malaise (Youssef & DiLorenzo, 2001).

The number and frequency of bowel motions is dependent on both the age of the infant, as well as the type of milk feeding which predominates, with breastfed infants having a greater frequency of bowel motions (Table 8.1). Furthermore, the number of bowel motions naturally declines in the second half of the first year of life (Table 8.1). Any perceived differences in stool patterns can be a source of worry for parents as they think there is a serious underlying cause.

Table 8.1 Average bowel movements per day and per week during the first year of life

	Average Number of Bowel Movements/Day*	Average Number of Bowel Movements/Week*
0-3 months (breastfed)	2.9	5-40
0-3 months (formula fed)	2.0	5-28
6-12 months	1.8	5-28

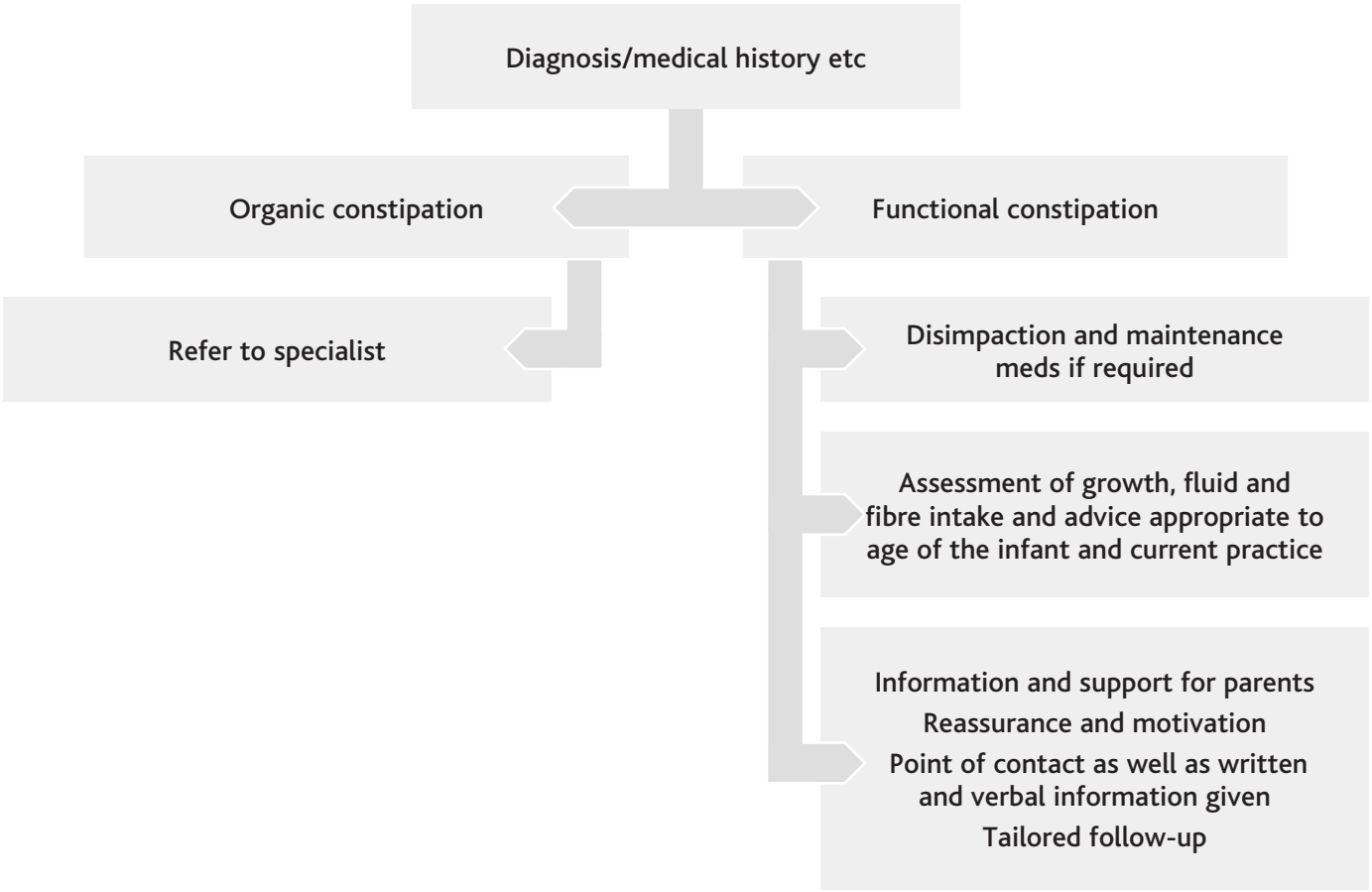
*Adapted from Fontana *et al*, 1989

A careful history should be carried out for all infants to diagnose either functional or organic constipation. Only a small number of children will have an organic cause for constipation, and beyond the neonatal period, constipation in children and infants is commonly functional constipation (NASPGHAN, 2006).

Constipation Idiopathic, or functional constipation, is constipation which cannot be explained by anatomical or physiological abnormalities (NICE, 2010). Functional constipation can be defined as at least 2 weeks of scybalous, pebble-like, hard stools for most stools, or firm stools 2 or fewer times per week, in the absence of structural, endocrine, or metabolic disease. Functional constipation is most commonly caused by painful bowel movements with resultant voluntary withholding of faeces by a child who wants to avoid unpleasant defecation. Many events can lead to painful defecation such as changes in routine or diet, toilet training, stressful events, recurrent illness, unavailability of toilets, or postponement of defecation. Withholding of faeces can lead to prolonged faecal stasis in the colon, with reabsorption of fluids and an increase in the size and consistency of the stools. The subsequent passing of large, hard stools may cause pain and a further withholding of stools. After several days without bowel movements, irritability, abdominal distension, cramps, and decreased oral intake may occur (NASPGHAN, 2006).

The desirable outcome of the optimal management of constipation is a normal stooling pattern brought about by interventions which have few or no adverse side effects and with resultant resumption of functional health (NASPGHAN, 2006). Long-term management and compliance is important in any treatment. A combination of family education, a well-balanced diet, behavioural management and potentially disimpaction and maintenance medications is required for the treatment of infant constipation (NICE, 2010).

Figure 8.1 Suggested flow chart for the treatment of constipation in infants



Data adapted from NICE, 2010

An adequate fluid intake is vital (see Table 8.2). Milk (either human breast milk or formula milk) is the most important fluid during infancy. Any additional fluids needed should be provided by cool boiled water (NICE, 2010). However, it is vital that any water given does not displace milk in the infant's diet. It is important to note that children in hot environments may require some extra fluids.

Table 8.2 Recommended fluid intake for infants during the first year of life

	Average Number of Milk Feeds in 24 hours	Average Daily Fluid Intake According to Baby's Weight
Birth to 3 months	6 to 8 (feed every 3 to 4 hours)	150ml per kg
4 to 6 months	4 to 6 (feed every 4 to 6 hours)	150ml per kg
7 to 9 months	4	120ml per kg
10 to 12 months	3	120ml per kg

Data adapted from the Institute of Medicine (2006)

An age appropriate fibre intake is also essential in the treatment, management and prevention of infant constipation. Due to their small stomach size, in addition to high energy requirements for growth, high fibre diets are not suitable for infants, and fibre intake should be substantially lower than those of adults. However, small amounts of fibre are important in the diet. Infant diets should include small amounts of fruit, vegetables and pulses, together with small amounts of brown bread (COMA, 1994). Small amounts of coarser wheat or oat-based cereals should only be introduced to infants over the age of 8 months (FSAI, 1999) (see Chapter 5 for further details). Juices that contain sorbitol such as prune, pear and apple juices can decrease constipation in infants. There is currently insufficient high quality evidence to recommend changes in infant formula or the use of probiotics.

Parental education and support is crucial to ensure that they understand what may be underpinning the constipation, as well as the rationale for interventions (Biggs & Dery, 2006). It is important to provide written information to families, and support should be provided by the clinical primary care team. Functional constipation should ideally be dealt with by the primary care team which should include dietetic input.

8.2 Colic

Colic is a widespread condition affecting infants in the first year of life. The exact cause of colic is uncertain, and symptoms of colic resolve spontaneously in the vast majority of infants by 4 to 5 months of age. Reassurance and support are vital, as symptoms of colic can be a significant cause of distress for parents. Colic should ideally be managed within the primary care team.

Infantile colic is a widespread clinical condition which is easily recognised but incompletely understood and difficult to solve. Defined during the 1950s by the 'rule of three', colic is characterised by excessive crying in otherwise healthy infants that lasts at least 3 hours a day (and often occurs at night), on at least 3 days per week for at least 3 weeks (Wessel *et al*, 1954). Using this definition, colic has been reported to affect 9% of infants (Canivet *et al*, 1996). Colic can also be viewed as a syndrome in which excessive crying is one symptom. Other symptoms may include pain, abdominal distension, passing of gas, and difficulties in passing stools, with lactose intolerance or excessive gas being one of the leading explanation for the above (Swaddling & Griffiths, 2003).

Colic is considered a self-limiting condition, and although it is usually more severe in the first weeks of life, spontaneous improvement often occurs with the vast majority of infants recovering uneventfully by 4 to 5 months of age (Wade & Kilgour, 2001; Garrison & Christakis, 2000).

Several causes have been proposed and include medical hypotheses such as food intolerance or sensitivity, immaturity of the gut function or dysmotility, or behavioural hypotheses such as inadequate maternal-infant interaction, anxiety of mother or difficult infant temperament (Savino, 2007). Disturbances in gut flora have also been proposed as a factor leading to colic (Lehtonen *et al*, 1994; Savino *et al*, 2004; Savino *et al*, 2005). A very small subset of infants experiencing symptoms of colic may go on to be diagnosed with an allergy (see section 8.6). However, the exact cause of colic remains speculative.

The use of hydrolysed infant formula for the treatment of colic has been explored, and several small studies support the use of hypoallergenic feeds in this group. In a double-blind, randomised, placebo-controlled trial of 43 healthy infants less than 6 months of age in the primary care setting, a significant reduction in crying time was reported for infants receiving the 25% whey hydrolysate formula, compared with standard infant formula, over the course of one week (Lucassen *et al*, 2000). Similar results were obtained in a larger study of 267 infants under 4 months of age with colic. Treatment with an infant formula containing partially hydrolysed whey protein concentrations was more effective in reducing colic episodes after one week, as well as a reduction in crying episodes at 14 days (Savino *et al*, 2006), compared with the control group, who received a standard cows' milk protein based formula in addition to simethicone (6mg/kg twice daily). Casein based hydrolysates were also effective in the treatment of colic in infants (Jakobsson *et al*, 2000). A specialised anti-colic infant formula was shown to be effective in the resolution of colic in 87% of cases, as determined by a reduction in crying time, improved feeding continuity, as well as a reduction in intestinal gases (Infante Pina *et al*, 2008). Advice to mothers to cease breastfeeding and to try feeding with infant formula should not be recommended (Crowcroft *et al*, 1998).

Sucrose has an analgesic effect on newborn infants and 2ml of a 12% sucrose solution when the infant was crying has been shown to have an ameliorative effect on symptoms of colic in infants (Markestad, 1997). Also, 1ml of a 20% hypertonic glucose solution was also more effective than placebo in decreasing symptoms of infantile colic although the placebo group also responded quite well (Akçam & Yilmaz, 2006).

Those most affected by colic are often parents. Sleepless nights and the inability to console a new baby are a significant source of stress, especially among first time parents (Rogovik & Goldman, 2005). Healthcare providers must offer support, reassurance and empathy to the caregiver.

8.3 Gastroenteritis

Acute gastroenteritis occurs very commonly in infants and young children. Rehydration is the main treatment goal and a reduced osmolality oral rehydration solution should be offered *ad libitum* in addition to the infant's normal milk feeding.

Acute gastroenteritis is one of the most common illnesses occurring in childhood, with all children expected to have experienced some degree of this within the first 3 years of life (Guarino *et al*, 2008). Despite the frequency with which acute gastroenteritis is seen among infants and young children, the severity is usually mild in European and other developed countries (Guarino *et al*, 2008).

Dehydration is the main clinical feature of acute gastroenteritis and will reflect disease severity. Weight loss, prolonged capillary refill time, skin turgor, and abdominal respiratory pattern are the best individual clinical signs of dehydration. In 2008, ESPGHAN and the European Society for Paediatric Infectious Diseases (ESPID) joined force to create guidelines for the management of acute gastroenteritis in otherwise healthy children. From this, rehydration should be considered the key treatment aim and should be applied as soon as possible. Reduced osmolality oral rehydration solution should be used, and should be offered *ad libitum*. Hospitalisation should only be required if IV fluids are needed. Regular feeding (either breast milk or formula milk) should be continued and not stopped. Regular milk (lactose-containing) is suitable in the vast majority of cases (Guarino *et al*, 2008). Transient lactose intolerance may occur during acute gastroenteritis, and if present, this transient lactose intolerance can be easily treated with a lactose-free formula and/or weaning diet.

8.4 Gastro-oesophageal Reflux

Gastro-oesophageal reflux is a normal physiological process occurring several times per day in healthy infants which resolves spontaneously by 12-14 months of age. Provided growth continues normally; uncomplicated gastro-oesophageal reflux requires parental education and reassurance.

Gastro-oesophageal reflux (GOR) is the passage of gastric contents into the oesophagus with or without regurgitation or vomiting. Gastro-oesophageal reflux is a normal physiological process occurring several times per day in healthy infants (Sherman *et al*, 2009). Other terms such as 'spitting up', 'posseting' or 'spilling' are considered equivalent to regurgitation. Regurgitation resolves spontaneously in the majority of infants by 12-14 months of age (Hegar *et al*, 2004; Miyazawa *et al*, 2002; Nelson *et al*, 1998), and requires no specific treatment. Reflux is not a common cause of unexplained crying, irritability or distress in healthy infants. It is important to monitor weight and be on the alert for failure-to-thrive, diarrhoea, constipation, fever and lethargy. Provided growth is normal, uncomplicated gastro-oesophageal reflux requires parental education, reassurance, and anticipatory guidance only. Anti-reflux/anti-regurgitation milk products which are thickened with starch, guar gum or carob bean may decrease visible regurgitation, but do not decrease the number of oesophageal reflux episodes. Supine positioning is recommended because of the risk of Sudden Infant Death Syndrome (SIDS) associated with prone or lateral positioning which are not recommended.

Gastro-oesophageal reflux disease describes reflux of gastric contents that causes troublesome symptoms or complications. Gastro-oesophageal reflux disease in infants is rare; however, it is sometimes wrongly diagnosed in healthy infants with troublesome but harmless symptoms of 'physiological' gastro-oesophageal reflux, and this has led to increasing, and potentially inappropriate use of acid reducing medications.

8.5 Fussy Eaters and Food Neophobia

Food neophobia and fussy eating relate to the rejection of foods and have the potential to increase the risk of inadequate intakes of certain essential nutrients. It is important to reverse this trend in childhood as early intakes may have a far-reaching impact on adult eating patterns. Positive parental-child feeding, social facilitation and several exposures may be required to bring about acceptance of a new food.

Food neophobia is often described as the reluctance to eat or the avoidance of new foods (Birch *et al*, 1998). This may have had an evolutionary benefit, as naturally rejecting bitter tastes may have helped to decrease the consumption of noxious or toxic plants (Dovey *et al*, 2008). Rejecting new foods may increase the risk of deficiency or lead to a suboptimal intake of certain nutrients, and furthermore, it is important to reverse the aversion to new foods during childhood as this may be a critical period which informs adult food consumption. Food neophobia appears to decrease naturally with age (Koivisto & Sjoden, 1996).

Figure 8.2 Food neophobia and fussy eating may require several strategies to increase acceptance

Multiple Exposures	A new food may require several exposures in order to bring about acceptance.
Positive Parent-child Feeding Style	It is important to always present food in a positive light and not to create pressure to consume a new food.
Social Facilitation	Introducing a new food in a positive environment in which other individuals are eating the same food can help bring about acceptance of a new food.

Learned taste acceptance is brought about through repeat exposures, particularly of bitter tastes of fruit and vegetables from the citrus and brassicae family (Birch & Marlin, 1982).

Positive parental child-feeding style is integral to overcoming a child's natural rejection of novel foods (Dovey *et al*, 2008). A stressful feeding encounter is not likely to stimulate a positive response from a child to novel and/or aversive tasting foods (Dovey *et al*, 2008).

Neophobia is linked with emotional involvement related to feelings of disgust. Feelings of disgust and associated facial expressions may relate to bitter or perceived potentially harmful foods (Martins & Pliner, 2005). Food neophobia can be reintroduced by negative experience within the initial series of exposures (Dovey *et al*, 2008), and parental pressure has been associated with food neophobia (Wardle *et al*, 2005; Adessi *et al*, 2005). Considering this, it is important to always present food in a positive light and not create pressure to consume new foods.

Social facilitation is defined as an increase in the frequency of a familiar behaviour pattern in the presence of other individuals displaying the same behaviour pattern at the same time and can decrease acute expression of food neophobic behaviours (Visalbeghi & Addessi, 2000). Therefore, introducing a new food in a positive environment in which other people are consuming the same food will increase the chance of food acceptance. This setting of a positive example shows better results than linguistic reasoning (Dovey *et al*, 2008).

Neophobia covers pre-tasting and only extends to when a new food is placed in the mouth. The 'phobia' regarding the new food is said to be lost when in the mouth and tasted (Pliner & Hobden, 1992). Rejection of this taste is then under the realm of fussy eaters. Picky or fussy eating is behaviourally and theoretically distinct from food neophobia, and picky eaters generally have a higher risk of consuming an inadequate variety of foods (Dovey *et al*, 2008). Picky eating can extend to the general flavour and texture avoidance, rather than being confined to just one food. It is likely that the 'picky/fussy' eater may require many more exposures in order to accept a particular food (Dovey *et al*, 2008).

Infants are predisposed to more readily accept sweet or salty tastes, and to more naturally reject new foods (neophobia). Using this set of predispositions, infants will more readily accept sweetened and salty foods such as confectionary, crisps and chips, whereas 'healthier' options such as puréed vegetables, meats and dairy produce may be rejected. The liking for complex food flavours which are not dominated by sweet or salty tastes must be learned (Paul *et al*, 2007). As the initial neophobic response is most often transient, parents should be encouraged to persevere, as the infant will typically accept the food following repeated tasting opportunities. In addition to repeated exposures to healthy foods, parents should be alerted to cues for fullness when feeding complementary foods. Pursed lips, closed mouth, spitting out food, turning of the head, and leaning back are all examples of cues to stop feeding (Paul *et al*, 2007).

The period of birth to 3 years is a critical period for the development of the controls of food intake, the development of food preferences and eating behaviours. There is evidence that early feeding practices are linked to patterns of food acceptance and the developing controls of food intake. A feeding style using coercion is unlikely to be effective in the short-term. When introducing solid foods, parents should be aware that new foods may be initially rejected, and should be advised to be patient, as learning to like new foods takes time. If parents offer new foods repeatedly, over a series of 5 or 10 days, many of these foods will eventually be accepted, and even preferred (Paul *et al*, 2007).

8.6 Nutritional Management of Food Allergy in Infants

8.6.1 Definitions of allergy

Allergy: a hypersensitivity reaction initiated by immunologic mechanisms (Greer *et al*, 2008)

Atopy: a personal or familial tendency to produce immunoglobulin E (IgE) antibodies in response to low-dose allergens; confirmed by a positive skin prick test result (Greer *et al*, 2008)

Atopic disease: clinical disease characterised by atopy; typically refers to atopic dermatitis, asthma, allergic rhinitis, and food allergy (Greer *et al*, 2008)

Food allergy: an immunologically mediated hypersensitivity reaction to a food or ingredient, e.g. cows' milk, including IgE mediated and/or non-IgE-mediated allergic reactions (Greer *et al*, 2008)

8.6.2 Feeding in infants at risk of allergy

For all infants, including those at increased risk of developing allergy, there is currently insufficient evidence to support the delayed introduction of potentially allergenic foods such as eggs, fish and nuts. As with all complementary foods, these should be introduced one-by-one and in small amounts from 4 to 6 months of age. No complementary food should be offered before 4 months (17 weeks of age). There is insufficient evidence to avoid potentially allergenic foods during pregnancy or lactation, although care should be taken to ensure the mother does not consume a food which she herself is allergic to.

Infants with at least one first degree relative (parent or sibling) with documented allergic disease are deemed to be at increased risk of developing allergy, as the risk of atopy increases if a parent or sibling has atopic disease (20 to 40% and 25 to 35% respectively), and is higher still if both parents are atopic (40 to 60%) (Björksten, 2005).

To reduce the risk of allergy development, it has traditionally been recommended to delay the introduction of foods which have been identified as potentially allergenic. The conventional wisdom has been that early exposure to allergenic food proteins during pregnancy and lactation, or during early infancy, could lead to food allergies. However, there is insufficient evidence to support this view, and this has led to a shift away from food allergen avoidance for at-risk individuals during this time.

A Cochrane review failed to find evidence of an effect of maternal dietary antigen avoidance during pregnancy or lactation on atopic eczema in the first 18 months of life (Kramer & Kakuma, 2006). Studies eliminating food allergens during infancy and lactation have consistently failed to reduce long-term IgE mediated food allergy in children. Conversely, in countries in which there has been early avoidance of food allergens (UK and USA), a high prevalence of allergy is observed in comparison with countries in which infant consumption of food allergens such as peanuts is higher (Lack *et al*, 2008; Du Toit *et al*, 2008). These data support the hypothesis that oral tolerance induction, rather than dietary elimination, is required to prevent the development of food allergies. The dual-allergen-exposure hypothesis for the pathogenesis of food allergies explains how exposure to the skin (cutaneous exposure) leads to sensitisation, whereas oral exposure through consumption of allergenic proteins results in the induction of oral tolerance (Lack *et al*, 2008).

Other studies examining the timing of the introduction of complementary foods and atopic disease have failed to show a benefit in delaying the introduction of potentially allergenic foods until later in infancy. There was, however, a positive relationship observed between inappropriately early introduction of complementary foods and allergy in later life (Kajosaari *et al*, 1991; Fergusson *et al*, 1983; Fergusson *et al*, 1990), further supporting the recommendation that no infant should receive complementary foods before 4 months (17 weeks) of age.

Complementary foods should be added one at a time, separated by one day to allow the detection of potentially adverse reactions to individual components. There is no convincing scientific evidence that the avoidance or delayed introduction of potentially allergenic foods such as fish or eggs leads to a reduction of allergy either in high-risk or non high-risk infants (Greer *et al*, 2008; ESPGHAN, 2008). Elimination diets carry the risk of inducing insufficient supplies of critical nutrients with adverse effects on health and well-being, particularly in infants and children, and so infants and children should not be burdened with unnecessary dietary restriction, and these should not be recommended unless a proper diagnostic assessment has been conducted (Koletzko & Koletzko, 2009).

8.6.3 Infants with cows' milk protein allergy

Infants with a suspected allergy require a prompt diagnosis. This is essential both for infant wellbeing, and that of the parents, as this can be a cause of distress. All cases of suspected allergy should be seen by a paediatrician, and all positive diagnoses should receive dietetic support. It is difficult to detect an allergy until a potential allergen has been encountered, either through the diet or through cutaneous exposure. For this reason, one of the more common allergies or intolerances found in infants during the first year of life is an adverse reaction to some component of cows' milk.

Between 5 to 15% of infants show some symptoms which suggest an adverse reaction to cows' milk protein; however the vast majority of these infants (92.5 to 98%) do not have an allergy to cows' milk protein (Vandenplas *et al*, 2007). Cows' milk protein allergy (CMPA) can be easily missed in the primary care setting but needs to be considered early, as symptoms of cows' milk protein allergy (see Table 8.3) can be a significant cause of stress to both infants and parents (Ewing, 2005). CMPA may be IgE mediated, or non-IgE mediated (Vandenplas *et al*, 2007).

A careful history should be completed as factors such as age of onset; nature of symptoms; frequency of manifestation; timing between ingestion and onset of symptoms; quantity of milk necessary to provoke symptoms; method of milk preparation; reproducibility of the reaction; interval of time since last reaction and growth records, are important for diagnosis.

Table 8.3 Symptoms of CMPA

Organ Involvement	Symptoms
Gastrointestinal tract	Frequent regurgitation
	Vomiting
	Diarrhoea
	Constipation
	Blood in stool
	Iron deficiency anaemia
Skin	Atopic dermatitis
	Swelling of lips and eye-lids
	Urticaria unrelated to acute infection, drug intake or other causes
Respiratory tract (unrelated to infection)	Runny nose (otitis media)
	Chronic cough
	Wheezing
General	Persistent distress of colic (irritable >3 hours per day) at least 3 days per week over a period of greater than 3 weeks

Data adapted from Vandenplas *et al*, 2007; CMPA, cows' milk protein allergy

CMPA in the breastfed infant

Although the prevalence of cows' milk protein allergy is lower in exclusively breastfed infants, Ð-lactoglobulin, if consumed by the breastfeeding mother, is expressed in breast milk at low levels, and may be sufficient to cause symptoms in the breastfed infant. CMPA should not be viewed as a barrier to breastfeeding.

A maternal avoidance diet is the primary treatment for this group, in addition to strict avoidance of cows' milk protein during the weaning stages (Vandenplas *et al*, 2007). An elimination diet for the mother should exclude all cows' milk protein for at least 2 weeks, as well as excluding all egg. Maternal calcium supplementation with 1,000mg per day is essential during this trial, to ensure that sufficient calcium is consumed. This maternal exclusion diet should be continued for up to 4 weeks for cases of atopic eczema or allergic colitis and the effect assessed after this time (Vandenplas *et al*, 2007; Fiocchi *et al*, 2010) (see Figure 8.3). If symptoms continue to persist, an amino acid based formula can be tried, and if no improvements are seen, then the infant should be referred to a specialist for further care (Vandenplas *et al*, 2007; Fiocchi *et al*, 2010) (see Figure 8.3). If a breastfed infant presented with symptoms following the introduction of a cows' milk protein based formula, then an extensively hydrolysed infant formula should be tried first, and if symptoms persist, then an amino acid-based infant formula may be tried. It is vital that a GP or paediatric specialist has diagnosed CMPA before a maternal exclusion diet or changes to milk feeding are made.

CMPA in the formula-fed infant

For the formula-fed infant, a hydrolysed formula should be tried. Extensively hydrolysed formulae may be more effective than partially hydrolysed formulae in the prevention of atopic disease (Greer *et al*, 2008, von Berg *et al*, 2008). If symptoms persist, then an amino acid-based formula may be tried.

A cows' milk challenge is essential for infants who become symptom-free during a cows' milk protein-free diet to reduce the number of false positive diagnoses of CMPA (Vandenplas *et al*, 2007). It is vital that a GP or paediatric specialist has diagnosed CMPA before changes to milk feeding are made.

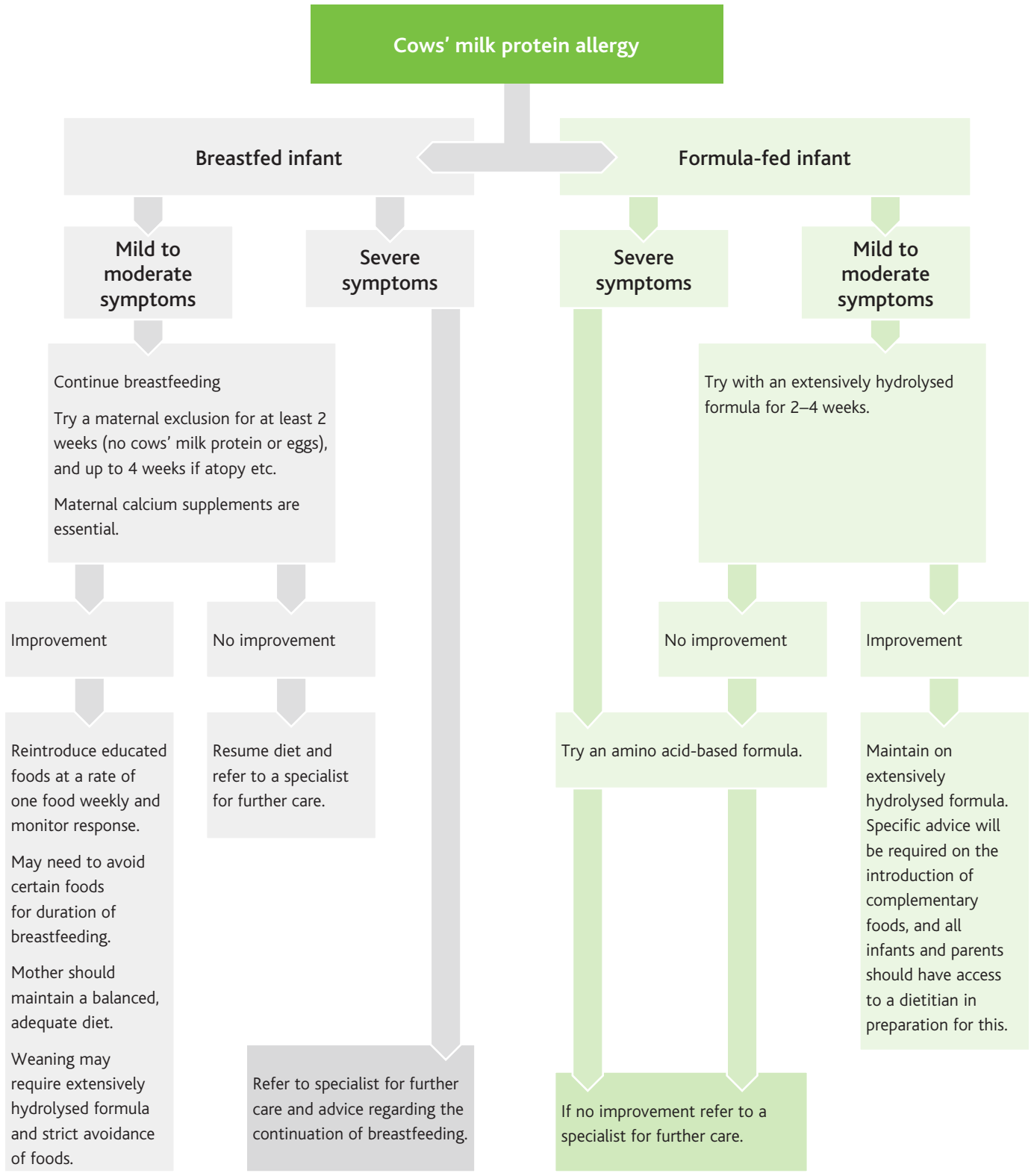
For an infant with cows' milk protein allergy, soy milk, or other mammalian milks such as goats' milk should not be used. Soy-protein formulae are not hypoallergenic, and reactions to soy-based infant formulae have been observed in 10-35% of cases of cows' milk protein allergy (Klemola *et al*, 2002). Due to the risk of cross-allergenicity, other mammalian milks are not recommended (Vandenplas *et al*, 2007).

Hypoallergenic feeds are tolerated in 90% of patients with cows' milk protein allergy

Soy-based are not appropriate, but may be used as a last resort for those infants refusing hydrolysed, ex hydrolysed and AA-based formulae, however there is a chance of cross-allergenicity.

The input of a dietitian is crucial, particularly around weaning advice in identifying foods and recommending milk-free products, and food preparation methods which will be suitable for the infant with cows' milk protein allergy. As with all elimination diets, the avoidance of cows' milk in the diet of infants must be carefully supervised and monitored to a similar degree as drug treatments. The need for continued dietary elimination should be reviewed on a regular basis and re-challenges considered (Kolezko & Koletzko, 2009).

Figure 8.3 Suggested flow chart for the management of cows' milk protein allergy in infants



Fiocchi *et al*, 2010; Vandelplas *et al*, 2007

Summary

- Several conditions including constipation, colic, gastroenteritis, gastro-oesophageal reflux and fussy eating can arise during infancy.
- Many of these such as colic and reflux are transient conditions, resolving as the infant ages. Others such as constipation may require a more long-term change in behaviour and feeding practices to avoid recurrence in the future.
- All of these conditions require effective care-giver education and reassurance to avoid undue distress.
- For conditions that most commonly arise during the first year of life, it is generally not necessary to change the type of milk an infant receives.
- A fast diagnosis, as well as early interventions which are within the means of the family are preferred, however specialised medical attention should be sought if the symptoms persist, or if there is uncertainty regarding the presence of an underlying organic cause.
- **Awareness and promotion of best practice management of the above conditions amongst healthcare professional in the community is ideal.**
- **Caregiver support, education and reassurance are an essential part of the management of these conditions which frequently arise during infancy, and further medical attention should be sought quickly if symptoms continue to persist.**

CHAPTER 9. CHILDREN REQUIRING SPECIFIC NUTRITIONAL CARE

9.1 Nutritional Management of the Pre-term Infant

Pre-term infants have specific nutritional requirements, and it is essential that these are met both to maximise growth potential and minimise adverse health outcomes. Breast milk is the best form of nutrition for pre-term infants and mothers should be encouraged to breastfeed and breast pump support given. If breastfeeding is not possible, formula milk specifically designed for pre-term infants should be used. Pre-term infants should be carefully monitored, and the feeding regime should be tailored to the individual infant by a dietitian specialising in neonatal care.

Pre-term infants have specific requirements for both macro-nutrients (energy giving nutrients) in particular protein and energy intakes, and micro-nutrients (non-energy giving nutrients) (ESPGHAN, 2010). Good nutrition during this time is vital to support organ development, the immune system and gastrointestinal integrity.

Early feeding has been associated with both short and long-term developmental benefits (Aggett *et al*, 2006; Lucas *et al*, 1998). Providing adequate energy to allow growth is essential, as is giving the correct protein-to-energy ratio to support the effective synthesis of new tissue, with the goal of mimicking intrauterine growth as closely as possible. This is vital, as a suboptimal intake of protein, energy and certain other nutrients during this time has been linked with adverse health consequences such as lower cognitive achievements in later years (Lucas *et al*, 1998). In addition to achieving a standard for short-term growth and preventing feeding related morbidity and mortality, nutrition support for the pre-term infant should focus on optimising health in the longer term. As growth of pre-term infants often falls behind what is required (Dusick *et al*, 2003), intensive and specialised support is essential in order to best maximise growth potential in the pre-term infant.

The nutritional assessment of the pre-term newborn begins at birth, and the evaluation of post-natal growth should be continued throughout infancy. Specific growth charts designed for use with pre-term infants are available and should be used such as those adapted for pre-term babies by WHO/RCPCH. Plotting birth weight against gestational age helps to determine whether the infant is appropriate, small, or large for gestational age. It is acceptable to correct for gestational age until approximately 2 years of age or sooner, if catch up growth is achieved. The comparison with weight, length, and head circumference measurements provides information as to whether the anthropometric parameters are proportionate or disproportionate (Aggett *et al*, 2006). At the time of hospital discharge, growth may be appropriate or may be indicative of growth restrictions. Intrauterine growth restrictions may still be evident, or early post-natal catch-up growth may be occurring or have occurred. The overall pattern of growth will depend on each individual infant, as well as being influenced by the feeding policy within the maternity/neonatal unit (Aggett *et al*, 2006).

Human breast milk should be used as standard practice for pre-term infants and should be fortified where necessary in order to meet requirements (ESPGHAN, 2010). Breast milk feeding may reduce the incidence of necrotizing enterocolitis (NEC) in pre-term infants, and for this reason mothers are strongly encouraged to provide breast milk for their infant, especially whilst feeds are being established. If a mother's own breast milk is not available, pasteurised donor human milk is sometimes considered; however, this practice is not routine. In the event that a mother is unable to or does not wish to breastfeed, or if there is no access to donor breast milk, infant formula milk which has been specifically designed for use in the pre-term infant should be used (ESPGHAN, 2010).

As nutrition for the pre-term infant has a significant impact on short and long-term developmental outcomes, all pre-term infants should receive nutritional input and have access to a dietitian specialising in neonatal care. The significant benefit of including a neonatal dietitian within the team has been documented, and shown to result in improved nutrient intake and growth, with reduced length of hospital stay and related costs (Kuzma-O'Reilly *et al*, 2003), and increased intensity of important aspects of nutritional care that may improve outcomes (Olsen *et al*, 2005). Guidelines for the dietetic input required for optimal care of the pre-term infant have been developed. These guidelines, developed by the Neonatal Taskforce, advise that all neonatal units should have access to dietetic support and advocate 0.05-0.1 whole time equivalents (wte) for each intensive care cot, 0.025-0.05 wte per high dependency cot. A further 0.017-0.033 wte is advised for each special care cot available in the neonatal unit (NHS & Department of Health UK, 2009).

In making feeding decisions for pre-term infants post discharge, consideration should be given to achieving catch-up growth if required, as well as reducing long-term growth deficits and risk of potential adverse effects in adulthood (Aggett *et al*, 2006).

For the pre-term infant, complementary foods should be introduced from 5 to 8 months after the actual birth date (British Dietetic Association, 2010). The weaning process should follow the same course as for the term infant, and the progression through this process tailored to the unique physiological and developmental needs of the infant (see Chapter 5 on weaning for further information).

As with all other infants, pre-term infants should be given a vitamin D only supplement providing 5µg (200I.U) of vitamin D_3 daily throughout the first year of life.

9.2 Inborn Errors of Metabolism

The National New-born Screening Programme in Ireland was established in 1966, and is based in the Children's University Hospital, Temple Street, Dublin 1 (see www.nnsp.ie). All infants born in the Republic of Ireland are offered a 'heel prick' test between 72 and 120 hours after birth. Although the programme was initially set up to screen for phenylketonuria (PKU), the programme currently screens for five disorders; phenylketonuria (PKU); classical galactosaemia; maple syrup urine disease (MSUD); homocystinuria (HCU); congenital hypothyroidism (CHT); and cystic fibrosis (CF). In-born errors of metabolism usually require specific infant feeding regimes. Infants suffering from inborn errors of metabolism such as galactosaemia or phenylketonuria should be under the care of the metabolic unit, which includes access to dietetic support. All health-care professionals should encourage parents to attend the metabolic unit with their infant.

9.2.1 Nutritional management of galactosaemia

Due to the high prevalence of galactosaemia, all new-born infants from the travelling community should be given a soy-based infant formula until the results of the Beutler test are known. Infants with galactosaemia should remain on soy-based infant formula for the first year of life and should be given regular fortified soy-milk from 12 months of age. Specific advice on weaning foods should be provided by a dietitian.

Galactosaemia is an autosomal, recessive genetic disorder which affects the individual's ability to metabolise galactose. This can lead to a build up of toxic levels of galactose in the blood, and can lead to brain and other organ damage. Individuals with galactosaemia must avoid galactose in the diet, as well as lactose which can be broken down into glucose and galactose in the body.

A test for galactosaemia is included in the routine new-born screening programme in Ireland. Infants diagnosed with galactosaemia should be fed with a soy-based infant formula which is free from both galactose and lactose. A lactose-free cows' milk protein based formula is not suitable for infants with galactosaemia as although free from lactose, this formula contains galactose which cannot be broken down by infants with galactosaemia. Infants for whom a diagnosis of galactosaemia has not been made should not remain on a soy-based infant formula and should receive breast milk, or an infant formula based on modified cows' milk protein (see Chapter 4 for further details).

There is a relatively high prevalence of galactosaemia within the travelling population, and due to the risks associated with galactosaemia and infant brain and organ function, all infants from the travelling community should be started on a soy-based formula from birth pending results from the Beutler screening test. It is important that the results of this screening test are returned to the family as soon as possible after the birth of the infant. If no diagnosis has been made, then the infant should start on breast milk or if the mother does not wish to breastfeed, a standard infant formula. Although the results of the Beutler test are generally returned within 24 hours to parents in the Dublin area, outside of Dublin this is often not the case. This needs to be addressed and improved to ensure that the Beutler test results are returned to families of all infants within 24 hours. For non-galactosaemic infants, breast milk remains the superior form of nutrition, and if a mother wishes to breastfeed her baby, she should be encouraged to express milk whilst awaiting the results of the test to ensure that breastfeeding can be commenced following screening, if desired.

Weaning for the infant with galactosaemia will involve the continued avoidance of lactose and galactose containing foods, and these infants should not be offered cows' milk protein containing foods. Soy yoghurts and soy cheese can be offered as part of the weaning diet, and from 1 year, the infant should receive soy milk fortified with calcium and vitamin D as the main milk drink. A soy-based infant formula should not be continued past 1 year of age.

Growth monitoring is essential for infants with galactosaemia, as failure-to-thrive is more common than the general population (see Chapter 7 for further information about growth monitoring in infancy).

Infants with galactosaemia should be under the care of the metabolic unit, based in Temple Street Children's Hospital, Dublin. Parents should be encouraged to make frequent contact with this unit in order to effectively monitor growth and the nutritional adequacy of the diet.

As with all other infants, infants with galactosaemia should be given a vitamin D only supplement providing 5µg (200 IU) of vitamin D_3 daily throughout the first year of life.

9.2.2 Nutritional management of phenylketonuria

Phenylketonuria (PKU) is a genetic in-born error of metabolism and requires specific dietary management. All infants with PKU should receive a specific phenylalanine-free infant formula. Although exclusive breastfeeding is not recommended, partial breastfeeding offers significant benefits to both the mother and infant, and should be encouraged. All infants with PKU should be under the care of the metabolic unit. They should be encouraged to comply with guidelines, make frequent contact with this unit for regular monitoring of blood levels of phenylalanine, and ensure that a diet which supports optimal growth and development is consumed.

Phenylketonuria (PKU) is an autosomal, recessive in-born error of metabolism which requires life-long dietary management. Individuals with PKU lack the ability to effectively metabolise the amino acid phenylalanine to tyrosine. If left untreated, phenylalanine levels will rise in the blood stream and negatively impacts brain development, leading to mental retardation, brain damage and seizures. Infants with PKU will require specific dietary management, and should be fed a synthetic phenylalanine-free infant formula. Although exclusive breastfeeding is not recommended for infants with PKU, some breastfeeding is beneficial and should be encouraged in addition to the synthetic infant formula. The amount of breast milk which can be given to achieve safe levels of phenylalanine in the blood will be dependent on the individual infant, and should be assessed on a case-by-case basis by a metabolic dietitian. To maintain the adequate flow of milk needed to continue with this partial breastfeeding, all mothers of infants with PKU should receive information and support on how to express and freeze breast milk (see Chapter 3 for further details).

When weaning an infant with PKU, focus should initially should be given to low-protein weaning foods such as fruit and vegetable purées (see Chapter 5 for further information). Protein exchanges for other foods should be calculated by the metabolic team of specialists within the metabolic unit. All infants with PKU should be under the care of the specialised metabolic unit in Temple Street Children's Hospital, Dublin. Individuals in the community should be encouraged to make frequent contact with this unit in order to effectively monitor blood levels of phenylalanine, and ensure that a balanced, nutritionally complete diet which supports optimal growth and development is consumed.

As with all other infants, infants with PKU should be given a vitamin D only supplement providing 5µg (200I.U) of vitamin D_3 daily throughout the first year of life.

9.3 Nutritional Management of Coeliac Disease in Infants

Coeliac disease is a chronic immune-mediated sensitivity to gluten. A gluten-free diet for life is the only effective treatment for coeliac disease. Infants may present with coeliac disease following the introduction of complementary foods containing gluten, and dietary advice in addition to careful monitoring of growth, should be carried out for infants in which a diagnosis of coeliac disease has been made. Infants with coeliac disease should continue to be breastfed, or a suitable infant formula should be given. A vitamin D only supplement providing 5µg vitamin D_3 should be given daily throughout the first year of life.

Coeliac disease is a gluten sensitive, immune mediated chronic condition defined as a permanent sensitivity to wheat and related proteins found in barley and rye (Hill *et al*, 2005). Coeliac disease represents a unique autoimmune disease in that the environmental factor triggering the immune response (gluten) is known. Human leukocyte antigen (HLA) status appears to be the strongest genetic determinant of risk for coeliac autoimmunity because of the role that specific HLA class II alleles play in the presentation of gluten to T cells. Of the affected individuals, 95% have DQ2 (*HLA-DQA1*05-DQB1*02*), in comparison with the general population in which about 30-35% have either DQ2 or DQ8 (Bevan *et al*, 1999; Högberg *et al*, 2003).

IgA anti-tTG is the currently recommended screening test. EMA is also used if the former is not available (Leffler *et al*, 2010). Small bowel biopsy remains the confirmatory corner-stone test for coeliac disease (BSPGHAN, 2006). Coeliac disease affects as much as 0.5% to 1% of European or European ancestry population but most cases remain undiagnosed (Fasano *et al*, 2008). Siblings of affected children should also be screened.

Many studies indicate that children with coeliac disease frequently have gastrointestinal symptoms such as diarrhoea with failure-to-thrive, abdominal pain, vomiting, constipation, abdominal distension, or iron deficiency anaemia which is unresponsive to treatment (Hill *et al*, 2005). It is recommended that coeliac disease be an early consideration in the differential diagnosis of children with failure-to-thrive and persistent diarrhoea, as well as in those children with persisting gastrointestinal symptoms including abdominal pain, constipation and vomiting. Coeliac disease can also co-exist with other conditions such as type 1 diabetes.

A gluten-free diet for life remains the only scientifically proven treatment available for symptomatic individuals with coeliac disease. It has been shown that treatment with gluten-free diet reverses the poor bone mineralisation in children with coeliac disease and that gastrointestinal symptoms and poor growth are improved when following gluten free diet. Regulation 41/2009/EC of the European Commission states that the label 'gluten free' is permitted only on foodstuffs that contain 20mg gluten/kg. Other foodstuffs which consist of or contain one or more ingredients made from wheat, rye, barley, oats or their crossbred varieties which have been specially processed to reduce gluten, shall not contain a level of gluten exceeding 100mg/kg and shall bear the term 'very low gluten' (FSAI, 2010).

To be effective, implementation of the gluten-free diet has to take local dietary habits into account by using gluten-free products which fit into the family and cultural lifestyle. Wheat, rye and barley are the predominant grains containing the peptides known to cause problems in coeliac disease. Triticale (a combination of wheat and rye), kamut, and spelt (sometimes called faro) are also harmful. Other forms of wheat are semolina (Durum wheat), farina, einkorn, bulgar and couscous. Concern remains regarding oats as contamination of oats with gluten during the harvesting and milling process is known to occur and purity can often not be guaranteed. The Coeliac Society can provide information on sources of pure oats.

For an infant with coeliac disease, gluten-free complementary foods are required. Gluten-free baby rice, vegetable, potato and fruit purées are suitable for first foods, as are meat, fish and chicken purées and dairy products. Nutritious weaning foods including those rich in iron and calcium are important. Gluten-free commercially prepared baby foods can also be used. Gluten-free breads, rice and pastas may be introduced at a later stage of weaning. Information, support services and advice should be given to parents. It is recommended that children with coeliac disease be monitored with periodic visits for assessment of symptoms, growth, physical examination, and adherence to a gluten free diet (Hill *et al*, 2005). The diet requires ongoing collaboration between patients, health-care professionals and dietitians, and the recommendations require periodic review and modification in light of new scientific evidence.

Primary prevention is important and infant feeding practices, which are associated with a lower risk of coeliac disease such as prolonged breastfeeding, and the slow and small and not too early or late introduction of gluten should be promoted (see Chapter 5 for further details). For further information and support, all patients and their families should join the Coeliac Society of Ireland (www.coeliac.ie). This ensures that the most up-to-date information is being followed. Healthcare professionals who care for individuals with coeliac disease may also join the Coeliac Society in order to have the most up-to-date information.

9.4 Nutritional Management of Cystic Fibrosis in Infancy

Cystic fibrosis is a common genetic disorder which can significantly affect growth and nutritional status, if not managed well. Infants with cystic fibrosis may require more intensive nutritional input; requiring a protein and energy dense diet, in addition to supplementation with essential vitamins and minerals. Infants with cystic fibrosis should have their growth and development carefully monitored, and early intervention is required if problems are identified.

Cystic Fibrosis (CF) is an inherited condition, affecting mainly the lungs and digestion of foods. Children with CF can suffer from recurrent pulmonary infections and symptoms of malabsorption. Increased energy expenditure coupled with increased loss of nutrients may result in faltering growth. Intensive continuous medical and nutritional intervention is required from an early age. 'Towards a Better Service', otherwise known as the Pollock report, (Cystic Fibrosis Association of Ireland, 2005) advocated for the inclusion of cystic fibrosis within the routine newborn screening programme, and this is due to commence towards the end of 2011. By screening for CF in newborns, treatments can start before symptoms occur, which can enhance nutrition and minimise or delay pulmonary complications. Until recently, CF was considered a disorder of childhood; however, life expectancy is increasing, and improved survival rates have meant a considerable increase in the number of adult patients with cystic fibrosis in Ireland.

Following diagnosis of CF, goals are to maintain normal growth and development as improved nutritional status is associated with better pulmonary outcomes (Konstan *et al*, 2003). Specialised therapies, including pancreatic enzymes to aid digestion and a high-energy high-protein diet are introduced.

Due to pancreatic insufficiency, fat malabsorption may occur which can negatively impact the energy obtained from the diet, as well as the intakes of many important fat soluble vitamins and minerals. Pancreatic enzyme replacement therapy (PERT) should be commenced if fat malabsorption is evident, or in the event of laboratory evidence of pancreatic insufficiency (Borrowitz *et al*, 2009). PERT reduces fat malabsorption in infants (Durie *et al*, 1980; McClean *et al*, 1993) and should be given with both human breast milk and infant formula milk (Borrowitz *et al*, 2009), as well as with complementary foods. The amount of PERT required will change in line with the size of the infant and the amount of milk or foods consumed.

Special attention to growth and nutrition during the first year of life is essential. It has been recommend that children reach a weight-for-length status of at least the 50th percentile by two years of age (Stallings *et al*, 2008), BMI should be calculated frequently during childhood and plotted on appropriate BMI percentile charts in paediatrics. There is a strong association with BMI/BMI percentile and lung function, which is specific to patients with CF (Pedreira, *et al*, 2005; Kastner-Cole, *et al* 2005; CF Foundation Patient Registry, 2011).

Serial height, weight and where indicated, head circumference, measurements should be taken and plotted on appropriate growth charts. Care should be taken to plot growth accurately, as small inaccuracies may lead to a slower identification of growth faltering. All equipment should be calibrated regularly, and staff training is essential (see Chapter 7 for further information on growth assessment). More frequent weighing may be required for infants with cystic fibrosis than for the healthy infant, and early interventions are important to reduce the risk of weight faltering, particularly if the infant is unwell.

Breast milk is the optimal form of nutrition for infants with CF (Borrowitz *et al*, 2002; Sinnaasppel *et al*, 2002). As infants with CF may consume greater volumes of milk, extra support may be required for the breastfeeding mother to enable her to breastfeed for as long as possible. For those infants who are not breastfed, a standard infant formula should be used. There is currently insufficient evidence to recommend the use of a hydrolysed protein formula (Borowitz *et al*, 2009). As with other infants, infants with CF should be supervised at all times when feeding, and fed on demand.

For infants who are growing well, no additional intervention is required other than careful monitoring of intake, feeding patterns and growth, and the same basic principles apply to infants with cystic fibrosis as to all other healthy infants. For those infants who are not achieving optimal energy intakes and growth, dietary intervention may be required. Calorie and protein supplementation may be required along-side human breast milk or if the infant is not being breastfed, high-calorie infant formulae can be used.

Energy dense complementary foods can be used from an appropriate age. The types and texture of foods should be appropriate to the age of the infant and their developmental readiness (see Chapter 5 for further details). The same recommendations regarding the introduction of gluten, cows' milk and honey should be followed, as for all infants. As infants with cystic fibrosis are often accustomed to sweet tastes (fruit purées from a spoon to aid with consumption of PERT) from a young age, care should be taken to offer many other savoury flavours, and encourage a wide variety of foods as weaning progresses.

Supplementation of fat soluble vitamins is recommended and the level of supplementation should be altered to achieve normal plasma levels (Cystic Fibrosis Trust, 2002).

For further information and support please contact the Cystic Fibrosis Association of Ireland (www.cfireland.ie).

9.5 Nutritional Issues for an Infant with Down Syndrome

Down syndrome is characterised by delayed psychomotor development, and infants and children with Down Syndrome may experience problems with feeding, as well as a delayed progression to solid foods. A multidisciplinary team with specialised knowledge should be involved in the care and assessment of an infant with Down syndrome. Practical support and education should be provided to all parents, so that infants with Down syndrome can reach feeding milestones at, or close to the time-frame recommended for other infants. As with all infants, breastfeeding with the use of specialised equipment, if necessary, should be encouraged, and a vitamin D only supplement providing 5µg vitamin D_3 supplement given daily for the first year of life.

Down Syndrome is characterised by delayed psychomotor development. Infants and children with Down Syndrome also have an increased risk of concomitant disorders such as congenital heart, gastrointestinal defects, coeliac disease and hypothyroidism (Roizen & Patterson, 2003). Neuromotor coordination associated with Down Syndrome includes hypotonia, poor tongue control, and open mouth posture. These frequently interfere with the development of effective oral-motor skills. It has been suggested that feeding difficulties in Down Syndrome are associated with low muscle tone, which affects strength, mobility and range of motion of the oral muscles. This can result in weak suckling, swallowing, lip closure, and tongue protrusion and gastroesopagheal reflux (Lewis & Kritzinger, 2004). Exhaustion driven by low muscle tone

and heart defects was reported by the vast majority of parents to significantly affect feeding ability, and time taken to feed. The combination of reduced oral space and limited control will also contribute to feeding problems in these infants (Lewis & Kritzinger, 2004), as does narrowed nasal passages and increased respiratory efforts. Finally, the risk for intrauterine growth retardation resulting in low birth weight in infant with Down Syndrome can result in early feeding problems (Lewis & Kritzinger, 2004).

The complexity of feeding difficulties in infants with Down Syndrome should be addressed from birth onwards by a multidisciplinary team with specialist knowledge, skills and sensitivity. The multi-disciplinary team should consist of medical professionals and speech and language therapists, dietitians, as well as peer support groups. The early assessment team should include an occupational therapist who can advise on oral sensitivity issues, specialised utensils and positioning. The feeding regime should be safe, must support optimal growth, must also be realistic, and should aim to progress the child through the normal stages of weaning, at a pace in line with the child's abilities. As with all infants, all aspects of infant feeding should be driven by the individual needs and experiences of the infant. Parents need to be provided with information and support during this time, and the infant needs to be carefully monitored to ensure no weight loss or growth delay occurs. Specifically designed growth charts for use with infants with Down Syndrome are available and should be used (Child Growth Foundation, 2000).

Breastfeeding within the context of Down Syndrome is important as breastfeeding has been shown to increase attachment between mother and baby and optimal attachment can decrease maternal stress associated with the diagnosis of Down Syndrome in an infant. However, a lower prevalence of breastfeeding has been reported amongst mothers of infants with Down Syndrome (Weijerman *et al*, 2008; Pisacane *et al*, 2003).

Infants may experience problems with the transition from breast/bottle feeding to cup feeding, and from liquids to solids resulting from an inadequate lip closure, poor chewing ability, and choking. The presence of Down Syndrome did not affect breastfeeding in a cohort of Dutch infants (n=44) with Down Syndrome compared with controls (n=37); however, it did appear to delay the introduction of complementary foods which may affect and impair oro-motor development (Hopman *et al*, 1998). However, it is important to note that this delay was associated with parents' low expectations of their infants' development ability. With support from healthcare professionals, infants with Down Syndrome can attain feeding milestones at, or close to that recommended for other infants, e.g. the early stages of weaning, i.e. pureed foods, should not be unnecessarily prolonged for infants with Down Syndrome, and efforts should be made to help the infant with Down Syndrome progress through the normal stages of weaning onto solid foods, albeit in line with their abilities. Support must be provided to parents, and a feeding assessment should form part of the overall assessment of the infant with Down Syndrome.

As with all other infants, infants with Down Syndrome should be given a vitamin D only supplement providing 5µg (200I.U) of vitamin D_3 daily throughout the first year of life.

The benefits of a family-focused approach cannot be underestimated, and effort to increase care-giver involvement in the early intervention process benefits everybody both in the long and short term. For further information and support please contact Down Syndrome Ireland (www.downsyndrome.ie).

9.6 Nutritional Aspects of Cleft Lip or Cleft Palate Management in Infancy

Cleft lip and palate are correctable birth defects which occur in the early weeks of pregnancy. Feeding problems may arise, and can have a negative impact on growth and development. All infants with cleft lip or palate should have their growth carefully monitored, and parents should be provided with information and support regarding feeding methods to help optimise nutritional intake.

Cleft lip and cleft palate are correctable birth defects affecting 1 in 700 infants (Glenny *et al*, 2004). Cleft lip is a separation of the upper lip. Cleft palate is an opening in the roof of the mouth resulting from incomplete development of lip and/or palate in the early weeks of pregnancy. The cause of this failure to close remains uncertain.

The presence of cleft lip or cleft palate raises several nutritional issues concerning feeding. Although feeding difficulties do not automatically arise, often the infant finds it difficult to gain and maintain suction in the mouth (Mizuno *et al*, 2002), and specialised feeders such as a Haberman feeder or a squeezable bottle under the direction of a speech and language therapist may be beneficial.

A Haberman feeder is a standard bottle with soft variable flow test and a pump action valve requiring no active suction. Information on the correct use of these specialised feeding devices can be provided by cleft coordinator and the Cleft Lip and Palate Association (The Cleft Lip and Palate Association, 2004). A squeeze bottle may also be used to feed and may be more appropriate than a standard infant bottle. Specialist advice from a health professional with expertise in feeding infants with a cleft lip or palate, e.g. speech and language therapist should be consulted before deciding to use a squeezy bottle.

In a prospective, longitudinal study of infants with cleft lip or palate (*n*=62) followed from birth, 32% were determined to be poor feeders, slow to establish feeding, took longer to feed, and displayed poor weight gain at 2 weeks. By 3 months, 18.5% were categorised as poor feeders and by 14 months, this was reduced to 15%. At 14 months, those infants who were poor feeders were bottle fed, had not progressed to the age appropriate stage of weaning; were fed puréed solids and were drinking from a bottle or spout cup (Reid *et al*, 2006). Abnormal oral motor function was observed in 31% of neonates and 15% of toddlers aged 14 months, and this was characterised by inability to sustain a suckle pattern beyond two minutes. Nasal regurgitation was also observed in a sub-set of poor feeders, wet or gurgly phonation, coughing, choking, and gagging (Reid *et al*, 2006).

As feeding difficulties can arise, there is evidence that a delay in growth may be of concern, and so growth should be closely monitored in these infants (see Chapter 7 for further information on growth monitoring), and intervention introduced early if required. Growth impairments in weight and length have been identified in some (Jensen *et al*, 1988; Jones, 1988; Cunningham and Jerome, 1997; Lee *et al*, 1997; Lazarus *et al*, 1999; Gopinath & Muda, 2005), but not all studies. A recent study in France failed to observe impairments in growth during the first two years of life, although the sample size of 34 was small (Mcheik *et al*, 2010). In a retrospective analysis of data from birth to 5 years (*n*=307), predicted weight and length percentiles for age had initially decreased during the first year of life with nadirs at 5.2 and 15 months respectively. Recovery was observed from 12 months and appeared to be related to successful education and feeding interventions (Zarate *et al*, 2010).

Reasons suggested for the delayed growth include feeding difficulties, under-nourishment, infections in the upper airways, and surgical interventions (Jensen *et al*, 1988).

In a Cochrane review including four randomised control trials (RCTs) of infants with cleft lip or cleft palate (*n*=232), it was identified that although no feeding method had a significant impact on growth, squeezable bottles appeared easier to use than rigid bottles (Glenny *et al*, 2004). Breastfeeding may be difficult; however, mothers should be encouraged to breastfeed with expressed breast milk if necessary, as breast milk is the superior form of nutrition for infants with cleft lip or palate.

The birth of an infant with cleft lip and palate (CLP) can be an emotionally traumatic time which generates anxiety for many parents. When a newborn is found to have cleft lip and/or palate, most parents initially experience shock, denial, sadness, anger and anxiety before they are able to form a bond with their babies (Drotar *et al*, 1975). Every effort should be made to support parents in this situation and provide clear and evidence based information. The felt needs of parents of infants with CLP from birth to 3 months has been examined recently and it was observed that information on feeding was the most prevalent felt need amongst parents, followed closely by information on surgery, financial and speech problems during the first week after the birth. At one month following birth, the need for information about surgery was key for parents, and this remained the most prominent concern for the 3 months following birth, although the need for information on feeding, speech and finances still remained (Chuacharoen *et al*, 2008).

Information about how to best feed an infant with cleft lip or palate, how to choose supplementary foods, how to feed after surgery, and the effect of wound healing on feeding should be provided to all parents. Support should be given to organisations which provide support and guidance for parents of infants with cleft lip or palate. In line with the guidelines for all other infants, infants with cleft lip or palate should be fed on demand and not according to a schedule, and should be given a vitamin D only supplement providing 5µg vitamin D_3 daily throughout the first year of life. Age appropriate nutritionally dense complementary foods should be introduced between 4 to 6 months, with the exact timing of introduction dependant on the unique requirements of the individual infant (see Chapter 5 for further details). As dental care and good dental health are vital for success of later dental specialist work, parents should be encouraged to follow good dental care practices (see Chapter 6 for further details). For further information and support, please contact The Cleft Lip and Palate Association of Ireland (www.cleft.ie).

9.7 Cerebral Palsy

Cerebral palsy is thought of as a group of disorders involving the brain and nervous system functions. Individuals with cerebral palsy often have difficulty with movement, learning, hearing, seeing and thinking. Feeding difficulties and malnutrition are common and can have a negative impact on growth and development. It is vital that infants and children with cerebral palsy are connected with a multidisciplinary early intervention team and should receive tailored nutritional input and support early in the first year of life from a dietitian specialising in the care of infants and children with disabilities.

Cerebral palsy is a group of permanent disorders that involve brain and nervous system functions such as movement, learning, hearing, seeing and thinking. Damage to the structure of the brain is static and permanent. However, the consequent symptoms are variable and may change over time (Rosenbaum *et al*, 2009). In addition to disordered movement or posture, children with cerebral palsy may have a range of associated disabilities including: intellectual disability, hearing and visual deficits, feeding and swallowing problems, which will affect nutritional intake (Bell *et al*, 2010).

Poor growth and malnutrition can be thought of as important secondary health conditions which impact the global health and well-being of infants and children with cerebral palsy and their families (Kuperminc & Stevenson, 2008). Abnormalities in growth and body composition, once thought to be intrinsic to cerebral palsy, result from a variety of causes, some of which might be altered to improve growth. Malnutrition, endocrine dysfunction and a variety of other factors such as mechanical forces and neurological differences contribute to this poor growth (Kuperminc & Stevenson, 2008). These factors appear to act synergistically to affect growth in every dimension including diminished linear growth and weight gain, and abnormal body composition (Kuperminc & Stevenson, 2008).

Malnutrition in children with cerebral palsy is often caused by poor oral-motor function which impairs the child's ability to safely consume calories and nutrients necessary to support growth (Fung *et al*, 2002; Sullivan *et al*, 2002; Sullivan *et al*, 2000). Feeding can be slow and onerous on the parent or caregiver. Excessive loss of food, drooling, spitting, coughing, choking and vomiting make mealtimes a stressful time for both the infant and their parents. Both infants and their parents would benefit from individual nutritional assessment and support as an integral part of their care.

Challenges in growth surveillance in children with Cerebral Palsy arise for two main reasons. First, it is difficult to obtain reliable measurements of growth, particularly linear growth or stature. Second, the generally accepted reference standards may not be appropriate, such that interpretation of growth data is difficult. Children with Cerebral Palsy may need measures of body composition in order to assess nutritional status (Kuperminc & Stevenson, 2008). It is vital that infants and children with cerebral palsy are connected to an early intervention team. This should include ready access to a dietitian as early as possible during the first year of life to improve nutritional outcomes. For further information and support, please contact Enable Ireland (www.enableireland.ie).

9.8 Obesity in Infancy

Levels of overweight and obesity in both adults and children in Ireland are rising. Excessive weight gain in infancy is thought to increase the risk becoming obese or overweight in adult life. Although breastfeeding has been shown to decrease the risk of obesity in later years, breastfeeding initiation and duration rates are suboptimal in Ireland and this need to be rectified to stem this worrying public health trend. Awareness of this risk among healthcare professionals is essential, and growth monitoring during infancy alongside prompt practical interventions in the event of a problem are important. An increased focus on the first year of life to identify programmes and interventions which reduce the risk of obesity in later life is warranted.

Over the past 2 decades it has become clear that early life growth patterns and behaviours play an important role in the aetiology of obesity (Paul *et al*, 2009). Many overweight children grow up to become overweight or obese adults, and this is likely to increase the risk and prevalence of many serious long-term health consequences such as diabetes and cardiovascular disease. Risk factors such as hyperinsulinaemia, impaired glucose tolerance and hypertension have been identified in children as young as 5 years of age (Young-Hyman *et al*, 2001). The upward crossing of weight centiles between the ages of 0 and 5 years is recognised as a risk factor for later overweight and obesity. Numerous studies have indicated that overweight infants or toddlers are at a greater risk of staying overweight as they age, and it has been hypothesised that overweight or obesity at this stage 'programmes' components of the metabolic and energy storage systems (Paul *et al*, 2009). The prenatal period, infancy and early childhood may be stages of particular vulnerability to obesity development because they are unique periods for cellular differentiation and development. This unique vulnerability might make it possible for actions taken at these stages to determine the future course of adiposity, highlighting the need for targeted focus on primary prevention of obesity in infancy by the medical, behavioural health and public health communities (Paul *et al*, 2009).

Childhood obesity is emerging as a major public health problem in developed and developing countries, and research in Ireland has shown that the prevalence of overweight and obesity in school children has risen since 1990 (Griffin *et al*, 2004). Data from the North/South survey of children's height, weight and body mass index conducted in Ireland in 2001 and 2002 demonstrated that at the time of data collection almost one in four boys and over 1 in 4 girls between the ages of 4 and 16 years were either overweight or obese in both Northern Ireland and the Republic of Ireland (Whelton *et al*, 2007). More recent data collected from Irish school children in 2007 and 2008 as part of the World Health Organization's European Childhood Obesity Surveillance Initiative indicated that 28.8% of children aged 7 years in Ireland were overweight or obese.

Although evidence is accumulating that early infancy may be a critical period for the development of obesity, programmes which target this time period are few (Flynn *et al*, 2006). It is important that this is addressed in order to interrupt the vicious cycle of obese children becoming obese adults who subsequently may have offspring who themselves are obese (Paul *et al*, 2009). Evidence suggests that breastfeeding offers modest protection against obesity in later life when compared with formula feeding, with both exclusivity and duration strengthening this association (Owen *et al*, 2005; Arenz *et al*, 2004; Gilman *et al*, 2001). This may be due to self-regulation of food intake by breastfed infants (Dewey *et al*, 1991) in contrast to the more parent-driven food intake of formula fed infants. Compared with nursing infants, bottle-fed infants are fed on a more regular schedule and the volume of feeds is very consistent, suggesting that parents are driving intakes. The protein content of formula milk may also contribute to the greater weight gain, particularly in the second half of life, in formula fed infants compared with breastfed infants (Ong *et al*, 2009; Koletzko *et al*, 2009).

For families choosing to bottle feed, parents should be given specific education aimed at reducing problematic bottle-feeding behaviours, e.g. parents should be encouraged to feed their infants when they are hungry, rather than on a set schedule outside of the immediate newborn period. This applies to healthy well babies and not to babies with specific medical conditions who may have been advised differently. Parents should be instructed to be responsive to cues for satiety, rather than ensuring their infant finishes the bottle contents. Alternatively, encouraging parents to discern whether an infant is hungry or needing alternative soothing may reduce overfeeding of the bottle-fed infant (Paul *et al*, 2009). Parental perceptions of weight gain and eating habits are important to consider as many maintain that 'a chubby baby is a healthy baby' despite evidence to the contrary (Paul *et al*, 2009). The association of food with love in some cultures may also contribute to higher infant weight (Bruss *et al*, 2003). As the family may be crucial to the success or failure of any health promotional activity, it is therefore important that the family are provided with sufficient information from the ante-natal period to ensure the success of these programmes.

Given the childhood obesity epidemic and the evidence that early upward crossing of major percentile lines on the growth curve is associated with later obesity, clinicians must pay close attention to patterns of growth during childhood and the way in which parents interpret infant growth (Paul *et al*, 2009). Centralised growth monitoring data should be used to monitor growth and predictors of overweight and obesity within the Irish population, in order to more effectively design and test intervention programmes in Ireland. For physicians who monitor growth of infants, practice guidelines should emphasise the expected, natural, and health-promoting aspects of 'slower' growth in breastfed infants during the second 6 months after birth and beyond. Plotting on the appropriate chart and parental reassurance and education are important aspects of this (Paul *et al*, 2009). See Chapter 7 for further details about growth monitoring during infancy.

Other interventions include:

- Avoid placing cereal in a bottle, complementary foods should only be given on a spoon. Additions of solids to a bottle can increase the risk of overweight and does not help an infant to sleep through the night despite this common belief
- Delay introduction of complementary foods until the infant is close to 6 months of age (infants should not be introduced to complementary foods before 4 months (17 weeks) of age
- Avoid giving juices to infants under 6 months of age. If parents choose to give juices they should be actively encouraged not to do so until the baby is at least 6 months, and use unsweetened juices ensuring that the juice is well diluted, e.g. 1 measure of juice to at least 8 to 10 measures of cooled boiled water. Parents should be advised not to give more than 1 small cup (measuring 120mls to 180mls (4oz to 6oz)) of diluted fruit juice per day and limit it to one mealtime only, also not to give juice between meals and not to give juice from a bottle
- Use non-food items as rewards later in infancy
- Use repeated exposure to healthy foods as a response to normal infant neophobia
- Emphasise healthy dietary choices that have a high nutritional value such as fresh fruits, cooked vegetables, cheese, yoghurt, wholegrain breads and crackers and cereals. Small portions of fibre-rich foods such as fruits, vegetables, wholegrain breads, crackers and cereals should be offered as large amounts of these may create bulk in the diet and negatively affect the energy density of the diet, as well as interfering with the absorption of important minerals such as iron
- Avoid 'added sugar' foods and high-sugar, high-fat, high-salt snacks or confectionary foods
- Avoid television watching for children under 2 years of age and keep televisions out of bedrooms

9.9 Prader-Willi Syndrome

Prader-Willi Syndrome is a genetically determined neurodevelopmental disorder. An initial disinterest in food is seen commonly in infants with Prader-Willi syndrome, although this changes to a propensity to overeat leading to severe obesity in later years. A multidisciplinary approach to the treatment of infants with Prader-Willi Syndrome is essential.

Prader-Willi syndrome is a disorder of chromosome 15 with a prevalence of 1:12,000-15,000 (both sexes, all ages). Common characteristics include feeding problems and poor weight gain in infancy followed by excessive or rapid weight gain between 1 and 6 years of age, with central obesity common in the absence of intervention. Global developmental delay is seen before age 6 with mild to moderate mental retardation or learning problems evident in older children. Hyperphagia and a failure of the normal satiety response to food intake, food foraging, obsessions with food are also characteristic of this condition (Holm *et al*, 1993), and result in overweight and obesity. Hypothalamic dysfunction is thought to be the cause of the disordered appetite and this, coupled with decreased calorie utilisation as a result of low muscle mass and inactivity, results in a chronic risk of obesity and excessive weight gain.

During the first year of life, hypotonia may create feeding problems, poor oral-motor skills, and delayed speech, and so a speech and language assessment is important. Feeding assessment and growth monitoring throughout the first year of life are important also to ensure adequate growth during this period.

In later years, periodic weigh-ins as well as dietetic review and support are essential for the management of this condition. Control of food access, in addition to a balanced low kcal diet is recommended alongside adequate calcium and vitamin D intakes, as osteoporosis may be problematic. Encouraging a suitable meal and snack plan, which can be routinely and consistently offered by parents or carers, is ideal.

Summary

- Certain chronic conditions can arise during infancy in which nutrition plays an important role. Specialised medical and nutritional input is required to ensure that growth and development continues as normal, and that the short or long-term health risks associated with these conditions are minimised.
- Effective growth monitoring is important, as if feeding is in any way compromised as growth can be affected more quickly than in healthy infants. Quick action and contact with the specialised unit is essential.
- **Although infants with these chronic conditions should be under the care of a specialised team, it is important that awareness is present in the community and that important checks can be carried out if the infant presents for care for a potentially unrelated issue.**
- **Caregiver support and reassurance is vital, as is encouraging them to maintain good contact with the specialised unit, particularly as the infant ages.**
- **Support services for these conditions in the community play an important role in the quality of life of parents and infants alike and should be promoted.**

CHAPTER 10. CHILDREN AGED 1 YEAR AND OVER

The transition from the exclusive milk diet of infancy to a modified adult diet is completed by 3 years of age. During this period, children have already begun to acquire food preferences and aversions which may greatly influence food choices in later years. As infants grow, their nutritional requirements rise and it is vital that the diet provides sufficient energy and other essential nutrients such as iron to support this.

From 12 months of age, infants are gaining more control over their eating habits, and as motor skills continue to develop, so too does the ability to self-feed. During this time, parents and carers should help establish a healthy feeding relationship by recognising hunger and satiety cues, and allowing infants and children to self-regulate their food intake by not forcing them to eat, or finish meals or snacks if they indicate they have consumed enough.

Taste preferences, which are developing at this time, can greatly influence food patterns in later years, and parents have a key role in facilitating healthy choices by providing a variety of foods for their toddler which will help meet their nutrient goals. Introduction of a variety of flavours in the first 2 years of life may lead to acceptance of a wider variety of flavours in later childhood, and may increase the likelihood of children trying new foods. Food acceptance is an important issue and parents should be made aware that repeated exposures to a particular food is usually recommended before it is accepted by an infant or toddler, with studies showing that up to 10 to 15 exposures may be required before a specific food is accepted.

Foods given from 12 months of age should be centred on the family's usual diet and routine, and this highlights the need for widespread promotion of healthy eating guidelines among the population. Key nutrients needed at this stage include energy and protein which are essential for continued growth. Foods which provide these nutrients should be offered whilst taking care not to exceed energy requirements leading to excessive weight gain. Due to its role in growth and development, iron may need special attention at this stage and iron rich foods should be included often in the infant's diet. Very high fat, high salt or sugary foods should be avoided as these are not suitable for infants and may promote unhealthy food patterns in later years.

From 12 months onwards, infants can move to whole cows' milk as the main milk drink. Fluids from this age onwards should be taken from a non-lidded cup and use of bottles at this stage should be avoided as this will keep infants in the 'baby stage' and prevent them from learning the new skills associated with self-feeding from a cup. Prolonged use of bottles has also been linked with an increased risk of developing dental caries.

It is the responsibility of the parents and carers to provide nutritious foods for their infants. Parents should realise that infants are heavily influenced by their parents' behaviour and that parents set an example for their infants and children in terms of diet and lifestyle choice. All healthcare professionals involved in caring for infants and children should keep up-to-date with best practice in infant feeding so they can guide parents to make the best choices for their own, as well as their infants' diets. A further review around best practice feeding for those infants and young children from 12 months of age onwards is warranted. This review should be used to inform the development of specific and practical guidance materials for parents' and healthcare professionals.

APPENDIX A. PRESCRIBING TO BREASTFEEDING MOTHERS (HSE, 2008)

Studies suggest that 90 to 99% of new mothers receive medications in the first week postpartum. Use of medications is one of the major reasons why women stop breastfeeding prematurely. One of the most common questions encountered by doctors and pharmacists concerns the use of medications while breastfeeding.

Breastfeeding

This information is for GPs and pharmacists: Drugs that are contraindicated in breastfeeding are:
(This is not an exhaustive list)

- Amiodarone
- Antineoplastic agents
- Chloramphenicol
- Ciprofloxacin
- Doxepin
- Ergotamine
- Gold salts
- Iodides
- Indomethacin
- Lithium
- Oestrogens (will decrease milk supply)
- Pethidine (multiple doses)
- Radioactive isotopes
- Vitamin D (high dose)

Resources you can Use when Prescribing

- http://www.neonatal.ttuhsc.edu.lact/
- http://www.nmic.ie
- Medications and Mother's Milk. 12th Edition Thomas W. Hale. Ph.D. Amarillo, TX: Pharmasoft Publishing, 2006 (This comprehensive reference book provides information on more than 814 drugs to help you make an educated decision about the appropriateness of a drug for an individual mother and baby)
- Clinical Therapy in Breastfeeding Patients. Thomas W. Hale. Ph.D. Pamela Berens. M.D. Pharmasoft Publishing, 2002
- Breastfeeding and Human Lactation. Jan Riordan. Kathleen G. Auerbach. 2nd Edition, 1999

Additional Reference Material

1. Drugs in Lactation. National Medicines Information Centre, Vol 8 No.4. 2002
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3. Hale TW, Berens P. Clinical therapy in breastfeeding patients. Amarillo, TX: Pharmasoft Publishing, 2002 Prescribing for breastfeeding mothers

For more information, see www.breastfeeding.ie

APPENDIX B. CAFFEINE CONTENT OF COMMONLY CONSUMED FOODS AND DRINKS

Food or Drink	Caffeine Content (mg)
1 cup of coffee, brewed	111mg (range 102-200mg)
1 can of Red Bull	80mg
1 cup of coffee, instant	78mg (range 27-173mg)
1 cup of tea, brewed	44mg (range 40-120mg)
1 bottle of Snapple (fruit and diet versions)	42mg
1 shot of espresso	40mg (range 30-90mg)
1 bottle of Diet Coke	39mg
1 bottle of Pepsi	32mg
1 bar of dark chocolate	31mg
1 bottle of Pepsi max	30mg
1 bottle of Coke	29mg
1 scoop of coffee flavoured ice-cream,	16mg (range 15-17mg)
1 bar of milk chocolate	11mg
1 cup of hot cocoa	8mg (range 3-13mg)
1 cup of coffee, decaffeinated	4mg (range 3-12mg)
1 bottle of caffeine free coke	0 mg
1 bottle of Fanta (all flavours)	0 mg
1 bottle of 7-up (diet and regular)	0 mg
1 bottle of Sprite (diet and regular)	0 mg

The exact amount of caffeine will vary according to cup size, brewing methods and brands of coffee or tea. 1 cup=200mls; 1 shot=30mls; 1 bar=45g; 1 scoop=60g

APPENDIX C. KEY TO EVIDENCE STATEMENTS AND GRADES OF RECOMMENDATIONS

Levels of Evidence

1++ High quality meta-analyses, systematic reviews of randomised controlled trials (RCTs), or RCTs with a very low risk of bias

1+ Well conducted meta-analyses, systematic reviews of RCTs and RCTs with a low risk of bias

1- Meta-analyses, systematic reviews of RCTs, or RCTs with a high risk of bias

2++ High quality systematic reviews of case control or cohort studies
High quality case control or cohort studies with a very low risk of confounding or bias and a high probability that the relationship is causal

2+ Well conducted case control or cohort studies with a low risk of confounding or bias and a moderate probability that the relationship is causal

2- Case control or cohort studies with a high risk of confounding or bias and a significant risk that the relationship is causal

3 Non-analytic studies, e.g. case reports, case series

4 Expert opinion

Grades of Recommendation

Note: The grade of recommendation relates to the strength of the evidence on which the recommendation is based. It does not reflect the clinical importance of the recommendation.

A At least one meta-analysis, systematic review of RCTs, or RCT rated as 1++ and directly applicable to the target population; *or*
A body of evidence consisting principally of studies rated as 1+, directly applicable to the target population, and demonstrating overall consistency of results

B A body of evidence including studies rated as 2++, directly applicable to the target population, and demonstrating overall consistency of results; *or*
Extrapolated evidence from studies rated as 1++ or 1+

C A body of evidence including studies rated as 2+, dir4ectly applicable to the target population and demonstrating overall consistency of results; *or*
Extrapolated evidence from studies rated as 2++

D Evidence level 3 or 4; *or*
Extrapolated evidence from studies rated as 2+

GLOSSARY

Allergy: A hypersensitivity reaction initiated but immunologic mechanisms (Greer *et al*, 2008)

Any Breastfeeding: Refers to all infants who received any breast milk, or a combination of breast milk and other non-human milk feeds, and/or solid foods

Atopic Disease: A clinical disease characterised by atopy; typically refers to atopic dermatitis, asthma, allergic rhinitis, and food allergy (Greer *et al*, 2008)

Atopy: A personal or familial tendency to produce immunoglobulin E (IgE) antibodies in response to low-dose allergens, confirmed by a positive skin prick test result (Greer *et al*, 2008)

Complementary Foods: Refer to all liquids, semi-solid and solid foods, other than breast milk, and infant formulae which are fed to infants during the weaning process

Exclusive Breastfeeding: Requires that the infant receives only breast milk (including expressed breast milk) and no other liquids or solids with the exception of oral rehydration salt solution, drops or syrups consisting of vitamins or mineral supplements, or medications (WHO, 2008)

Follow-on Formula: Follow-on infant formulae are foodstuffs intended for particular nutritional use by infants when appropriate complementary feeding is introduced, and constituting the principal liquid element of a progressively diversified diet of such infants (Directive 2006/141/EC). Although not strictly necessary, follow-on formulae may be used in infants over 6 months of age, and should only be used in conjunction with nutritious complementary foods. For the purposes of this report, the term 'follow-on formula' will refer to those formulae based on a modified cow's milk protein, unless otherwise specified

Food Allergy: An immunologically mediated hypersensitivity reaction to a food or ingredient, e.g. cows' milk, including IgE mediated and/or non-IgE-mediated allergic reactions (Greer *et al*, 2008)

Partial Breastfeeding: Breastfeeding in combination with formula and/or other non-human milk feeds or fluids, and/or solid foods

Predominant Breastfeeding: Requires that the infant receives breast milk (including expressed breast milk) as the predominant source of nourishment. However, the infant may also have received water and water-based drinks (sweetened and flavoured waters, teas, infusions etc), fruit juices, oral rehydration salt solutions, drops and syrup forms of vitamin and mineral supplements, medicines, and ritual fluids (in limited quantities). With the exception of fruit juice and sugar water, no food-based fluid is allowed under this definition (WHO, 2008)

Partial Breastfeeding: Breastfeeding in combination with formula and/or other non-human milk feeds or fluids, and/or solid foods

Any Breastfeeding: Refers to all infants who received any breast milk, or a combination of breast milk and other non-human milk feeds, and/or solid foods

Standard Infant Formula:
Infant formula are foodstuffs intended for particular nutritional use by infants during the first months of life and should satisfy, by themselves, the full nutritional requirements of infants until the introduction of appropriate complementary feeding (Directive 2006/141/EC). For the purposes of this report, the term 'standard infant formula' will refer to those formulae based on a modified cows' milk protein, unless otherwise specified

Follow-on Formula:
Follow-on infant formulae are foodstuffs intended for particular nutritional use by infants when appropriate complementary feeding is introduced, and constituting the principal liquid element of a progressively diversified diet of such infants (Directive 2006/141/EC). Although not strictly necessary, follow-on formulae may be used in infants over 6 months of age, and should only be used in conjunction with nutritious complementary foods. For the purposes of this report, the term 'follow-on formula' will refer to those formulae based on a modified cows' milk protein, unless otherwise specified.

Unmodified Cows' Milk:
The term 'whole cows' milk' refers to pasteurised, full-fat cows' milk. Whole cows' milk should not be given as the main milk drink until the infant is over 12 months of age, however, small amounts can be used when preparing complementary foods. Unpasteurised cows' milk is not suitable for infants and should never be given.

Weaning: Refers to the time period of gradual reduction in the frequency and volume of breastfeeding (or infant formula feeding), which starts with the first introduction of complementary foods. The progression through the weaning process should result in a dietary pattern which is customary in the infant's family during the second year of life (EFSA, 2009)

Complementary Foods: Refer to all liquids, semi-solid and solid foods other than breast milk, and infant formulae which are fed to infants during the weaning process

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